Statistik / Statistics

Nordelstatistiken för 1981 är delvis preliminär. Vanligtvis är de justeringar som måste göras små. De införes i nästa års statistik.

Definitioner

I Nordels definitioner har de använda uttrycken följande betydelse:

Installerad maskineffekt i en kraftstation angives i MW och är summan av de enskilda aggregatens nominella effekt, inklusive stations- och reservenheter.

Överföringsförmåga för en kraftledning är den effekt i MW, som ledningen med hänsyn till en eventuell begränsning härrörande från de anslutna anläggningsdelarna kan överföra under normala förhållanden.

Elproduktion angives i GWh och är den produktion, som vederbörande land uppger i sin officiella statistik.

Mottrycksproduktion är elektrisk energi, som produceras i en turbogenerator med ånga, som efter turbinen används till ett annat ändamål än elproduktion, till exempel fjärrvärme, industriånga etc.

Kondenskraftproduktion är elektrisk energi, som produceras i en turbogenerator med ånga, som efter turbinen kondenseras så att ångans energi uteslutande utnyttjas till elproduktion.

Import och export av elektrisk energi angives i GWh och är de energimängder, som avräknas som köp och försäljning mellan de respektive länderna. Nettoimport är skillnaden mellan import och export.

Bruttoförbrukning av elektrisk energi angives i GWh och är summan av elproduktion och nettoimport.

Nettoförbrukning av elektrisk energi angives i GWh och är summan av de energimängder, som är levererade till och uppmätta hos förbrukarna samt de energimängder, som produceras i industrin för eget bruk.

Förluster är skillnaden mellan bruttoförbrukning och nettoförbrukning.

Tillfällig kraft till elpannor är elektrisk energi, som används för framställning av ånga i stället för olja eller annat bränsle, och som levereras på speciella villkor.

Magasinskapacitet för ett vattenmagasin angives i GWh som den energimängd, som kan produceras i de nedanför liggande kraftverken vid en engångstömning av fullt magasin.

The Statistical data for 1981 are preliminary. The necessary adjustments, which are usually small, will be made in the next annual report.

Definitions

Used expressions have the following meanings according to Nordel definitions.

Installed capacity is the installed generating capacity of a power station 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 is the exchange of power 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.

Magasinsinnehåll vid en given tidpunkt angives i GWh som den energimängd, som kan produceras i de nedanför liggande kraftverken av magasinets vatteninnehåll över lägsta reglerade vattenstånd.

Magasinsfyllnadsgrad vid en given tidpunkt angives i procent som förhållandet mellan magasinsinnehåll och magasinskapacitet.

Storage contents of a reservoir at 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 given time is given as a percentage of the total reservoir capacity in terms of GWh.

Enheter

Effekt	=energi per tidsenhet
kW	=kilowatt
MW	=megawatt=1000 kW
kVA	=kilovoltampere
MVA	=megavoltampere=1000 kVA
Energi	=produkten av effekt och tid
J	=Joule
kJ	=kilojoule=0,24 kcal
TJ	=terajoule=10^{12} J=23,9 toe
PJ	=petajoule=10^{15} J
kWh	=kilowattimme=3600 kJ
MWh	=megawattimme=1000 kWh
GWh	=gigawattimme=1 million kWh
TWh	=terawattimme=1000 GWh =1 miljard kWh
Mtoe	=1 miljon-ton-olje ekvivalent motsvarar 11,63 TWh

Symboler

- – Värdet noll
- ○ Mindre än hälften av den använda enheten
- ●● Uppgift inte tillgänglig eller alltför osäker för att anges
- ● Uppgift kan inte förekomma

Units

Power	=energy per time
kW	=kilowatt
MW	=megawatt=1000 kW
kVA	=kilovoltampere
MVA	=megavoltampere=1000 kVA
Energy	=the product of power and time
J	=Joule
kJ	=kilojoule=0.24 kcal
TJ	=terajoule=10^{12}=23,9 toe
PJ	=petajoule=10^{15} J
kWh	=kilowatt-hour=3600 kJ
MWh	=megawatt-hour=1000 kWh
GWh	=gigawatt-hour=1 million kWh
TWh	=terawatt-hour=1000 GWh=10^{9} kWh
Mtoe	=1 million tons of oil equivalent corresponds to 11.63 TWh

Symbols

- – Magnitude zero
- ○ Magnitude less than half of unit employed
- ●● Data not available
- ● Category not applicable

Installerad effekt

Den sammanlagda installerade effekten i Nordelländerna steg under 1981 med 4 411 MW till 69 949 MW, dvs med 6,7 %. Den installerade effekten i vattenkraftstationer utgjorde ca 56 %. I Sverige och Finland fanns vid årets utgång totalt 8 625 MW kärnkraft.

Fördelningen mellan vatten- och värmekraft är mycket olika Nordelländerna emellan. I Danmark användes nästan enbart värmekraft och i Norge nästan enbart vattenkraft. På Island dominerar vattenkraften medan Sverige har ungefär lika stor effekt installerad i vatten- och värmekraft. I Finland utgör värmekraften ca tre fjärdedelar av den installerade effekten.

Installed capacity

In 1981 the total net capacity in the Nordel countries increased by 4 411 MW to 69 949 MW. Of the total capacity 56 % consisted of hydro power. The nuclear capacity was 8 625 MW.

In Nordel the distribution of hydro and thermal power differs considerably. In Denmark the generating plants are almost entirely thermal, where as in Norway they are hydro. In Iceland hydro power predominates while Sweden has an equal amount of thermal and hydro installations. In Finland thermal amounts to around 3/4 of the installed capacity.

Fig 10. Installerad effekt 1981-12-31 och korresponderande medelårsproduktion för installerad vattenkraft
Installed capacity Dec. 31. 1981 and corresponding average-year production by hydro power

	Danmark	Finland	Island	Norge	Sverige	Nordel
Vattenkraft MW Hydro power MW	8	2460	612	21004	14919	39003
Medelårsproduktion, GWh Average-year production, GWh	20	11760	3770	95971	61505	173026
Värmekraft MW Thermal power	7418	8730	137 2)	275	14386	30946
Därav of which						
mottryck, fjärrvärme konv. back pressure, district heating conv.	162	1360	–	–	2338	3860
mottryck, industriell back pressure, industry	105	1480	–	163	881	2629
kondens, process condence, process	–	110	19	53	–	182
kondens, kärn condence, nuclear	–	2200	–	–	6425	8625
kondens, konventionell condence, conventional	6829 1)	2670	–	24	2973	12496
gasturbin, diesel gasturbine, diesel	322	910	118 2)	35	1769	3154
Totalt installerad effekt Total installed capacity 1981 MW	7426	11190	749 2)	21279	29305	69949
1980 MW	6768	11130	670 3)	19553	27417	65538
Nytillskott under 1981 MW Additions in 1981 MW	675	60	79	1726	1934	4474
Bortfall under 1981 Retirements in 1981 MW	17	–	–	–	46	63

1) Inkl. kondensturbiner med uttag för fjärrvärme Incl. condensing turbines with some steam drawn for district heating
2) Härav geotermisk kraft 17 MW Of which 17 MW is geothermal power
3) Härav geotermisk kraft 12 MW Of which 12 MW is geothermal power

Fig 11. Nya aggregat tagna i drift under 1981
New power plant capacity 1981

Kraftslag/ kraftstation Power category/plant	**Nyinstallation under 1981** New units taken into operation			**Total 81-12-31** Total	
	Antal aggr. Number of units	Ny effekt New capacity MW	Ökning av medelårsprod. Increase in average-year production GWh[1]	Inst. netto-effekt Total installed net capacity MW	Medelårs-produktion Total average-year production GWh[1]
Danmark					
Vattenkraft Hydro power	–	–	–	8	20
Konv. värmekraft Conventional thermal power	1	675	k/o	7418	•
Asnæsværket	1	675	k/o	1435	•
Finland					
Vattenkraft Hydro power	3	43	130	2460	11760
Porttipahta	1	35	100	35	100
Konv. värmekraft Conventional thermal power	2	19	•	6530	•
Kärnkraft Nuclear power	–	–	•	2200	•
Island					
Vattenkraft Hydro power	1	70	••	612	3770
Hrauneyafoss	1	70	450	70	450
Konv. värmekraft Conventional thermal power	••	9	•	137	•
Norge					
Vattenkraft Hydro power	••	1644	4984	21004	95971
Sima	2	620	1714	1120	2802
Ulla-Førre	2	380	1598	460	2259
Holen	2	213	310	213	310
Steinsland	2	147	454	147	454
Osa	2	90	314	90	314
Tafjord V	2	80	160	80	160
Kvinen	1	80	219	80	219
Konv. värmekraft Conventional thermal power	4	82	•	275	•
Tofte	1	45	a	45	•
Øye	1	14	g	14	•
Orkla	1	21	g	21	•
Sverige					
Vattenkraft Hydro power	••	60	244	14919	61505
Åsele	1	28	120	28	120
Volgsjöfors	1	20	80	20	80
Konv. värmekraft Conventional thermal power	2	59	•	7961	•
Sundsvall, Korsta	1	56	a	56	•
Kärnkraft Nuclear power	2	1815	•	6425	•
Ringhals B3	1	915	•	2465	•
Forsmark B2	1	900	•	1800	

[1] Endast för vattenkraften. För den konventionella värmekraften anges bränsleslag (o=olja, k=kol, g=gas, t=torv, a=avfall)
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)

Fig 12. Beslutade större kraftstationer Decided large power plants

Kraftslag/ kraftstation Power category/plant	Inst. netto-effekt 81-12-31 Installed net capacity MW	Medelårs-prod. 81-12-31 Average-year production GWh	Beslutad nyinstallation Decided new plants: Antal aggr. Number of new units	Ny effekt New capacity MW	Ökn. av medelårsprod. Increase in average-year production GWh[1]	Beräkn. idrifttagn. Estimated to be brought into service in
Danmark						
Konv. värmekraft Conventional thermal power						
Randersværket	19	–	1	45	k	1982
Herningværket	–	–	1	87	k	1982
Studstrupværket	415	–	2	700	k/o	1984/85
H. C. Ørstedværket	181	–	1	73	k/o	1985
"Hovedstadsområdet"	–	–	1	350	k/o	1988/89
Finland						
Vattenkraft Hydro power						
Anjalankoski	–	–	1	22	90	1983
Vajukoski	–	–	1	21	70	1984
Konv. värmekraft Conventional thermal power						
Kuopio	36	–	1	60	t	1982
Naantali 3[2]	120	–	1	96	k	1982
Inkeroinen	100	–	1	40	g	1983
Salmisaari[3]	92	–	1	140	k	1984
Äänekoski	20	–	1	28	t	1984
Vaskiluoto	160	–	1	160	k alt o	1985
Tampere	128	–	1	60	k	1985
Joensuu	–	–	1	60	t	1986
Jyväskylä	35	–	1	80	t	1986
Island						
Vattenkraft Hydro power						
Hrauneyafoss	70	450	2	140	400	1982
Norge						
Vattenkraft Hydro power						
Sildvik	–	–	1	56	238	1982
Aurland	755	1710	4	142	575	1982/84
Orkla/Grana	–	–	6	318	1100	1982/86
Ulla-Førre	460	2259	7	1500	2088	1982/88
Årøy	4	30	2	91	306	1983
Sørfjord	5	42	1	55	220	1983
Skarje	–	–	1	160	325	1986
Alta	–	–	2	150	687	1987
Kobbelv	–	–	2	300	691	1987
Sverige						
Vattenkraft Hydro power						
Ligga G3	160	777	1	169	–	1982
Messaure G3	300	1834	1	140	–	1983
Stenkullafors	–	–	1	56	223	1983
Stornorrfors G4	410	2019	1	170	125	1985
Konv. värmekraft Conventional thermal power						
Helsingborg	–	–	1	55	k	1983
Norrköping, Händelö	–	–	1	75	k	1983
Kärnkraft Nuclear power						
Ringhals B4	2465	–	1	915	–	1983
Forsmark B3	1800	–	1	1050	–	1985
Oskarshamn B3	1020	–	1	1060	–	1985

[1] Endast för vattenkraften. För den konventionella värmekraften anges bränsleslag (o=olja, k=kol, g=gas, t=torv, a=avfall)
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] Ombyggnad från konv. kondenskraft till fjärrvärme. Nettoändring –24 MW
Reconstruction from conv. condense power to district heating. Net change –24 MW

[3] Bortfall 92 MW, nettoökning 50 MW
Retirements 92 MW. Net additions 50 MW

Det nordiska högspänningsnätet

Sverige har förbindelser med Danmark, Finland och Norge. Mellan Finland och Norge finns enbart ledningar för lokala leveranser från Norge till förbrukare i Finland. Vid årets utgång var den totala överföringsförmågan från Sverige ca 4000 MW och till Sverige ca 3000 MW. Mellan Danmark (Jylland) och Norge finns en likströmsförbindelse med överföringsförmågan 500 MW i vardera riktningen. Södra Jylland har 400, 220 och 60 kV-förbindelser med Västtyskland. Mellan Finland och Sovjetunionen har i år tillkommit en 350 MW likströmsförbindelse. Detta är den första stamnätsförbindelse av denna storleksordning mellan Sovjet och Västeuropa. Sedan tidigare finns en mindre samkörningsförbindelse mellan Norge och Sovjet, och lokala förbindelser mellan Finland och Sovjet. Island är ej elektriskt förbundet med övriga Nordelländer.

The Grid system in the Nordel countries

Sweden is connected to Denmark, Finland and Norway. The latter two countries are not interconnected except for a few lines from Norway to Finland for local consumption there. The total capacity from Sweden was about 4 000 MW and to Sweden about 3 000 MW. The DC cable connection between Denmark (Jutland) and Norway has the capacity of 500 MW in both directions. From southern Jutland there are 400, 220 and 60 kV interconnection links to western Germany. Between Finland and the Soviet Union a new 350 MW DC link has been taken into operation. This is the first main grid connection of this size between the Soviet Union and western Europe. Between Finland and the Soviet Union and between Norway and the Soviet Union there have for many years been a number of local interconnections. Iceland is not electrically connected to the rest of the Nordel countries.

Fig 13. Överföringsledningar (km)
Transmission lines

	400 kV		220, 300 kV		110, 132, 150 kV	
	Tagna i drift under 1981 Brought into service in 1981	I drift 81-12-31 In service 81-12-31	Tagna i drift under 1981 Brougth into service in 1981	I drift 81-12-31 In service 81-12-31	Tagna i drift under 1981 Brought into service in 1981	I drift 81-12-31 In service 81-12-31
Danmark	–	16[1) 2)]	–	275[3)]	77[4)]	3151[5)]
Finland	–	3029	–	2152	450	11250
Island	–	–	9	323	158	938
Norge	243[6)]	994[7)]	174	4571[3) 8)]	150	8170
Sverige	64	8732[1)]	121	5626[3)]	••	13100[9)]

[1)] Inkluderar halva 400 kV kabelförbindelsen (4 km) Sjælland–Sverige
Including half of the 400 kV cable line (4 km) Sjælland–Sweden

[2)] Härav 13 km i drift med 220 kV, 293 km med 150 kV och 48 km med 132 kV
Of which 13 km in service with 220 kV, 293 km with 150 kV and 48 km with 132 kV

[3)] Härav 80 km i Danmark och 96 km i Sverige (Konti-Skan) samt 89 km i Danmark och 151 km i Norge (Skagerak) i drift med 250 kV likström
Of which 80 km in Denmark and 96 km in Sweden (Konti-Skan) and 89 km i Denmark and 151 km in Norway 'Skagerak) with 250 kV DC

[4)] Härav 9 km i drift med 50 kV
Of which 9 km with 50 kV

[5)] Härav 23 km i drift med 60 kV och 96 km med 50 kV
Of which 23 km with 60 kV and 96 km with 50 kV

[6)] Härav 11 km sjökabel och 50 km i drift med 132 kV
Of which 11 km of submarine cable and 50 km with 132 kV

[7)] Härav 82 km i drift med 132 kV
Of which 82 km with 132 kV

[8)] Härav 61 km i drift med 66 kV
Of which 61 km with 66 kV

[9)] Värde för år 1979
1979 value

Fig 14. Det nordiska högspänningsnätet

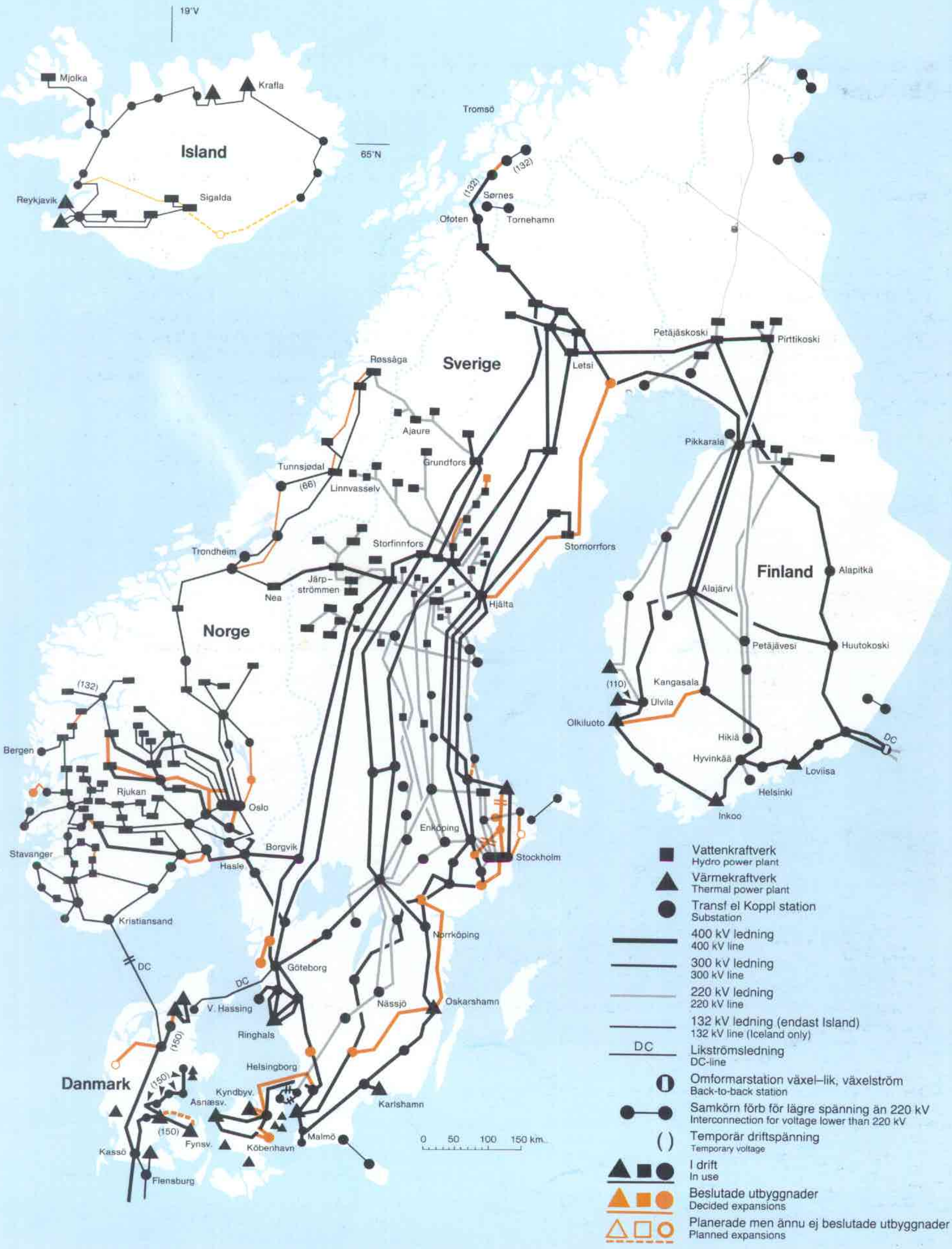


Fig 15. Samkörningsförbindelser mellan Nordelländerna
Interconnections between the Nordel-countries

Länder Countries	**Stationer** Terminal stations	**Nominell spänning** Rated voltage kV	**Överföringsförmåga** Transmission capacity MW		**Längd** Length km	**Kabel** Cable km
			Från Danmark From Denmark	Till Danmark To Denmark		
Danmark–Norge	Tjele–Kristiansand	±250=	510	510	240/pol	127/pol
			Från Sverige From Sweden	Till Sverige To Sweden		
Danmark–Sverige	Teglstrupgård–Sofiero	132	350[1]	350[1]	23	10[2]
	Hovegård–Helsingborg	400	700[1]	700[1]	91	8
	Vester Hassing–Göteborg	250=	260	260	176	87,5
	Hasle (Bornholm)–Borrby	60	60	60	47,6	43,3
Finland–Sverige	Ossauskoski–Kalix	220	} 900	} 400	93	
	Petäjäskoski–Letsi	400			230	
	Pikkarala–Messaure	400			423	
	Hellesby (Åland)–Skattbol	70	35	35	76,5	56
Norge–Sverige	Sørnes–Tornehamn	132	} 200	} 200	39	
	Ofoten–Ritsem	400			58	
	Røssåga–Ajaure	220	260[3]	100[3) 4)]	117	
	Linnvasselv[5]	220/66	50	50	–	
	Nea–Järpströmmen	275	500[3]	400[3]	100	
	Hasle–Borgvik	400	} 1000[3) 6)]	} 800[3) 6)]	106	
	Hasle–Trollhättan	400			135	
Totalt			4475	3515		
Beslutad: Decided:			Från Sverige From Sweden	Till Sverige To Sweden		
Danmark–Sverige	Hovegård–Helsingborg (1985)	400	[7]	[7]	91	8

1) Även vid parallelldrift är totala överföringsförmågan 700 MW i vardera riktningen
At parallel operation of the interconnections the total transmission capacity amounts to maximum 700 MW in both directions

2) Kabelsträckan består av fyra trefaskablar som är parallellkopplade två och två
The cable line consists of four three-phase cables which are parallel connected two by two

3) Med hänsyn till slingdriften över flera samkörningsförbindelser Norge–Sverige och vissa andra driftsituationer kan dimensionerande felfall ge en lägre överföringsförmåga
Transmission capacity is in some cases reduced by dimensioning fault case

4) 100 MW gäller vid maximal produktion i Gejmån–Ajaure–Gardikfors. Vid minimiproduktion i dessa stationer och maximalt 250 MW produktionsöverskott i Helgeland är överföringsförmågan 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) Samkörningslänken är en 220/66 kV transformator i den norsk–svenska kraftstationen Linnvasselv
The interconnection consist of a 220/66 kV transformer in the Norwegian–Swedish power station Linnvasselv

6) Efter nätutbyggnader i Norge ökar kapaciteten till 1200 MW från Sverige och 1000 MW till Sverige
After extensions in Norway this will increase to 1200 MW Sweden–Norway and 1000 MW Norway–Sweden

7) Överföringsförmågan efter utbyggnaden ännu ej fastställd
Transmission capacity is at present unknown

Fig 16. Maximal belastning 3:e onsdagen i december 1981
Maximum load on the 3rd Wednesday in December 1981

	Max kraftstations-belastning Max power station output		**Installerad nettoeffekt** Installed net capacity	**Max systembelastning** Max system load			
				1980		1981	
	Lokaltid Local time	MW	MW	Lokaltid Local time	MW	Lokaltid Local time	MW
Danmark							
Väster om Stora Bält (ELSAM) West of the Great Belt	17–18	2300	3647	17–18	2501	17–18	2575
Öster om Stora Bält exkl Bornholm (ELKRAFT) East of the Great Belt excl Bornholm	17–18	2170	3616	17–18	2057	17–18	2171
Finland	17–18	6507	11190	17–18	6494	8–9	6889
Island							
Syd-, väst- och nord-Island South, West and North Iceland	10–11	450	691				
Norge							
Söder om (south of) 67,5° N	9–10	15001	20115	9–10	11979	9–10	14414
Norr om (north of) 67,5° N	10–11	790	1164	14–15	766	10–11	865
Sverige	8–9	18819	29305	8–9	17489	8–9	19117
Nordel exkl Island (excl Iceland) Mellaneuropeisk tid Central-European time	8–9	45298	69037	8–9	40834	8–9	45636

Elenergiomsättning

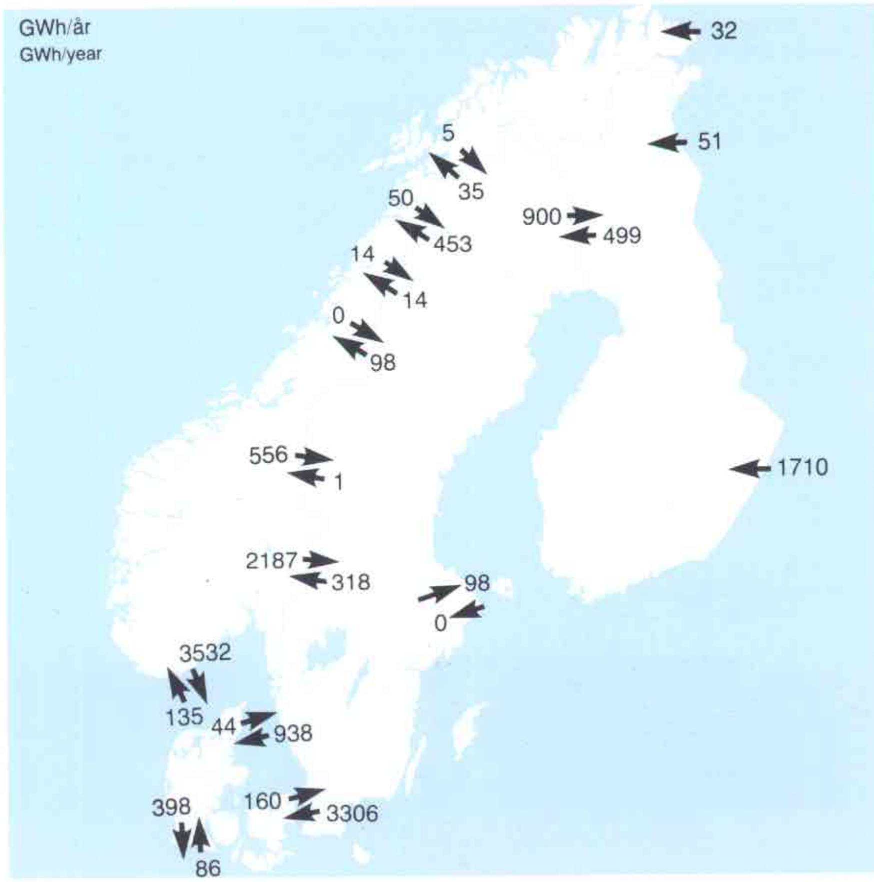


Fig 17. Översikt över omsättningen av elektrisk energi i Nordel 1981
Review of the electric energy turnover in Nordel 1981

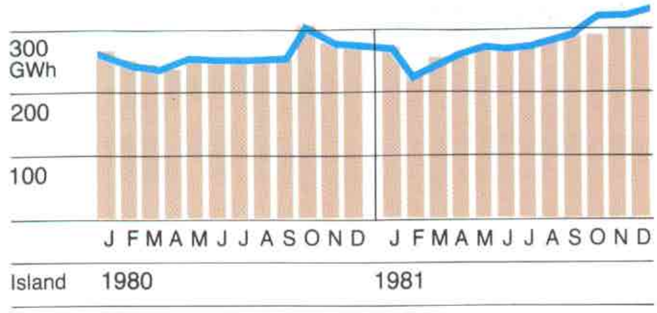
Fig 18. Elenergiomsättningen 1981 (GWh)
Electric energy turnover in 1981

	Danmark	Finland	Island	Norge	Sverige	Nordel
Produktion Production	16881	39075	3258	92770	100008	251992
Därav vattenkraft Of this hydro power	20	13424	3085	92693	58821	168043
Import	7862	2759	•	1086	3515	1879
Total produktion och import Total production and import	24743	41834	3258	93856	103523	267214
Export	737	499	•	6344	6161	398
Bruttoförbrukning Gross consumption	24006	41335	3258	87512	97362	253473
Tillfällig kraft till elpannor etc. Excess hydro power for electric boilers etc.	•	32	•	3120[1)]	••[2)]	••[2)]
Bruttoförbrukning exkl. tillfällig kraft till elpannor etc. Gross consumption excl. excess hydro power for electric boilers etc.	24006	41303	3258	84392	97362	250321
Förändring från 1980 % Change as against 1980 %	−1,1	3,5	3,7	2,9	3,5	2,8

1) Därav pumpkraft 600 GWh
Of this pumped storage power 600 GWh

2) Statistik finnes endast fr o m juli 1981
Statistical data available from July 1981 only

Fig 19. Produktion och bruttoförbrukning exkl avkopplingsbara elpannor
Production and gross consumption excl excess hydro power to electric boilers



Elproduktionen

Den totala produktionen inom Nordel var 1981 ca 252 TWh, en ökning med 3,5 % jämfört med 1980. Vattenkraften svarade för ca 67 % och kärnkraften för 20 %. Motsvarande siffror för 1980 var 64 resp 13 %.

Electricity production

The total production in Nordel was 252 TWh in 1981. This is an increase of 3.5 % compared to 1980. Hydro power amounted to 67 % (64) and nuclear power to 20 % (13) of the total production.

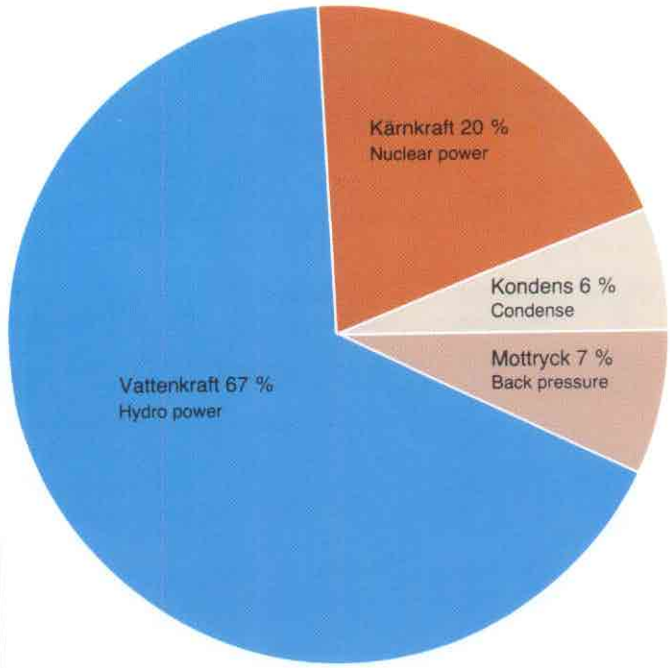


Fig 20. Totala elproduktionen i Nordel
Total electricity production within Nordel

Fig 21. Elproduktion (GWh)
Electricity production

	Danmark	Finland	Island	Norge	Sverige	Nordel
Vattenkraft 1981 Hydro power	20	13424	3085	92693	58821	168043
Vattenkraft 1980 Hydro power	20	10115	3053	83963	57696	154847
Värmekraft 1981 Thermal power						
Mottryck, fjärrvärme Back pressure, district heating	2900	3753	•	–	1830	8483
Mottryck, industri Back pressure, industry	260	5485	•	37	2810	8592
Kondens, process Condense, process	–	405	8	–	–	413
Kondens, kärn Condense, nuclear	•	13971	–	•	36036	50007
Kondens, konventionell Condense, conventional	13588	1972	•	18	230	15808
Gasturbin, diesel m.m. Gas turbine, diesel etc.	113	65[1)]	165[2)]	22	281	646
Värmekraft 1981 Thermal power	16861	25651	173[2)]	77	41187	83949
Värmekraft 1980 Thermal power	23856	28595	89[3)]	137	35885	88562
Total produktion 1981 Total production 1981	16881	39075	3258	92770	100008	251992
Total produktion 1980 Total production 1980	23876	38710	3142	84100	93581	243409
Förändring i procent Increase, per cent	−29,3	0,9	3,7	10,3	6,9	3,5

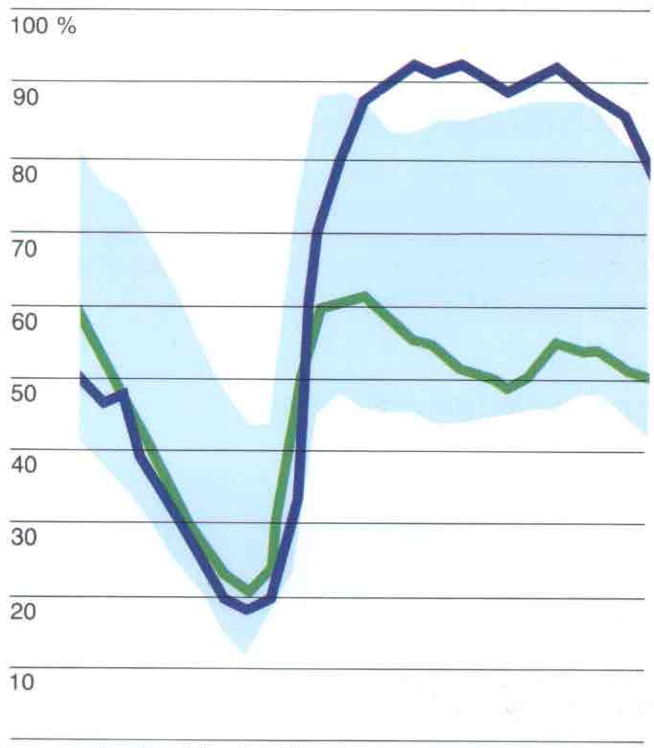
1) Därav 59 GWh med naturgas Of this 59 GWh from natural gas
2) Därav 123 GWh geotermisk kraft Of this geothermal 123 GWh
3) Därav 44 GWh geotermisk kraft Of this geothermal 44 GWh

Fig 22. Magasinsfyllnad

Kurvorna visar magasinsfyllnaden i % av helt fyllda magasin under åren 1980 och 1981. De övre och undre begränsningskurvorna för de senaste årens magasinsvariationer är markerade. Begränsningskurvorna är högsta respektive lägsta veckovärden under tioårsperioden 1971–1980.

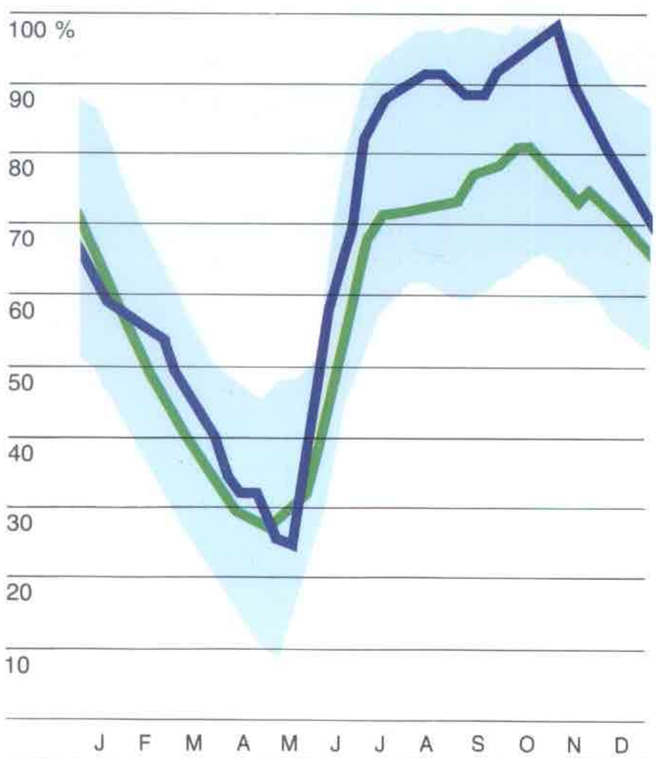
Water reservoir

The curves show the impounded water in per cent of total storage capacity for 1980 and 1981. The field gives upper and lower extremes which are composed of the weekly maxima and minima recorded for the ten-year-period 1971–1980.

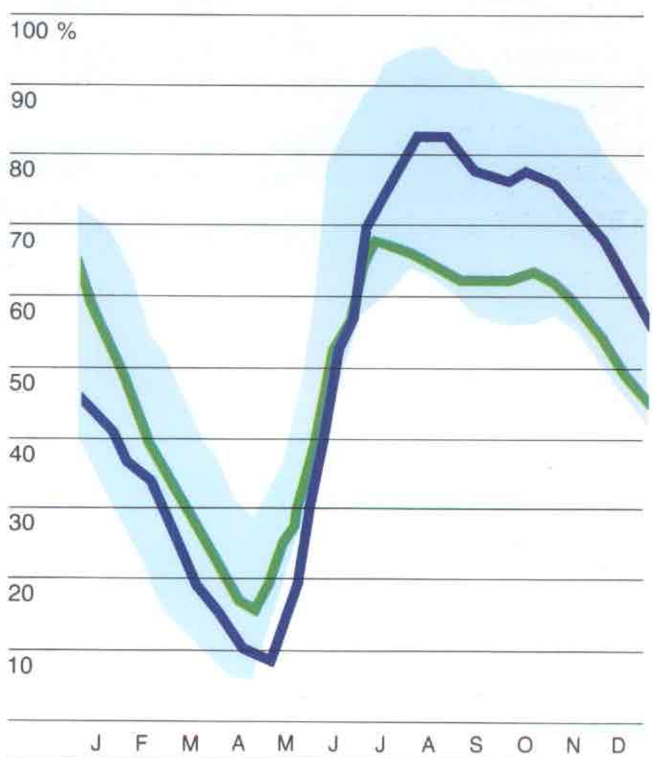


Finland — Magasinskapacitet / Reservoir capacity — 1981-01-01 4425 GWh, 1981-12-31 4425 GWh

1980
1981
Extrema värden / Extreme values (1971-01-01–1980-12-31)



Norge — Magasinskapacitet / Reservoir capacity — 1981-01-01 58312 GWh, 1981-12-31 61547 GWh



Sverige — Magasinskapacitet / Reservoir capacity — 1981-01-01 32210 GWh, 1981-12-31 32410 GWh

Elenergiutbytet

Kraftexporten från Norge och Sverige ökade kraftigt jämfört med föregående år. Finlands import ökade, men ej i så hög grad som Danmarks.

Tabellvärdena avser det avräknade kraftutbytet. Om ett land exporterar el på en samkörningslinje, och samtidigt importerar motsvarande kvantitet el på en annan linje från samma land, medräknas båda utbytena i export- och importangivelserna.

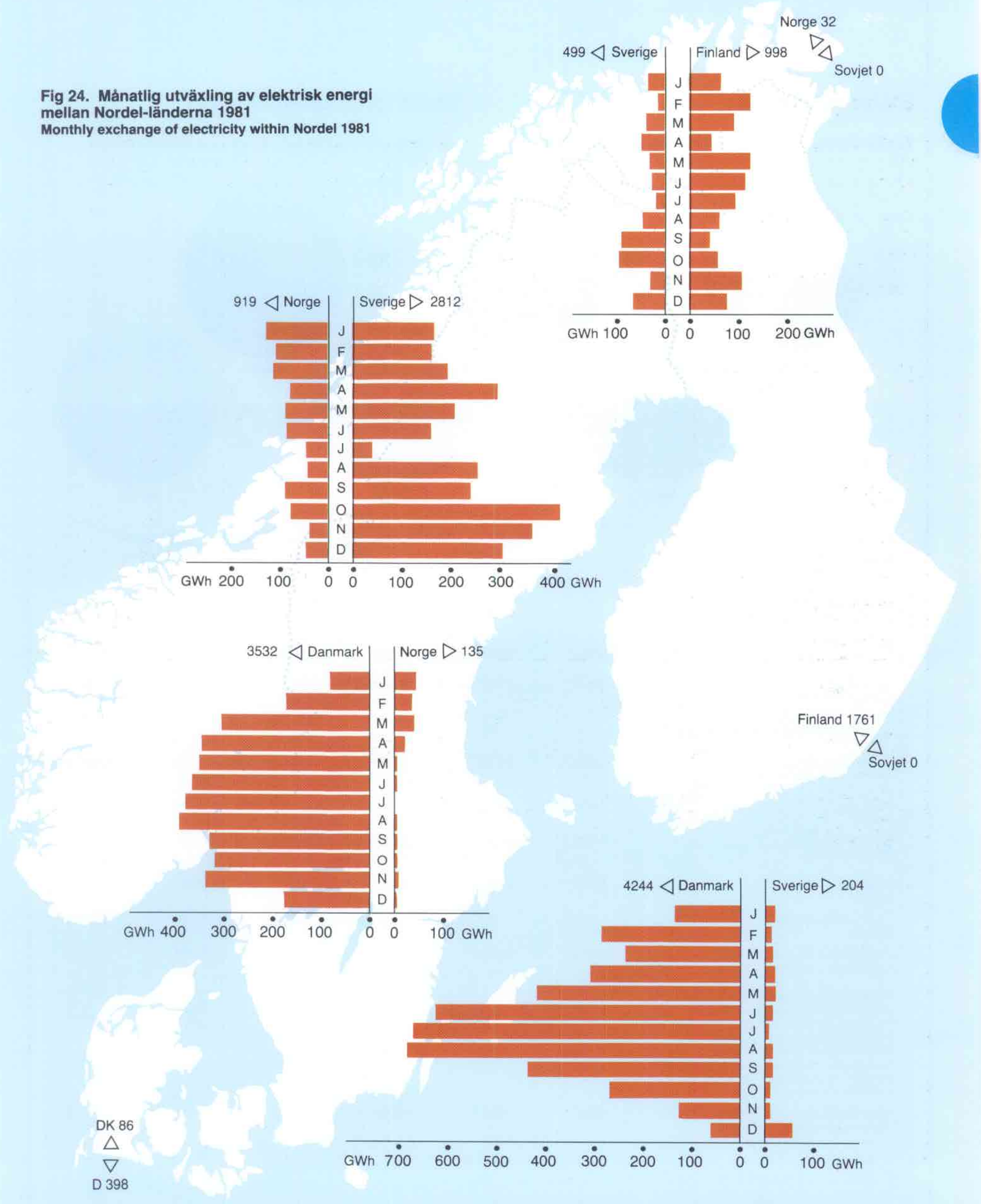
Power exchange

The electrical energy export from Norway and Sweden increased considerably compared to 1980. The import to Finland increased but not as much as the import to Denmark.

Fig 23. Elenergiutbyte 1981 (GWh)
Exchange of electric energy in 1981

Export	Import till / Import to	Danmark	Finland	Norge	Sverige	Nordel-länder / Nordel countries	Andra länder / Other countries	Total Export 1981	Total Export 1980
Export från: / Export from:									
Danmark		•	•	135	204	339	398	737	1593
Finland		•	•	–	499	499	–	499	1163
Norge		3532	•	•	2812	6344	–	6344	2251
Sverige		4244	998	919	•	6161	–	6161	2834
Nordel-länder / Nordel countries		7776	998	1054	3515	13343	398		
Andra länder / Other countries		86	1761	32	–	1879			
Total import	1981	7862	2759	1086	3515				
	1980	1979	2374	1787	3366				
Nettoimport	1981	7125	2260	–5259	–2646				
	1980	406	1211	–464	532				
Nettoimport/ bruttoförbrukning i % / Net import/gross consumption in per cent	1981	29,7	5,5	–6,0	–2,7				
	1980	1,7	3,0	–0,6	0,6				

Fig 24. Månatlig utväxling av elektrisk energi mellan Nordel-länderna 1981
Monthly exchange of electricity within Nordel 1981



Elförbrukningen

Electricity consumption

Fig 25. Elförbrukning fördelat på konsumentgrupper

Electricity consumption distributed on consumer groups

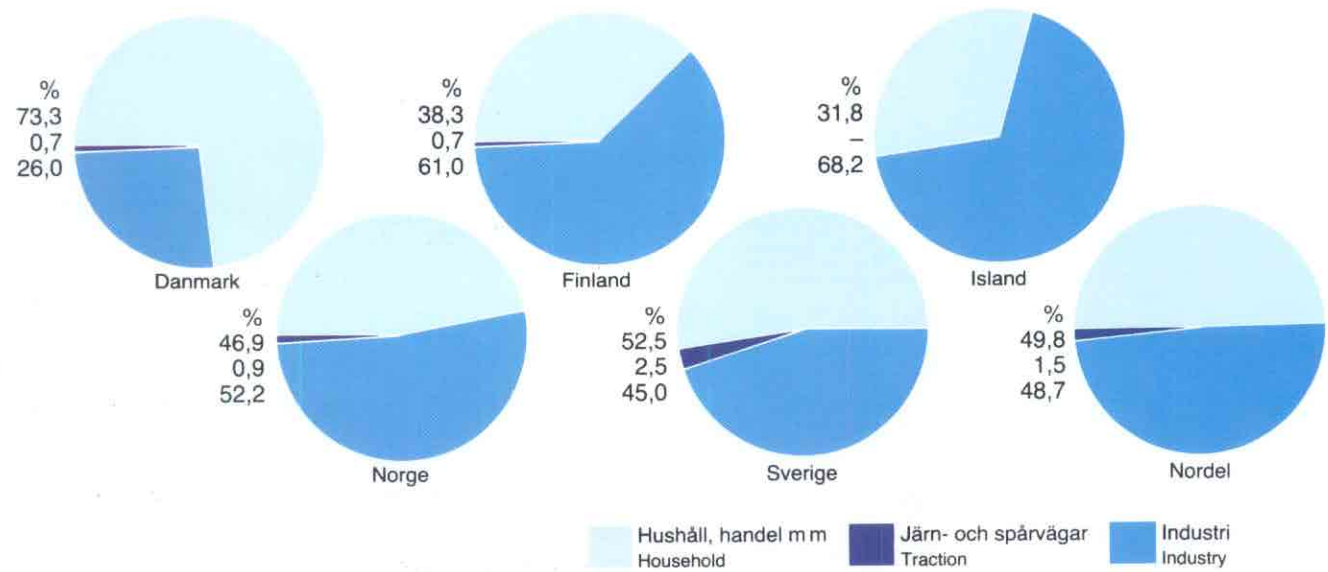


Fig 26. Elförbrukning 1981, GWh
Electricity consumption 1981

	Danmark	Finland	Island	Norge	Sverige	Nordel
Bruttoförbrukning Gross consumption	24006	41335	3258	87512	97362	253473
Tillfällig kraft till elpannor Excess hydro power to electric boilers	–	32	–	3120[2]	●●[3]	●●[2)3)]
Bruttoförbrukning[1] Gross consumption	24006	41303	3258	84392	97362	250321
Förluster Losses	2506	2303	302	8725	8473	22309
Nettoförbrukning Net consumption	21500	39000	2956	75667	88889	228012
Industri Industry	5600	23800	2017	39500	40041	110958
Järn- och spårvägar Traction	145	265	–	700	2261	3371
Hushåll, handel m.m. Households, trade etc	15755	14935	939	35467	46587	113683
Förändring av bruttoförbrukningen jämfört med föregående år i %[1] Increase in gross consumption as against previous year, %	–1,1	3,5	3,7	2,9	3,5	2,8
Genomsnittlig förändring av bruttoförbrukningen under de sista 10 åren i %[1] Average increase in gross consumption in the last 10 years, %	4,4	5,8	7,4	3,7	3,7	4,2
Bruttoförbrukning per invånare i kWh[1] Gross consumption per inhabitant	4700	8603	14040	20620	11701	11240

1) Exkl. tillfällig kraft till elpannor Excl. excess hydro power to electric boilers.

2) Därav pumpkraft 600 GWh Of which pumped storage power 600 GWh.

3) Statistik finnes endast fr o m juli 1981 Statistical available from July 1981 only.

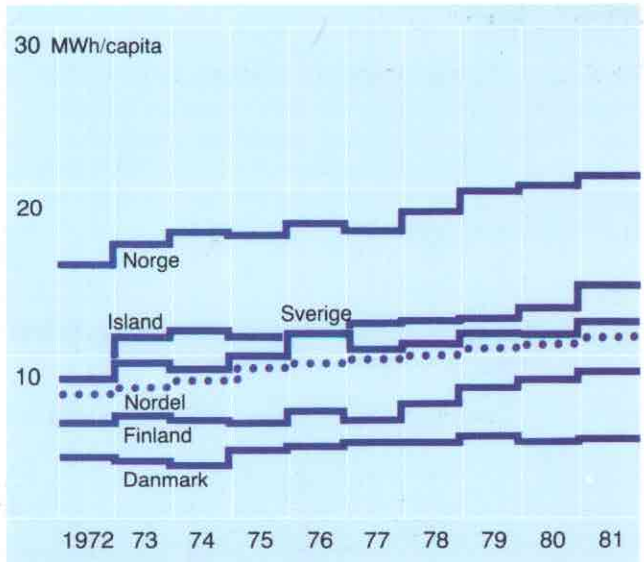


Fig 28. Bruttoförbrukning[1] av elenergi per invånare
Per capita consumption

[1] Exkl tillfällig kraft till elpannor
Excl. excess hydro power to electric boilers

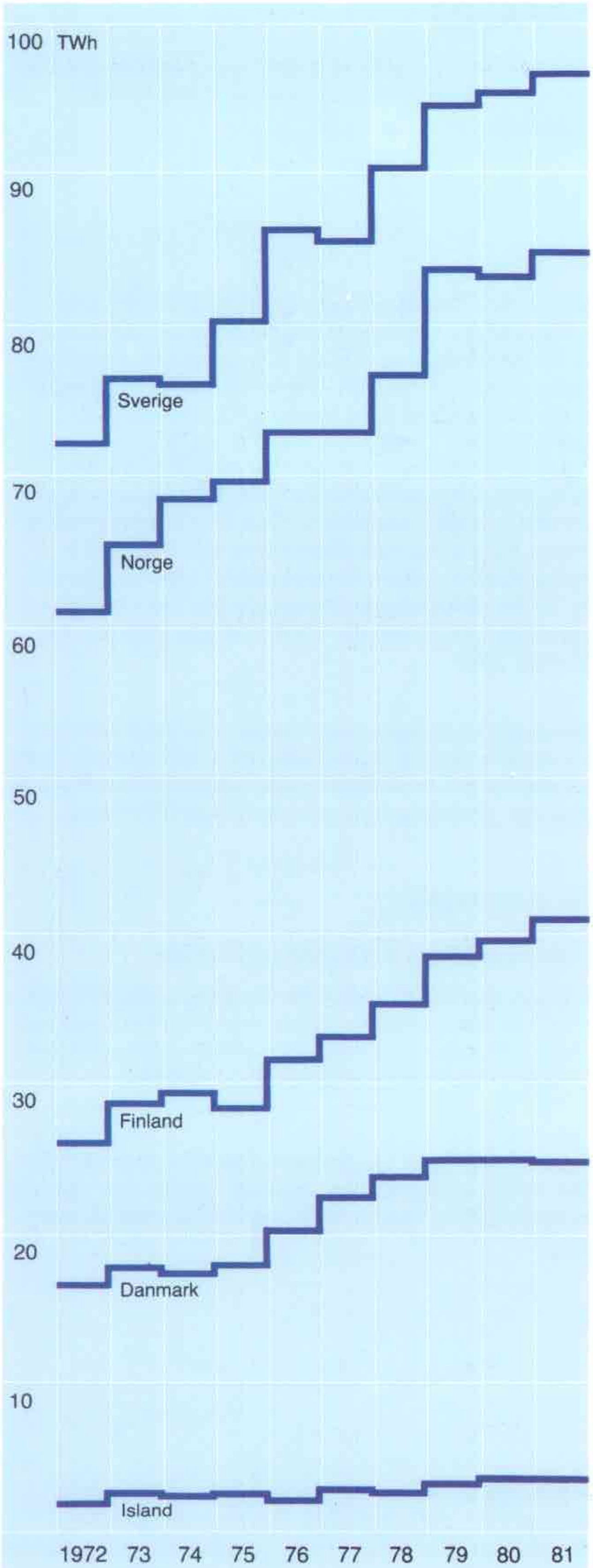


Fig 27. Bruttoförbrukningen[1] av elenergi 1972–1981
Gross consumption of electricity 1972–1981

[1] Exkl tillfällig kraft till elpannor
Excl. excess hydro power to electric boilers

Prognoser

Prognoserna för åren 1985 och 1990 bygger på kraftföretagens egna värderingar om den sannolika utvecklingen. Prognoserna ligger till grund för utbyggnadsplaneringen av kraftöverföringssystem och produktionsanläggningar. Om den faktiska utvecklingen är lägre än prognoserna kan justeringar enkelt göras.

Fig 29. Faktisk och prognoserad elenergiförbrukning TWh/år
Electrical energy consumption, and forecast TWh/year

	1981	1985	1990
Danmark	24,0	26	31
Finland	41,3	49	57
Island	3,3	4	4,5
Norge	84,4	92	105
Sverige	97,4	114	130
Nordel totalt	250,4	285	328

Fig 30. Faktiska och prognoserade effekter MW
Power, and power forecast MW

	1981	1985	1990
Danmark	4760	5300	6300
Finland	7100	8500	9900
Island	530	635	755
Norge	15800	16600	19200
Sverige	19640	20800	23700
Nordel totalt	47830	51835	59855

Fig 31. Faktiska och prognoserade installerade effekter i MW inom respektive land (värden per 31.12 respektive år)
Installed and forecasts for installed capacity in MW in each country (valid per Dec. 31.)

	1981	1985	1990
Danmark	7426	8350	8400
Finland	11190	11650	12450
Norge	21279	23700	27100
Sverige	29305	33050	34500
Nordel exkl Island	69200	76750	82450

Forecasts

The forecasts for 1985 and 1990 in the following tables are made by the power companies in the Nordel countries.

Fig 32 visar den faktiska elenergitillförseln 1980 samt prognoser för 1985 och 1990. De olika Nordelländerna utom Island visas var för sig. Uppdelning har skett på kategorierna vattenkraft, kärnkraft och annan värmekraft med angivande av de olika bränsletyperna. Vattenkraften i prognosen avser medelårsproduktion. För Norges del innebär detta betydande mängd tillfällig kraft som kan utnyttjas i inhemska elpannor och/eller exporteras. Den norska kraftproduktionen förutsättes vara dimensionerad med en extra fastkraftreserv utöver förbrukningsprognosen, jämför fig 29. Produktionspotentialen för fast kraft inkl importrättigheter förmodas bli 99 TWh/år 1985 och 112 TWh/år 1990.

Elenergifördelningen visas i jämförelse med ländernas energiförbrukning utanför elsektorn. För varje år visas två staplar per land. Den vänstra anger fördelningen av elenergi. Den högra visar övrig energiförbrukning.

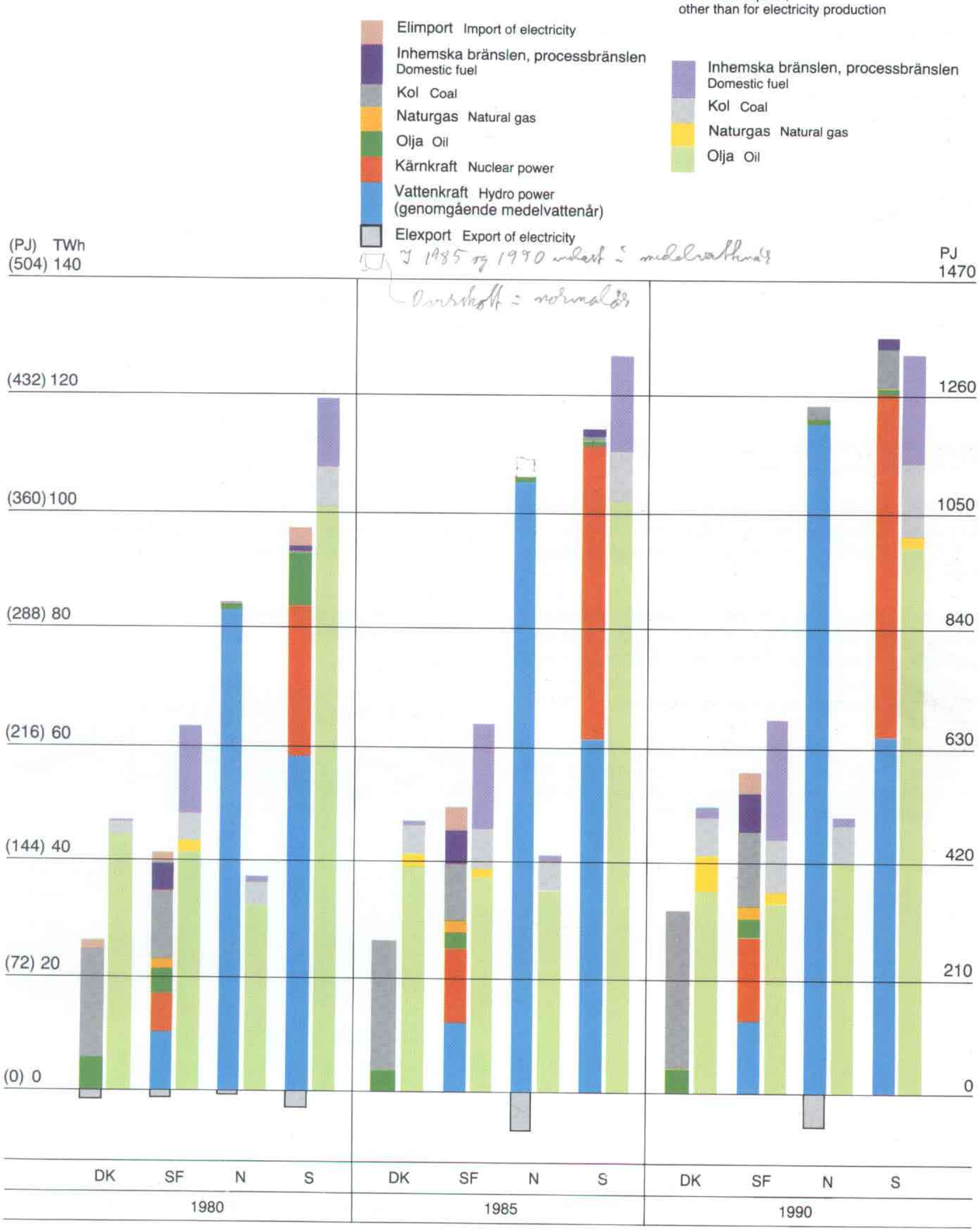
För skalorna gäller:

- vänstra skalan i TWh gäller eltillförseln
- högra skalan i PJ gäller för övrig energiförbrukning, och är vald så att den också visar vilka bränslemängder som åtgår till produktion av den elektricitet som ingår i den vänstra stapeln (10,5 PJ/TWh).

Figuren möjliggör en jämförelse mellan elsektorn och den övriga energisektorn. Speciellt tydligt visar figuren vattenkraftens dominerande roll i norsk energiförsörjning.

Figure 32 shows the energy supply in 1980 and the forecasts for 1985 and 1990. For each country the distribution of electric energy supply (left) and the total energy supply except electricity (right) is shown.

Fig 32. Energitillgång i Norden
Energy supply within the Nordic countries



Total energitillförsel

I äldre tider var de nordiska länderna i stort sett självförsörjande på energi. Ved var den främsta energiråvaran fram till en god bit in på 1800-talet. Från omkring år 1900 började kol och koks att svara för en större del av energiförsörjningen än ved. Omkring 1950 övertog oljan kolets roll som den viktigaste energiråvaran.

Under 1800-talets senare del började vattenkraften användas för elproduktion, och sedan dess har elandelen i energiförsörjningen ökat ganska jämnt.

I början av 1970-talet introducerades kärnkraft i Finland och Sverige och den svarar nu för en betydande del av elförsörjningen i Norden.

Efter oljekrisen 1973 har målet varit att minska oljeberoendet. Detta har bl a resulterat i att kol har kommit tillbaka och har börjat ersätta olja.

Idag är alltså Norden långt ifrån självförsörjande på energi och en övervägande del av bränslet importeras främst i form av olja och kol.

De inhemska energiråvaror, som är av någon större betydelse, är förutom vattenkraften ved, torv (Finland), kol (Svalbard, Norge) och geotermisk energi (Island).

Olje- och gasfyndigheter finns i de nordiska delarna av Nordsjön och från 1974 har de norska fyndigheterna utvecklats till en årsproduktion av 23,3 miljoner ton olja och 25,8 miljarder kubikmeter gas under 1981. Tillsammans motsvarar detta cirka 2 000 PJ.

Figuren visar energitillförselns utveckling i Danmark, Finland, Norge och Sverige under tioårsperioden 1972–81. Vattenkraft och kärnkraft är omräknade efter det teoretiska energiinnehållet, dvs 1 TWh=3,6 PJ.

Total energy supply

Long ago the Nordel countries were self-supporting for their energy supply. The main energy source was wood. Later a change occured and coal became the prime source. From about 1950 oil was the most common source of energy.

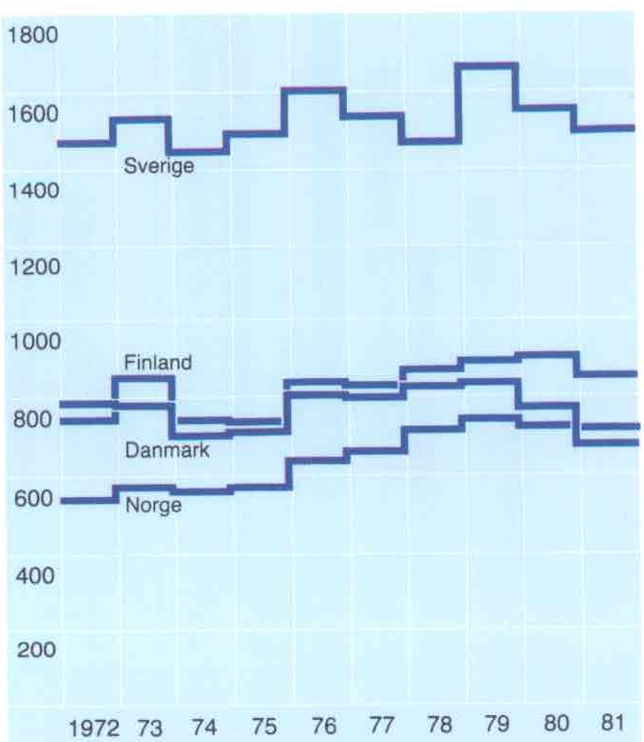
About a century ago hydro power was introduced and it now accounts for an important share. Nuclear power came about 1970 and is very significant in Finland and Sweden.

Today the Nordel countries for their energy supply are highly dependent on imported oil and coal. However, since the oil crises in 1973 the goal has been to became less dependent on imported energy.

The domestic sources of energy in the Nordel countries are hydro power, wood, peat, coal on Svalbard, Norway and geothermical energy on Iceland. The oil and gas from the north-sea in 1981 amounted to 23.3 miljon tons of oil and 25.8 billion m³ of gas.

The figure shows the energy supply in the Nordel countries during the period 1972–1981. Hydro and nuclear power are valued according to their theoretical energy content, i.e. 1 TWh=3.6 PJ.

Fig 33. Total energitillförsel PJ
Total energy supply



English Summary

Nordel 1981

In 1981 and especially during the summer the power situation in the Nordel countries was very positive. Unusually great amounts of electrical energy was exchanged between the countries. Denmark, for example, imported one third of the electrical consumption in 1981. Within Nordel the gross consumption rose by 2.8 % compared to 1980. There was a great variation between the countries from a 1.1 % drop in Denmark to an increase of 3.7 % on Iceland.

The production system was extended with some new nuclear units and nuclear energy now gives an important contribution to the Nordel energy balance and keeps the oilfired production down.

Nordel's Activities in 1981

The ordinary annual meeting of Nordel was held at Bäckaskog in South Sweden on September 3. An extra meeting was held in Copenhagen on the 3rd of March.

At the meetings the actual power situation within the five Nordic countries and future prospects were reviewed. Besides, there were reports from a number of the committees and ad hoc working groups being responsible for and coordinating the work wihtin Nordel, and from Nordel's representatives and contact groups wihtin various international organizations.

Operations committee

As in previous years, the committee continued to deal with current questions related to joint operations, such as the power situation in the Nordic countries, as well as with operational reliability and breakdowns in the Nordic power grid.

Output and energy balances covering the next 2–3 years have been prepared as a basis for evaluation of the power situation during this period.

Exchanges of temporary excess power between countries have for many years been subject to an agreed maximum surcharge on the seller's marginal production cost. This price ceiling was raised during 1979 from SEK 35/MWh to SEK 50/MWh. The committee continued to discuss the level of this price ceiling during the year. These discussions led to an additional increase, to SEK 75/MWh. However, a country with long-term shortages of power or energy has the right to a reduction to SEK 50/MWh.

Pricing principles for standard exchanges of power were also discussed in connection with talks on price ceilings. The principles recommended by Nordel in 1971 will be followed until further notice, but a number of alternatives were discussed.

There were no serious disturbances in Nordic joint operations during the year. In the light of the physical fluctuations in power during 1980, Nordel assigned the Committee the task of arranging a symposium on stability in cooperation with the Planning Committee. This symposium was held in Stockholm at the beginning of February. The participants were specialists in problems referring primarily to operation but also to planning of large scale power systems. Denmark, Finland, Norway and Sweden were each represented by a number of participants. The sympoisum was considered to be successful as well as very constructive and generated guidelines for dealing with anticipated fluctuations during the next few years. Among other things, a review is in progress of the information exchange between control rooms in the Nordic countries, as well as of damping equipment (angular derivative equipment) in power stations.

In the course of the year the Committee continued to deal with technical and administrative questions in connection with joint power reserves that are immediately accessible.

Another important question dealt with in the course of the year was the network protection study. The goal of this study is to achieve better coordination of all automatic adjustments in the event of frequency disturbances. These adjustments can be of various types, including temporary reserves in various types of production plants, automatic start-up of hydro plants and gas turbines, automatic load shedding and automatic variation of power transmitted on DC links.

Nordel's thermal power specifications were discussed during the year. All new plants, no matter how few in number, should comply with the specifications recommended by Nordel. This ensures appropriately designed thermal power stations for the long term future of the total system.

In the course of the year the Committee met with its Continental counterpart (UCPTE) and a valuable exchange of operational experience was obtained.

The next such meeting is planned for 1983.

Low demand conditions during the summer of 1981

Consumption of electricity in the Nordel system has increased very slowly during the past few years. Several new nuclear power stations went into operation last year. During the winter of 1980–81, Nordel's Operations Committee analyzed the power surplus anticipated for the summer of 1981. The Committee authorized minimization of oil-based electricity production and vigorous reduction of the long-term hydro reserves. In Sweden, similar analyses led to the offer of price discounts for some subscribers during the summer holidays, in an effort to redistribute the load to some extent. Planning for introduction of more electric boilers over the next few years was accelerated. In the spring, it was determined that large quantities of precipitation had been accumulated in the form of snow. The amount of precipitation was also greater than normal during the summer.

It is now clear that there was a very large power surplus during the summer despite minimized production of power based on fossil-fuel and vigorous reduction of long-term hydro reserves. The considerable surplus was used in several ways, including maximization of exports on all connections with Denmark and full utilization of electric boilers. A portion of exports to Denmark could not be utilized there and were resold to West Germany.

Nevertheless, a quantity of water corresponding to approximately 2.5 TWh had to be spilled past operational turbines, the greater part of it in Norway. In addition, production at nuclear plants was cut back with reference to the low demand by about 1.8 TWh, most of it in Sweden.

The Operations Committee has discussed power balances for the next few years and has determined that the conditions of the previous summer will prevail for several years even with normal precipitation. Efforts to export power to Denmark and the Continent, to increase deliveries of electric boilers and to redistribute consumption by means of selective rates should continue.

In addition, the maintenance periods for nuclear plants should be even more concentrated. An attempt should also be made to reduce long-term hydro reserves before the onset of the spring floods.

In the judgement of the Operations Committee, power surpluses during future summers will necessitate reduction of nuclear power output and spilling of water past operational hydro power plants despite the implementation of the measures described above.

Planning committee

A book entitled "Energy and Society" has been prepared by the Planning Committee. The book has been approved by Nordel and is now being published in Danish, Finnish, Norwegian and Swedish editions. It describes basic concepts and aspects of energy and the energy flow in a society.

Comprehensive work has been done on a scenario study on the Nordel system extending into the beginning of the next century. Reports on the study were given at the Nordel meetings on March 3rd and September 3rd, 1981. Nordel has commissioned the Planning Committee partly to summarize the material in a comparatively brief report, partly to use the collected material for putting forward some fields suitable for more detailed studies. The work on a brief report is in progress. One subject being studied more in detail is an analyse of the further advantages which could be reached if the co-operating Nordic Power systems could be regarded as one unity. In the scenario study it has proved important to use a common pattern for the descriptions of the energy system in the Nordic countries. Such a pattern usable for total energy and electric energy has been made. It will be supplemented with a brief instruction and also with some special surveys for more detailed information.

A report containing proposals for the transmission capacities of the interconnections at 1985 level was treated at the Nordel meeting on March 3rd, 1981. Nordel agreed to the suggested capacities (shown in the Nordel annual report 1980). The calculations and analyses making the basis of the above mentioned proposal now are being used for forming an estimate of the transmission capacities which can be considered to be valid at 1990 level.

Network analyses as well as production studies have been made with respect to the value of and the need for strengthening the HVDC interconnection between Jutland and Sweden (the Kontiskan transmission). Negotiations about a doubling of this interconnection now are in progress between Denmark and Sweden. In Norway preliminary studies have started of a possible doubling of the HVDC-interconnection between Jutland and Norway (the Skagerak Transmission).

A survey of different heat pumps projects and the use of solar energy either approved or planned in the Nordic countries in which the power companies are involved or of which they are informed, was put forward at the annual meeting of Nordel on September 3rd, 1981. The aim of that report partly is to inform of some installations, partly to make contacts and co-operation easier and to avoid duplications of work. The Planning Committee has the intention to up-date the report at certain intervals. The Planning Committee also has started a survey on the work going on in the fields of wind energy and geothermal energy. The intention also is to include the power companies judgement of the economy for these types of power production. In the future similar surveys are planned to be made for remaining new, renewable energy sources.

An outline of the power balance during the next 10–15 years for the individual Nordic countries and for the whole of Nordel has started.

As a contribution to the present work within the ECE Committee on Electric Power (ECE=Economic Commission for Europe), regarding increased future electricity cooperation between Western and Eastern Europe Nordel has been engaged to make a report on the experience of the HVDC transmission in the Nordic power system. The work is in progress. Besides account of the technical and economical experience from the HVDC transmission the report also briefly will treat the technical design of the HVDC installations. Furthermore, the report will throw light upon some technical views on HVDC transmission compared to HVAC.

For many years a map of the high voltage grid in Western Europe has been produced by UCPTE (Western European cooperation organization) and one of the high voltage grid in Eastern Europe by CMEA (Eastern European co-operation organization). At the instance of ECE Nordel has decided to produce a similar map of the Nordic high voltage grid. The aim is that the map shall be up-dated every second year.

In 1982 the Planning Committee will contribute to Cigré a report on the stability problems in the co-operating Nordel system. The report to a large extent dwells on the damping problems which have been noticed in the system during the last years and describes the methods which will be used to eliminate those problems.

To "ECE Seminar on the Medium Term and Long Term Prospects for the Electric Power Industry" in London (UK), October 26–30, 1981 the Planning Committee had submitted a report on the Nordic electricity co-operation. Representatives of the Committee took part in the seminar.

The Planning Committee also was represented at a seminar arranged by the Nordic Council in Södertälje, November 10–11, 1981. The subject for this seminar was "Energy in the Nordic countries – economy, environment and supply security".

Thermal power committee

The committee has held two meetings during the year and the following questions and reports were discussed:

In the annual report from the working group on nuclear fuel the continued decline in the prices of nuclear fuel and accompaning services is notified. The report also describes how nuclear waste is beeing treated in the different countries. The report has been distributed also outside Nordel.

The working group on operation and maintenance has arranged two seminars during the year, one for mechanical maintenance personal and one for personal working with instrumentation. In the future these activities will be directed towards the excecutives of the power plants. The group also produces the yearly report "Availability for Thermal Power" and deals with operational problems in the plants.

An ad-hoc workinggroup (the R & D group) has given its final report. It sais that the R & D work that is going on at the different power companies is adequate and well distributed.

A survey of the costs of different types of power production has also been produced. The work with the Nordel specifications for thermal power stations is going on.

In Finland a seminar on the fluid-bed technics has been arranged by the committee.

The collaboration with the Nordic Liaison Committee for Atomic Energy (NKA) continues.

Denmark

Economic development and energy consumption

As in the previous year, Danish economy showed a downward tendency in 1981. The decline was most profound in housebuilding and business investments, but also the GNP and private consumtion declined. A result of this development has been a decline in energy consumption. In 1980 consumption of primary energy not used in electricity production plants went down by about 10 % (6 %). Much of this development was, however, due to the endeavours to obtain a more rational utilization of the energy resources.

In the 1981 consumption of electricity went down by 1.1 % to 24.0 TWh.

In late 1980 and during the first six montsh of 1981 the dollar rate increased tremendously. This increase heavily affected fuel prices and electricity prices. By the end of 1981 dollar rate as well as fuel prices were steadying. Because of this a less violent price development may be expected in the year to come.

From Januari 1981 to January 1982 the average price of electricity increased from about 67 öre/kWh to about 77 öre/kWh. Taxation and value-added tax accounts for about 25 öre/kWh of this price.

Electricity production

The stagnant electricity consumption together with a peak in the volume of imports of electricity from Norway and Sweden resulted in a considerable production decline in the coal and oil-fired Danish power plants: From 23.9 TWh in 1980 to 16.9 TWh in 1981. Of this production 87 % was based on coal, the remainder on oil. The conversion from oil to coal-firing has thus almost been completed.

In early 1981 Skærbækværket unit 2 of 269 MW was put into operation after conversion to coal-firing and by the end of the year the new coal-fired 675 MW unit, Asnæs 5, was commissioned.

Another two units, Vendsysselværket unit 1 of 133 MW and Stigsnæs unit 1 of 143 MW are being converted to coal-firing. The units are expected to be put into operation in 1982 and in early 1983, respectively. New units under construction are the backpressure units at Herning (95 MW), at Randers (45 MW) and at the H. C. Ørstedsværket in Copenhagen (73 MW). The units are to be put into operation in 1982, 1982 and 1985, respectively. In 1984 and 1985 two 350 MW units equipped with outlets for district heating will be commissioned at the Studstrupværket.

Due to the moderate growth in electricity consumption the last year the previously decided expansion of the Amagerværket with a unit of 480 MW for combined power and district heating production scheduled to be commissioned in 1985, has been abandoned. Instead a unit of about 350 MW for combined production will most probably be built in 1988/89 in the metropolitan area. A few minor back-pressure plants under 50 MW are, however, expected to be built in small towns that according to the heat planning are to be supplied with combined power and district heating.

Exchange of Electrical Energy between the Countries

In 1981 the Nordic cooperation once more showed its great value. The total transmission capacity of the interconnections between Denmark and Norway/ Sweden amounts to 1500 MW. In 1981 this capacity has been almost fully utilized. Total volume of imports amounted to about 8 TWh, corresponding to one third of Denmark's total electricity consumption. The reason for this heavy volume of imports was the extremely good hydro situation in Scandinavia, the commissioning of new nuclear units in Sweden, and the very high level of operating reliability of Swedish nuclear power plants.

The value of reducing the use of fossil fuel, by means of the best possible utilization of the hydro power resources of the Nordic Power System, is evident. On the initiative of Nordel Danish, Norwegian and Swedish electricity supply undertakings are, therefore, negotiating an expansion of the interconnections.

Certain problems may, however, arise when the volume of imports hits a level like the one in 1981. For long periods the volume of imports to each of the two Danish supply areas, Zealand and Jutland-Funen accounted for more than half of the areas own load. In such situations supplies become strongly dependent on the level of reliability of the interconnections. On August 4 a breakdown thus occured that blacked out Denmark east of Great Belt. 700 MW were imported from Sweden at the time of the interruption, i.e. about 70 % of the area's load. A technical fault on the 400 kV connection to Sweden, followed by another fault on one of the parallel 132 kV connections resulted in a disengagement of all connections between Sweden and Zealand. With the insufficient production capacity available at the time of interruption a total breakdown was inevitable. About two hours later supplies within the whole area were reestablished.

Fuel

The declining demand for fuel in the first six months of the year resulted in a downward tendency in oil prices in terms of $/t. During the summer the price level settled at about 160–170 $/t. Oil prices have, however, all through 1981 been considerably higher than in the previous year due to the heavy increase in the dollar rate in the first half of the year.

Due to the discontinuance of Polish supplies, a threatening coal strike in the USA and an overall increasing demand, the coal situation was not promissing at the beginning of the year. The pressure on demand resulted in many vessels waiting for loads in the American ports and this caused prices to rise considerably.

Because of a strike among the coal miners, the market settled down and a new quota arrangement was introduced in the ports. The queue of waiting vessels was now gradually reduced and prices declined. During the summer the demand for coal was further declining and by the end of the year the market was characterized by reluctance to buy and a stable price level.

The three big harbours at Asnæs, Ensted and Stigsnæs are important prerequisites of a safe and stable coal supply in a time when market conditions are constatly changing. Asnæs is capable of receiving part-loaded vessels of up to 150 000 t d.w. Ensted and Stigsnæs which can today receive fully-loaded vessels of up to 120 000 t d.w. are being expanded for vessels up to 170 000 t d.w. as from 1983.

Energy policy

The heat planning of the municipalities has been continued on the basis of the two bills passed in 1979 on heat supply and natural gas. The fact that the efforts of saving in the last year have started to show results has, however, created certain planning problems. Improved housing insulation together with the drastically reduced housebuilding activities have disturbed the planning foundation. It has, therefore, proved difficult to find a market for the amount of natural gas presupposed in stage one of the natural gas project within the areas picked out for natural gas. Therefore, the government is considering a proposal for an expansion of the network to Central and Northern Jutland.

According to the report of 1978 by the Heat Planning Committee a number of medium-sized towns have been chosen for supply of combined power and district heating from small back-pressure plants. On the basis of the evaluations carried through some municipalities have in principle decided to accept coal-fired back-pressure plants. The Ministry of Energy has, however, informed some municipalities and counties that they will have to wait to establish such plants until the total results of the heat planning are available in a few years. A few pilot plants may be allowed. The attitude of the Ministry must be viewed against the background that according to the Ministry, existing capacity, together with the already planned extensions, will be sufficient to cover the needs for the remaining part of this decade.

In February the Minister of Energy sat up a working group to evaluate the future need for combined power and district heating production within the metropolitan area. Agreement has been reached on the main principles, including the time for commissioning of a new unit for combined power and district heating production within the area. The question of location of the unit has not yet been finally decided.

In June the utilities submitted the report wanted by Parliament on the possibilities of disposal of high-level radioactive waste underground in Denmark. The authorities are now evaluating the report. A positive outcome of this evaluation does, however, not settle the question. The government wants clear evidence that the safety of nuclear power is satisfactory. An investigation in which the utilities have consented to give the technical assistance necessary, has been initiated by the authorities. As this work will not be completed until the end of 1982 a possible decision on introduction of nuclear power in Denmark cannot be made until 1983 at the earliest.

The government's Energy Plan 81 was published immediately before the general election in December and the utilities have, therefore, at the turn of the year not been in a position to comment on the details of the Plan. It can, however, be noticed with satisfaction that the Plan very clearly establishes the economic and security of supply advantages of nuclear power. In Energy Plan 81 a decision on introduction of nuclear power has been put off pleading over-capacity within the electricity sector, priority of plants for combined power and district heating and a slackening of the growth in electricity consumption. At the same time it must be recognized that a decision on nuclear power depends on a political accept of the society.
Finally has to be mentioned that in 1981 the utilities and the Ministry of Energy

have participated in a joint wind power programme, including the two 650 kW experimental mills at Nibe.

Finland

Economic development

The favourable economic trend which has continued during the last few years turned towards a recession in 1981. The GNP increased by merely one per cent to 210 000 million Finnish marks (FIM), while the economic growth was 5 % in 1981. The volume of industrial production increased by 1.5 %. Imports decreased by 5 %, mainly as a result of a slowdown in investments. The value of energy imports totalled FIM 19 000 million, which equals 30 % of the total imports. As exports increased by 2.5 %, the deficit in the balance of payments shrunk to FIM 1 700 million. Consumer prices rose by 12 % at an average.

As economic growth decelerated, the number of unemployed went up by 20 000 to 130 000, which corresponds to slightly more than 5 % of the work force.

Energy policy

A revision of the energy policy, which was passed by the Council of State in 1979, has been initiated by the parliamentary Energy Policy Council.

Energy consumption

Energy consumption increased by 1 % to 25.3 Mtoe during 1981. (Used conversion ratio according to Finnish statistics is 1 TWh=0,25 Mtoe.) The share of domestic energy in the total energy consumption was 33 %. The increase from 1980, when the corresponding share was 29 %, is mainly due to the good water situation. In addition, the availability of the nuclear power stations was high, and thus the coal consumption amounted to less than 3 million tons, i.e. half of the consumption the previous year. Oil consumption decreased by 6 %, while the share of oil in the total energy consumption decreased from 45 % to 42 %.

Electricity consumption rose by 3.5 % to 41.3 TWh. The electricity consumption of the industry increased by 2.5 % and other electricity consumption by 5.5 %. The number of homes heated with electricity increased by 25 000 to 218 000. During the previous year the corresponding increase was 16 000.

Electricity production

Imatran Voima Oy's (IVO) nuclear power unit Loviisa 2 of 440 MW was taken into commercial operation in the beginning of January. Teollisuuden Voima's second unit of 660 MW in Olkiluoto was also taken into operation, but the start-up was delayed by a rotor failure in the generator. Electricity imports from the Soviet Union reached the power of 500 MW in December, the import capacity agreed upon being 600 MW. The increase in hydropower was 43 MW, of which 35 MW was made up by Porttipahta hydropower plant.

Production of nuclear power doubled in comparison to the previous year and totalled 14 TWh, which corresponded to 34 % of the total production. As a result of the favourable water situation hydropower amounted to 13.4 TWh, i.e. some 10 % higher than normal. Owing to the high hydro and nuclear power production back-pressure production decreased by 13 % to 9.2 TWh. The forms of production mentioned above, including electricity imports of 2.8 TWh, covered about 95 % of the total demand.

Energy prices

Owing to the difficulties in the Polish supply of coal, several million tons of coal were imported from other countries, mainly the USA and Great Britain. During 1981 the coal price rose by 22 %. The price of heavy fuel oil increased by 25 % and the price of light fuel oil by 22 %.

The wholesale price of electricity rose in January and October by a total of 30 %. The electricity distributing utilities raised the distribution tariffs by an average of 18 %. The electricity tax rose in the beginning of 1981 by 0.3 pennies/kWh to 1.3 p/kWh and in the beginning of 1982 to 1.4 p/kWh.

Expansion and investigation projects

District heating capacity of totally 200 MW (electrical) is under construction in Helsinki and Kuopio. Imatran Voima Oy is transforming one of the condensing units at the Naantali Power Plant for production of district heat. Heat deliveries to the municipalities in the region of Turku are scheduled for 1982. IVO is also transforming the Vanaja Power Plant for heat production, and heat deliveries to the town of Hämeenlinna will start in the beginning of 1983. In addition, IVO is also constructing a peat-fired district heating power plant of 60/120 MW (electrical/thermal) in Joensuu and one of 80/180 MW in Jyväskylä. In these two towns heat deliveries are scheduled to begin in 1986. A number of other towns and cities are also planning to construct thermal power stations and district heating plants.

Owing to significant alterations in fuel prices six oil-fired power plants will be transformed into coal or peat-fired plants. The total capacity of these plants is about 600 MW. The three largest include Vaskiluoto (150 MW), Kristiinankaupunki (200 MW) and Kymijärvi (150 MW), which were taken into use in 1972, 1974 and 1976, respectively.

Investigations concerning a new large-scale power plant continued. According to the projected demand for electricity the next condense power plant would be needed in the early 1990s. The feasibility and economy of nuclear, coal and peat condensing power plants are examined in these investigations, both as alternative and complementary solutions.

In January, Imatran Voima Oy signed a cooperation agreement with Sofratome (France) concerning feasibility studies for a 900 MW nuclear power plant and in June a corresponding agreement with Atomenergoexport (the Soviet Union) concerning a 1000 MW nuclear power plant.

As an alternative to new coal-fired power plants for the Helsinki metropolitan area, investigations regarding the transmission of district heat from Loviisa (about 80 km) continued. The economy of this alternative has improved as a result of the coal price increases.

Electric heating. A nationwide investigation project concerning heating methods for small houses, launched by Imatran Voima in 1978, reached the quantitive target of 1 000 houses. This project published the first comprehensive comparison between the purchase costs of various heating methods, and an analysis of energy consumption. The results confirm the advantages of direct electric heating. Other similar investigations have also given results to that effect.

The Electricity Act. In accordance with the new Electricity Act, which came into force in the beginning of 1980, the Delegation for Power Supply submitted a proposal for the first general plan concerning the Finnish electric power supply for the years 1982–91 to the Ministry of Trade and Industry in August. The plan contains forecasts for the increase in electric supply capacity and a presentation of the proposal concerning the most important power plants and electric transmission equipment which will be started during the period 1982–84. The general plan was passed by the Council of State in February 1982. Among other things, the plan gives the guidelines for the granting of construction permits for power plants.

In accordance with the Electricity Act, 20 regional cooperation commissions with representatives for electric utilities, producers and the largest consumers were founded during 1981. The first regional plans will be drawn up for the years 1983–87.

National grid

A DC-connection between Finland and the Soviet Union was taken into use December 15, 1981. It was the first phase with a maximum capacity of 350 MW. Thus the first main grid connection from the Soviet Union to Western Europe is being realized through Nordel.

Revision of legislation on nuclear power

The committee which prepared a revision of the legislation on nuclear power finished its work and submitted the report to the Ministry of Trade and Industry. The report includes drafts for laws on the principles of the use of nuclear power, the construction of power plants, mining related to this field, supervision and the economic organization of the nuclear waste management.

Iceland

Electricity production

Total production of electrical energy in 1981 amounted to 3258 GWh, of which 94.7 % (97.2) was generated by hydro power, 3.8 % (1.4) by geothermal power and 1.5 % (1.4) by diesel power.

Gross consumption amounted to 3258 GWh (3142), of which 3108 was primary power and 150 GWh excess power. Gross consumption increased by 3.7 %. Energy-intensive industries accounted for 55.2 % (56.7) of the total, corresponding to an increase of 1.0 % as compared with 12.8 % in 1980.

During the first few months of the year, deliveries to energy-intensive industries had to be reduced somewhat as a result of difficulties with supplies, among other things. If the figures are adjusted for this rationing, potential gross consumption amounted to 3459 GWh, which corresponds to an increase of 6.1 % in total consumption and 5.9 % in consumption by energy-intensive industries.

Other consumption, which was not affected by rationing, increased by 7.2 % (1.6).

At year-end 1980 the installed output at Icelandic power stations totalled 749 MW (670), of which 612 MW (542) referred to hydro plants, 120 MW (116) to fuel-fired district heating plants (diesel, condenser, gas-turbines) and 17 MW (12) to geothermal plants.

As in previous years, the yield from the latter was limited by the quantity of geothermal vapour available.

The first of three 70 MW units at the Hrauneyjafoss hydro plants on Syd-Island went into operation in 1981. Start-up of the second unit was scheduled for February, 1982.

Primary grid

Expansion of the 132 kV national grid continued during 1981, and a link between Öst-Island and Höfn, on the south-east coast, went into operation in December. The last link in a grid around Iceland from Höfn along the south coast and across to the Sigalda power station on Sydlandet is expected to be finished in 1983.

Energy policy

In February, 1981 the Icelandic Parliament ratified a law authorizing the construction of new hydro plants and the expansion of existing plants corresponding to a capacity of 870 MW, or 161 % of the hydro-power capacity available at year-end 1980. The law also authorizes construction of geothermal power plants with a total capacity of 50 MW and of diesel or gas-turbine plants with the same capacity; the latter are intended as reserve units. An expansion of the main grid on the scale required to transmit the additional capacity is also authorized by the law.

The law is intended as a framework for the next 10–15 years (although the time scale is not specified), while individual phases of the expansion program are to be specially authorized by the Parliament, which is thus to determine the dates, the extent and the internal sequence of these phases. In this connection the Government submitted a proposal to Parliament at the end of November 1981 in which hydro power is to be expanded at the following rates:

1. Expansion of production capacity at existing hydro plants on the Thjórsá and Tungnaá Rivers in Syd-Island by a total of 750 GWh/year, by means of diversion of water courses and expansion of reservoirs; new installations totalling 140 MW in this area.

2. The Blanda hydro plant in western Nord-Island is to be expanded by a total of 150 MW, or 765 GWh/year.

3. The Fljótsdalur plant in Øst-Island is to be expanded by 252 MW, or 1330 GWh/year.

This proposal had not been authorized by the end of the year, while negotiations were still in progress with local agricultural interests in the Blanda area regarding compensation and the size of the main reservoir. It was intended that these discussions would be completed before the Parliament authorized the above proposal, in order to avoid a conflict. Corresponding negotiations in the Fljótsdalur area were completed in 1981. No agricultural interests are involved with the implementation of (1) above.

English Summary

The Government proposal specifies that this expansion will take place over the next 12 years.

During the winter the Government appointed an Energy Policy Commission with six members, two from each of the three coalition parties that support the Government. The Commission is to prepare the Government's energy policy program for the next ten years and present it to the Parliament. One of the main points of this program is expected to be the future approach to the development of energy-intensive industries in Iceland, a much debated and in any case hitherto a controversial subject. Another main point will be the reduction of the country's petroleum imports through (1) replacement of oil with electricity generated by hydro and geothermal power, (2) conservation of oil and – as a future possibility – (3) production of synthetic fuels based on electrolysis. A third important point in the formulation of an energy policy will involve securing a reliable supply of fuel for the country.

It is not yet clear when the Government intends to present its energy policy program in its entirety. However, in connection with the Government proposal for expansion of power plants mentioned above, the Commission has requested a continuous general report regarding alternatives for expansion of energy-intensive industries in Iceland over the next twelve years, corresponding to an electric power consumption of approximately 1800 GWh/year over and above the present level of consumption in this sector (1768 GWh in 1981).

The report identifies possible industrial projects for this perod, including a silicon-metal plant in Øst-Island, expansion of the existing ferro-silicate plant in Vest-Island, a pulp plant (based on wood imported from Canada or the US), a sodium chlorate plant, a new aluminium plant (possibly in Nord-Island, or presumably in Sydvest-Island) and a magnesium plant. Studies and investigations are in progress for several of these projects, but a good deal of work remains before decisions can be made. It is nevertheless considered possible that a Bill regarding a silicon-metal plant and a pulp plant will be proposed during 1982.

The so-called Energy Forecast Commitee, which is composed of representatives of various organizations within the energy sector in Iceland, issued a highly edited version of its previous electricity forecast for Iceland through the year 2000. This report contains two scenarios regarding new energy-intensive industries: (1) that "general" industry will be able to absorb the available labour power that is expected to seek employment in industry during the period up to the year 2000 and that industrial production in general will be maintained at a level high enough to fulfill certain minimum demands for economic development, and (2) that 25 % of available industrial labour power must find employment in new energy-intensive industries in order for productivity in these industries to be maintained. However, the first scenario assumes that these industries will not exhibit growth and will remain at present levels.
The results of the electricity forecast are summarized below:

	Production, GWh/year				
	1980	1985	1990	1995	2000
Scenario 1	3130	3904	4514	5161	5925
Scenario 2	3130	4400	5500	7500	9650

It can be seen that the two scenarios do not involve more than two different evaluations of the industrial development that is necessary to obtain a specific acceptable minimum of economic development. A faster development of energy-intensive industry than that contained in Scenario 2 is very conceivable, and this would result in a greater consumption of electricity, if the required political decisions are made. However, none of these decisions have been made as yet, so that this possibility has not been included in the forecasts. It can be seen that the expansion program initiated by the Government corresponds generally to Scenario 2 for the next 12 years.

Energy sources

In addition to the electricity forecast, the Committee has recently submitted forecasts of the consumption of oil and geothermal heat through the year 2000. These forecasts refer to the production and the import, respectively, of primary energy for Iceland, computed in oil equivalents (A) and thermal energy content (B):

	PJ/year				
A	**1980**	**1985**	**1990**	**1995**	**2000**
Hydro power (Scenario 2)	31.4	44.4	55.3	75.5	96.6
Geothermal energy	18.9	25.9	33.4	45.2	63.7
Petroleum products	23.0	23.0	23.0	24.0	24.0
Total	73.3	93.3	111.7	144.7	184.3

	PJ/year				
B	**1980**	**1985**	**1990**	**1995**	**2000**
Hydro power (Scenario 2)	11.0	15.5	19.3	26.4	33.9
Geothermal energy	22.8	30.5	39.4	52.3	71.3
Petroleum products	23.0	23.0	23.0	24.0	24.0
Total	26.8	69.0	81.7	102.7	129.7

The Government of Iceland has informed Alusuisse, the Swiss aluminium group, of its desire to negotiate a revision of the main contract between Alusuisse and Iceland that is the basis for operation of Iceland's only aluminium plant (in Straumsvík), which is owned by ISAL, a wholly owned subsidiary of Alusuisse. The Government's request is based on a report from an international auditing firm in London regarding ISAL's annual accounts for the last 5–6 years. In the Government's opinion or this report justifies the charge that Alusuisse has not complied with the provisions of the main contract. Alusuisse has stated its readiness to discuss the auditing firm's report, but claims that it has complied with the contract. The Government is expected to request an increase in the electricity rates paid by the aluminium plant as well as changes in the tax regulations applying to ISAL and Government participation in the ownership of ISAL. Negotiations between the Government and Alusuisse are expected to get under way during the first few months of 1982.

Two reports presented at an energy congress in Iceland in June, 1981 (see below) contained new information regarding the scope of the country's two most important energy sources, i.e. hydro power and geothermal energy.

As regards hydro power, the technically, exploitable potential is now estimated at 64 TWh/year. A considerable portion of this quantity, on the order of 40–50 TWh/year, is considered to be economical at current energy prices. This implies a revaluation of about 50 % in the economical potential, from the previous 28 GWh/year.

In terms of geothermal potential, previous evaluations have been highly uncertain, so that the new figures cannot be compared directly. It is still very difficult to evaluate the quantity of practically exploitable geothermal energy in Iceland, and the latest figures involve a number of uncertain factors. The geothermal energy which can be technically exploited is now estimated at 3500 EJ (exajoule) of thermal energy, which in pure energy terms corresponds to about 80 billion tons of oil. If this exploitation is distributed evenly over, for example, 50 years, it would correspond to 70 EJ or 19 400 TWh of thermal energy annually. The portion of this energy which can be converted to electricity is estimated at approximately 68 EJ of elctrical energy or 1.36 EJ per year over 50 years, corresponding to an average output of 43 GW.

The data base available is still not sufficient for an evaluation of how large a portion of this potential can be utilized economically in the light of current energy prices.

On June 9–11, 1981 a 3-day congress was arranged by the Icelandic Electricity Producers Association, the Icelandic Heating Producers Association, the Ministry of Industry, the State Energy Board, the Icelandic Engineer's Society, the State Research Council and the oil companies operating in Iceland. A total of 37 papers were presented regarding the international energy situation, Icelandic energy sources, the potential and problems connected with industrial utilization of these, the country's fuel supply and the national energy policy. The political parties also participated in the congress. The differences between the various parties' views of the development of energy-intensive industry and of energy policy on the whole were smaller than might have been expected. The congress attracted about 200 participants.

Norway

Economic development

Preliminary data indicates that the gross national product (GNP) increased by 0.7 % (by volume) in 1981 as compared to 3.9 % in 1980. This is a significant departure from the average growth rate of over 4 % in the 1970's. The slowdown in GNP growth rate is largely a result of a decline in industrial production and flat development of oil and gas production rates in the North Sea. GNP growth, excluding production of crude oil and gas, was about 0.9 %. Operations associated with the exploitation of oil and gas on the Norwegian continental shelf now employ about 44 000 people.

Agriculture, forestry, fisheries and services accounted for the greatest production increase. A gross production increase of 8.7 % was recorded in the electric power and water supply sector during 1981. Industrial production on the other hand declined by 1.3 %. Employment in industry continues to decline and production levels have been largely unchanged since 1974.

Private consumption increased by 1.3 % during 1981 as against 2.2 % in 1980. Gross investment in real assets increased by 16.5 %. Investment referring to oil and gas activities increased by 167 % while investment in industry increased by 11.4 %.

Energy consumption

Gross consumption of firm power increased by 2.9 % to 84.4 TWh during 1981. The average growth rate over the past 10 years has been 3.7 %. General consumption of electrical energy (including network losses excluding energy intensive industries) increased by 4.9 to 55.5 TWh. If the effect of abnormal weather condition is excluded the increase is estimated at 4.6 % to 54.2 TWh. General consumption has increased at an average annual rate of 5.3 % p.a. during the past 10 years. The latest Government white paper on energy assumes an annual growth rate of 3.1 % for the period 1977–85. The growth rate has so far been significantly higher. The reason appears to be that electrical energy, which is based on hydropower in Norway, is strongly competitive with oil products in the space heating market. The rapid increase in oil prices in recent years has caused a greater substitution of oil products by electrical energy than anticipated in the white paper.

Net consumption of electrical energy by energy intensive industry (production of chemical raw materials, iron, steel and ferro alloys and production of nonferrous metals, including aluminium) decreased by 1.7 % to 28.2 TWh in 1981. In 1980 the decrease was 3.3 %.

Maximum system load during 1981 referring to the power stations, is estimated at 15 800 MW.

Estimated gross consumption of energy in the country during 1981 was 732 PJ (10^{15} joule). This is practically unchanged from the previous year. During the past 5 years total energy consumption has increased by an average of 2.6 % anually. In 1981 total energy consumption was met by: electric power 43 %, petroleum products 42 % and other fuels (coal, firewood, gas etc) 15 %. Relative share of electrical energy has increased significantly and the share of petroleum products has declined in recent years due to rapidly escalating oil prices. Coal and fire wood have also increased their market shares.

Production of energy

Production of electrical energy increased by 10.3 % to 92.8 TWh during 1981. The above average runoff to the hydro power system contributed to this increase. During 1980 the runoff was only 87 % of normal. Favourable runoff conditions in 1981 produced a surplus production of water power of 8.3 TWh of which 3.1 TWh was sold as occasional power to electric boilers in domestic industry and pumped storage stations, and 5.2 TWh was exported.

Productive capacity in the Norwegian hydro power system (firm power) increased by 4.4 % (3.7 TWh) to 87 TWh in 1981 including assumed import potential for thermal power during extremely dry years. During the past 10 years the average annual increase in productive capacity was 2.9 %.

Maximum capacity at Norwegian power stations (greater than 1 MW) increased by 8.8 % or 1726 MW to 21 279 MW during 1981. Only 275 MW of this capacity was thermal power.

The State Power Board owns 31.3 % of total power station capacity, municipalities own 51.3 % and industrial groups and private enterprises own the remaining 17.4 %.

Production of crude oil in the North Sea during 1981 is estimated at 23.3 million tons as against 24.4 million tons in the previous year. Gas production is estimated at 25.8 and 26.1 billion m^3 in 1981 and 1980 respectively. The decline in production mainly is due to falling production at the Ekofisk field, which accounts for 70 % of total production on the Norwegian continental shelf, and no significant new fields have come onstream during the year.

Energy policy

The price of bulk energy contracted to general consumption from the State Power Board was increased to 8.56 N øre/kWh on July 1st 1981. The Norwegian Storting (Parliament) has decided that this price will be increased to 11.3 N øre/kWh July 1st 1982. The average price paid by household consumers in 1981 was 20.6 N øre/kWh, including VAT. In 1982 this price is expected to increase to about 23.8 N øre/kWh. The price varies considerably between local communities.

The new Government which took office following the autumn election of 1981 has not announced any major new policy changes on energy. The guidelines drawn up by the previous Government in a white paper on energy (St. meld nr. 54, 1979–80) is still in effect, but certain policy adjustments have been announced. These are related to the terms of sale of bulk power from the State Power Board to the energy intensive industries and to the pulp and paper industries. A government Bill will be presented to the Storting in a white paper in the spring session of 1982.

The government is continuing work, started before the last elections, on a comprehensive plan for the remaining water resources in Norway. The plan will include information on all relevant user interests in the waterways as well as a priority list of waterways suitable for hydro power development. The government will present a white paper on the progress of this work during the spring of 1982.

A special tax of 2.2 N øre/kWh on electrical energy sold to final users is now in effect. In addition, the consumer pays VAT of about 20 % on the billed amount, including the special tax. Certain hard-pressed industries have been granted a partial reduction of the special electricity tax.

Exploration for petroleum deposits on the Norwegian continental shelf has continued at a high level in 1981. Drilling started north of 62°N during the summer of 1980 and the Norwegian companies Norsk Hydro and Statoil have both made interesting gas strikes at Tromsøflaket during 1981. Statfjord is the largest developed oil and gas field on the Norwegian continental shelf. The second production platform, Statfjord B, was towed out and placed in the field in August of 1981. Only crude oil is produced at Statfjord to date. The Storting has approved a plan to bring gas from Statfjord ashore at Kårstø in the county of Rogaland. After processing the dry gas will be pumped via a new pipeline from Kårstø to the existing pipeline between the Ekofisk field and Emden, West Germany.

The Department of Oil and Energy decided that the Directorate of Electricity, will become the Directorate of Energy from Jan. 1982. The Storting approved this change in the duties of the Directorate. In addition to dealing with questions concerning the county's electricity supply, the Directorate of Energy assume new responsibilities related to energy questions in general.

Sweden

General economic development

The recession which began in 1980 continued throughout 1981. Sweden's GNP, which had risen by 1.8 % in 1980, went down by 0.8 % in 1981. Industrial output has successively declined by 6–7 % in volume terms since the spring of 1980. The decline is estimated to be around 2.5 % on a year-to-year basis between 1980 and 1981. The largest reductions in output occurred in iron-ore, timber, steel and shipbuilding.

The Swedish krona was devalued by 10 % in September, 1980. Certain companies subsequently registered an upturn in export orders and, owing to idle capacity, were able to rapidly expand production. However, no general increase in output is expected before the summer of 1982.

The Swedish trade balance showed a considerable improvement compared to the previous year, as a result of the weak general economic climate and a reduction of oil imports in particular. The balance on current account showed a slight improvement, but still registered a large deficit (SEK 14 billion). The interest on the foreign debt accounted for the largest part of that sum.

Investments are estimated to have declined by 6 % overall. The construction industry was very weak; the number of commenced dwellings dropped from 50,000 in 1980 to approximately 43,000 in 1981.

The labour market situation deteriorated successively during 1981. At the end of the year the number of unemployed amounted to 3 % of the labour force.

English Summary

The consumer price index rose by 9.7 % in 1981 compared to 14.3 % the year before. Last year's slower rate was to a certain extent due to a reduction of the value-added tax in the middle of November.

Energy policy

After a debate on Government Bill 1980/81:90, the Swedish Parliament voted in the spring of 1981 on national guidelines for energy policy. The decisions adopted included guidelines for a comprehensive energy conservation programme for the 1980s. Emphasis is placed on relatively short-term measures aimed at rapidly reducing Sweden's dependence on oil. Available electrical capacity is to be used in the most efficient way possible to replace oil for heating. An important component of the programme is the energy conservation plan for existing structures which had been decided upon in the spring of 1978. The goal has now been raised to correspond to a reduction of annual energy use in the nation's building stocks by around 48 TWh. The Government subsidies are now only given in the form on loans. Through a change in the act of municipal energy planning, it was also decided that every municipality in Sweden has to have an up-to-date plan for cutting down on oil consumption.

At the request of Parliament, the Government has appointed a Parliamentary committee (the 1981 Energy Committee) to ensure the phasing out of nuclear power and a continued reduction of dependence on oil. This committee shall propose guidelines for Sweden's energy supply in the 1990s and the subsequent period. The committee shall analyze the potential significance of various energy sources such as oil, coal, hydro power, peat, forest fuels, shale, natural gas and solar and wind power in the time perspective during which nuclear power is scheduled to be phased out. The committée's studies will be based on the assumption that the major unharnessed rivers, in line with previous decisions, shall be exempted from hydroelectric development.

The Government-appointed inquiry commission on means of control for energy conservation by industry and commerce has in its report, "Energy Cooperation Between Government and Business", proposed the introduction of an energy conservation law for industry and commerce. Under this proposal, major industrial companies shall report their energy plans to the Government energy authority.

On July 1, 1982 a new central Government authority, the National Swedish Energy Board, will be established with the primary task of dealing with energy supply questions. In addition to the Energy Board, two other new bodies will also be set up; an Oil Replacement Fund and an Energy Research Board, for long-term and overall tasks in relation to energy research.

The Committee on Management of Spent Nuclear Fuel was set up on July 1, 1981. This committee has to propose special charges on electrical energy to cover the costs of handling and disposal of spent nuclear fuel.

Preparations are under way for the introduction of Danish natural gas in southern Sweden in the fall of 1985. Swedegas is stydying the possibilities of increased sales of natural gas in Sweden. The Government has commissioned Vattenfall to draw up, in conjunction with Swedegas, preliminary plans for a pipeline over Swedish territory for possible transport of natural gas from nothern Norway to the Continent. An agreement has subsequently been reached between Statoil and Vattenfall on cooperation in investigations on this project.

The energy tax on heavy and light oils was raised again on April 1, 1982, and now amounts to SEK 253 per m³. At the same time, the special emergency reserves surcharge for petroleum products was raised to SEK 118 per m³.

Energy supply

The total energy supply in 1981 is estimated to approximately 401 TWh, a decrease by 3.6 % as compared to 1980. Net imports of crude oil and oil products decreased by more than 6 million tons or fully 20 %. Half of this decrease is a consequence of depletion of stock in the oil trade. The deliveries from the oil companies dropped because of lower level of production in the most energy intensive industries. Furthermore the increase of nuclear power production resulted in a heavy reduction of oil consumption for electricity production. The need for the heating of buildings, expressed in so called degree days, was somewhat lower than in 1980.

Electricity consumption

Total consumption of electricity, including transmission losses, amounted to 97.3 TWh in 1981. Compared with 1980, the increase was 3.2 TWh, or 3.5 %. The increase between 1979 and 1980 was 0.3 %. The rise is largely due to the fact that electricity consumption in 1980 had been reduced by about 0.7 TWh as a result of the labour market conflict that year, and that there were substantial deliveries to convertible electrical boilers (0.9 TWh). After adjustment for these factors, the increase in electricity consumption in 1981 was around 1.7 %. Above all this was due to the weak general business climate in Sweden. Industrial consumption of electric power declined for the second year in a row, reaching a level of only 40.1 TWh (–0.7 %). However, there was a certain upturn at the end of the year.

Electricity consumption by railroads and tramcars was on the whole the same as in 1980. Here, too, an upward trend could be noted towards the end of the year. In the household, farming and service sector, electric power consumption in 1981 went up by slightly more than 3 TWh, or 7 %. After adjustments for temperature, the increase was somewhat larger. Available statistics do not permit a more detailed analysis of the increase. Around 0.5 TWh relates to deliveries to electrical boilers in district heating plants. It is likely that regular electrical heating has also increased sharply, especially as a result of the shift from oil heating to electrical boilers and combination boilers.

The weather throughout Sweden was extremely cold for most of December, and electricity consumption that month was 15 % higher than in December 1980. In the household and service sectors, the increase was no less than 22 % (7 % after temperature adjustments). The highest recorded figure for hourly electricity consumption so far 19,641 MW, was registered on December 17 between 8 and 9 a.m. However, there were no difficulties to meet this heavy peak load.

English Summary

After extensive studies, the Central Operating Management (CDL) published a forecast in December of electricity consumption in Sweden in the period of 1978–1990. The main features of this prognosis may be seen from the following table.

	Consumption 1990, TWh	Increase 1978/90 % per year
Industry	50.0	2.1
Transport	2.7	1.7
Other sectors of which,	65.6	4.2
electrical heating in buildings	28.5	8.3
other uses	37.1	2.1
Total, incl. transmission losses	130	3.2

Electricity production

Total electric power production, excluding the power plants' own consumption, was 100.0 TWh in 1981, or 6.4 TWh more than in 1980 (+6.8 %). Hydro power production was 58.8 TWh, or up 1.1 TWh (1.9 %) over the previous year. The spring flood was more than the average for the 1940–1970 period. The rate of reservoir filling for all Swedish storage reservoirs was 46 % at the beginning of the year and 55 % at yearend. This is 9 percentage units under the median value for the most recent ten-year period. Installed hydro power capacity increased by around 50 MW in 1981, mainly as a result of the addition of the new Åsele and Volgsjöfors stations on the river Ångermanälven.

Nuclear power production increased from 25.4 TWh in 1980 to 36.0 TWh, or no less than 42 %. Nuclear power thus accounted for 36 % of total electricity production. Forsmark 2 (900 MW) was brought into commercial operation in July and Ringhals 3 (915 MW) in September, but both units contributed to production from the beginning of the year. However, Ringhals 3 had to be taken out of operation already at the end of October owing to leakage in the steam generators caused by faulty generator design. Ringhals 4 has the same type of steamgenerator. Both units will be running, however with reduced capacity, during most of 1982. Work is proceeding in the future nuclear units, Forsmark 3, and Oskarshamn 3.

Back pressure production declined from 9.3 TWh in 1980 to 4.6 TWh, and production from condense power plants (including gas turbines and diesels) dropped from 1.2 TWh to 0.5 TWh. This latter figure is the lowest on record since the mid-1960s. All together, fossil fuels accounted for only 5 % of total electricity production in 1981. Imports went up slightly from 3.4 to 3.5 TWh. Exports, on the other hand, more than doubled amounting to 6.2 TWh.

Electricity prices

Once the situation with respect to expansion of production had been clarified, new high-voltage tariffs were introduced in the major power companies on January 1, 1981. Compared with previous tariffs, the structure was changed by reducing capacity charges while raising energy charges. Further, the price regulation clauses were adjusted to the anticipated cost situation and power balances for the coming years. For an average high-voltage delivery, the price was increased by 1–2 % compared to 1980. Since general inflation during the same period was around 10 %, this represented a rather substantial reduction in real prices for high-voltage electric power.

In order to adjust the high-voltage tariffs better to the system costs Vattenfall has decided on certain general changes for 1982 and 1983. Briefly these imply a reduction of the energy charges during the period May to September and particularly during July, the holiday month. Furthermore the subscribers are entitled to disconnect the metering of the 6-hourly demand during the same period as well as during nights and weekends in October, March and April.

Developments in the low-voltage sector are not quite as clear-cut, since the various distributors raised their prices at different times during the year. However, on the average the increases seem to have amounted to around 10 %. The price hikes are due principally to increased distribution costs.

In 1981 a Government study on energy pricing was presented. This study emphasizes the importance of short-term marginal costs in determining the price of energy in order to obtain an optimal utilization of existing production and distribution capacity. Investigations are now under way in the various power companies on how these principles can be applied in practice. Development efforts are also being conducted with the aim of producing an electronic accessory to low-voltage meters so as to facilitate measurement and meter-reading if the energy charge varies during the year. On January 1, 1982 several companies i.e. Vattenfall and Sydkraft introduced an optional low-voltage tariff with a differentiated energy charge, i.e. a lower rate during the summer than for the rest of the year. Such tariffs provide better information on the seasonal variation of prices and increase the possibilities of rational electricity use and oil replacement.

National grid

A fourth 400 kV connecting line from the Ringhals nuclear power station was brought into operation in 1981.

To connect Unit 3 of the Oskarshamn nuclear power station, it was decided to construct two 400 kV lines, one to the Jönköping–Malmö 400 kV line at Alvesta, and the other to the 400 kV grid in the vicinity of Norrköping. Both lines are scheduled for commisioning in 1985.

A disturbance in the Zealand (Denmark) grid on August 4, 1981 led to the loss of both the 400 kV and 132 kV interconnections between Zealand and Sweden. The disruption did not affect the Swedish electricity supply, but most of Zealand was blacked out for 20 minutes.

A severe short-circuit on October 23 in a 220 kV switching station near Enköping caused a 1,300 MW loss of production in Forsmark and a disconnection of load of around 1,700 MW in the nothern part of the Greater Stockholm area. This disruption led to a frequency drop and increase of hydro power production. In Norway, a certain cutback in production was made in account of load oscillations. In addition, further production losses occurred in Sweden and on Zealand.

The disturbance occured when the load on the transmission from Norrland and on the interconnections from Norway was relatively high.

Reducing Dependence on Oil in Nordic Countries in particular through Production of electric Power

By Anders Löf, Swedish State Power Board, Secretary of the Nordel Planning Committee, in cooperation with the members of the Committee.

"The consumption of fuel in our day is so enormously great; it increases daily, and the price of fuel is rising so sharply that many are beginning to believe the old and often repeated prediction of a coming serious shortage of this indispensable material".

These fears of a coming shortage of energy were expressed as early as 1811 by Professor Christian Olufsen of Denmark. He was referring to a lack of wood. His statement applies today as well, although it would refer primarily to oil.

The present report deals with a number of activities for reducing dependence on oil, primarily within the Nordic electric power companies. As the Nordic countries have different natural resources for this task and thus use somewhat different methods, each country is discussed separately.

Cooperation within the framework of Nordel is of great significance in terms of efforts to save oil. The principle of Nordel cooperation is to use the means of production which currently bears the lowest variable costs. Oil-based production entails high variable costs, with the exception of district heating plants, i.e. combined production of electricity and heat. Other means of production are thus used in preference to oil-based plants. This is made possible by exchanging power along links that allow for joint operation. Faults can occasionally occur which require a rapid start-up of own, oil-based turbine plants. This can often be avoided through joint operations and imports from a neighbouring country.

Denmark

When the Western world was struck by the so-called oil crisis of the autumn of 1973, Denmark was one of the most oil-dependent countries. Oil accounted for 87 % of the total energy input, and for 80 % of the input to the electrical system. However, some plants were equipped for alternative oil- or coal-fired operation.

There was an urgent need for Denmark to reduce its great dependence on oil. Programs were initiated in a number of areas to attain this goal. Significant results have already been achieved. In particular, it should be mentioned that electric power plants have been converted from oil- to coal-firing at a rate which has aroused international notice. The share of oil consumed by the electricity sector has declined to about 20 % of present consumption and work is in progress to reduce this share even further. Conversions have generally been implemented to allow for alternative operation with oil and coal.

The fuel situation in the 1970's

The Danish power plants which were planned or under construction in 1973 were all designed for oil-firing, and no consideration had been given to future conversion to coal. Oil-firing involves less capital investment as well as a number of practical advantages, including:

- Simple transport and storage of fuel
- Simple combustion
- Rather uniform fuel quality
- No residual products in the form of slag and ash.

It was expected that coal-fired plants would account for a gradually decreasing share of production during the 1970's.

The oil crisis of the autumn of 1973 caused oil prices to rise to previously unknown levels. Production at existing coal-fired plants was increased in order to reduce oil consumption. These were primarily older units. Increased utilization involved high fuel consumption and frequent breakdowns.

It was very difficult to forecast the development of fuel prices. As late as 1974, it was uncertain whether coal would become as expensive as oil and thus make investment in conversion to coal-firing unprofitable.

In 1976 the price differential between oil and coal appeared to have stabilized at about DKK 3/GJ. The first large-scale investments in conversion from oil to coal were authorized in the hope that this price differential would be lasting. In the light of uncertainty as to the development of prices, decisions to invest in conversion were based on short-term pay-offs.

English Summary

Of the new Danish power stations, only the 610 MW unit in Ensted was designed as a coal-fired plant.

Coal-fired power plants

Coal-fired power plants are larger and therefore more expensive to build than oil-fired plants. In Denmark, it has been decided that both new and converted power plants will be able to operate with either coal or oil. The coal-fired plants are therefore to be fitted with the same equipment as the oil-fired ones, in addition to the special equipment that is needed for coal-fired operation, such as unloading and conveying systems, storage facilities, silos, cranes, coal burners, slag and waste silos and electric filters for flue-gas cleaning. Coal-firing also requires larger boilers and chimneys.

Conversion program

The studies which provided the basis for the conversion program covered both conversion of existing plants and changes in the design of plants under construction.

The most far-reaching changes occurred in connection with the decision to change the 675 MW unit at the Asnaes plant from pure oil-firing to coal/oil firing while the unit was under construction. Work on boiler design was already far advanced when the decision was made. The entire design had to be modified. The decision to convert involved delaying the start of operations by several years. This was made possible by the low rate of increase in consumption of electric power.

It had previously been decided that Block 4 (253 MW) in the Asnæs plant would be converted to coal/oil-firing and that both oil-fired units at the Stigsnæs plant would be converted. These decisions involved expanding coal ports and other facilities for handling coal and required large supplementary investment in 1979.

The conversion of the Fyn plant to coal-firing was completed at the start of 1981 and also involved heavy investment with reference to a considerable increase in boiler size, provision of facilities for storage of slag, etc.

Conversion of a unit at the Vendsyssel plant is scheduled for completion during 1982. This project has also required new port facilities with systems for coal transport as well as an expansion of facilities for storing coal.

The table below indicates coal-fired output at the larger Danish power stations.

Unit	MW	Year	
Asnaes	253	1978	Conversion
Vestkraft	244	1979	Conversion
Stigsnæs	270	1979	Conversion
Ensted	1/2·610	1979	New constr.
Skærbæk	269	1980	Conversion
Fyn	269	1981	Conversion
Asnaes	675	1981	New constr.
Vendsyssel	130	1982	Conversion
Stigsnæs	143	1983	Conversion
Total	2558		

Current and completed conversions to coal-firing at Danish power stations have resulted in a considerable decline in the amount of oil required for electricity production. In 1980, oil accounted for only about 20 % of total fuel consumption, as shown in Fig. 4.

The economy of conversion

The conversions which were authorized first were naturally the least expensive and thus the most profitable. A 250 MW unit could be converted for DKK 150 million. It was later shown that this investment could pay for itself in about 1 year.

To date, the Danish power companies have invested about DKK 1 500 million in conversion of plant with a total output of about 1 300 MW. Purchases of fuel for power stations in 1980 amounted to almost DKK 3 000 million. If no plants had been converted, oil would have accounted for about 50 % of the fuel consumed, instead of 20 %, which would generate an additional expense of about DKK 1500 million.

When conversions currently in progress are completed, the share of oil in electricity production will drop to about 10 %. The price differential for coal and oil appears to have stabilized at a level as high as DKK 15/GJ. The question of whether to convert any of the five remaining oil-fired units is therefore being considered.

The share of oil in production cannot be decreased to less than 5 %, as oil is required for start-up of plants as well as in case of breakdowns of coal-fired components and for fast adjustment of production. Many plants also require permanent complementary oil-firing in order to ensure stable combustion.

Coal supplies

The increased consumption of coal has required dealing with a number of questions related to coal handling, such as expansion of coal ports and storage facilities. The need for storage facilities large enough to ensure appropriate supplies involves large amounts of land.

Coal is imported from a number of countries in order to maximize the reliability of supplies. A good deal of coal is still purchased in Europe, but a continuously increasing share is imported from distant countries. Increasingly larger ships are used in an attempt to compensate for the greater cost associated with long distance transport. Vessels of up to 120 000 dwt can now discharge cargo at the ports in Stigsnes and Ensted, but it has been decided that these ports will be enlarged to accept ships of 170 000 dwt. It is expected that future coal carriers will load 170 000–250 000 tons. This will require expansion of ports in both exporting and importing nations. In Denmark, a study is in progress of the possibility of building a very large coal port from which coal could be shipped to other ports in smaller ships.

District heating systems

In 1980, Danish district heating plants delivered 30.8 PJ of district heating. This corresponds to about 10 % of the country's total energy requirement for space heating.

In combined production of heat and electricity in district heating plants, only about half of the fuel consumed should be used for production of heat; the other half should be used for electricity. Coal is the primary fuel. Combined production in these plants reduces annual imported coal requirements by about 750 000 tons.

District heating supplies will increase by about 100% during the 1980's, and this will be accompanied by further reductions in oil imports.

Finland

Supplies of raw materials for energy production were relatively well balanced among various fuels even before the oil crisis of 1973. Oil then accounted for about 50 % of these materials. Coal and other types of domestically produced fuels were already playing a natural role in the energy system. Hydro power had already been expanded by 1973 to a level only several hundred GWh/year below today's level. Natural gas began to be imported from the Soviet Union in 1974 and nuclear power was introduced in 1977.

Considerable energy savings and restructuring of the energy system for an increased share of domestic fuel have already been achieved, and these efforts are continuing.

Development of the electric power system

From the 1980's onward, nuclear power will account for a considerable share of Finland's electricity supplies, i.e. about 30 % by the mid-80's. In terms of fossil fuels, an increased share is expected for coal and a decreased share for oil. The use of domestic fuels had already grown prior to 1980, largely as a result of increased consumption of peat. Consumption of domestic fuel is expected to continue to increase somewhat. As far as hydro power and production of electricity from natural gas is concerned, only marginal increases are expected over present levels. On the other hand, imports of electricity from the Soviet Union during the first half of the 1980's are expected to increase to 4 TWh/year. Fig. 5 shows the forecast and actual distribution of types of energy in the electric power system for the period 1970–1990.

The share of oil-based electricity production was about 20 % during the early and mid-1970's. It declined to about 10 % by 1980. During the 1970's, oil was used primarily in industrial back-pressure plants (i.e. plants which produce both electricity and steam for industrial processes) and in condenser plants (i.e. plants which produce electricity only). Industrial oil based back-pressure production has amounted to about 2 TWh/year. The amount of oil consumed in condenser plants has varied from year to year, depending on the prevailing power situation.

In the light of violent fluctuations in price differentials for various fuels, work has started on converting oil-fired power plants, primarily for operation with solid fueld. This has not been accompanied by changes in production capacity. Conversions are planned for seven power plants with a total installed capacity of slightly more than 600 MW. The three largest plants, Vasklot at Vasa (150 MW), Kristinestad (200 MW) and Kymijärvi at Lahti (150 MW) went into operation in 1972, 1974 and 1976, respectively. The oil-fired boilers in the Vasklot and Kristinestad plants were replaced with new coal fired boilers. The boiler in the Kymijärvi plant was converted for coal-firing. Following these conversions, total coal-fired capacity amounts to 2 000 MW of condenser power and 1 100 MW of back-pressure power. Total installed capacity at the Finnish power plants amounted to about 11 000 MW at the start of the 1980's.

Two units in the coal-fired Nådendal power plant will be converted for production of heat. The present output of 120 MW of electricity per unit will then drop to 90 MW. On the other hand, about 170 MW of thermal energy can be extracted from each of the converted units. This heat will be fed into the district heating system in the Åbo area and will partially replace oil-fired space heating. The first unit will be ready in the autumn of 1982 and the second in 1986.

The Vanaja condenser power plant will also be converted to a coal- or peat-fired district heating plant and will supply Tavastehus with space heating. This project will be completed by the end of 1982 and will provide a district heating capacity of 80 MW. District heating for Tavastehus is currently based on oil and peat.

Current forecasts of electricity consumption assume that condenser power capacity will be expanded at the start of the 1990's. Nuclear power, coal and peat-based condenser power are being studied as alternatives.

Increased expansion of district heating network

The share of district heating in Finland increased during the 1970's, and is expected to continue increasing during the 1980's. However, as a result of of various energy-saving measures the increase in the number of dwellings connected to the district heating network has not been accompanied by a corresponding increase in the quantity of district heating delivered. Increases in production of district heating are based primarily on coal along the coast and peat in the interior. The degree of individual oil-fired heating is expected to decline sharply during the 1980's and to be replaced by electric heating or units that can be fired by both electricity and solid fuel, among other things.

The comprehensive expansion of district heating anticipated for the 1980's will involve large municipal investments. In this respect, power companies see an opportunity to promote and hasten development by providing help for construction of district heating plants and hot-water plants. These facilities are being engineered for coal- or peat-firing and are expected to generate reduced oil consumption in smaller localities as well.

District heating plants are currently under construction in Helsinki (coal-fired) as well as in Kuopio, Jyväskyla and Joensuu (peat-fired).

During annual overhauls of district heating plants, heat has been supplied to date primarily from reserve oil fired boilers. Electric boilers are being installed, so that from 1982 onward oil will be replaced by electricity during the summer. The output from electric boilers in the district heating network is expected to reach 400–600 MW by 1983.

Cooperation between industrial plants and municipalities in the same neighbourhood can be of advantage for both partners. This type of cooperation is already in progress at about ten localities in Finland. Purchases of district heating from industrial facilities can reduce oil consumption in a community, as solid fuel is often used in industrial plants. In addition, production of process steam can be combined with production of district heating for the community. This justifies larger plants and allows for more economical combined production of electricity and district heating.

Individual space heating

The Imatran Voima Power Company is running an experimental project involving studies of various space heating systems for one-family dwellings. The goals of the study include generating data on energy consumption and costs for various systems. The study covers 1 000 detached houses with different types of direct and indirect electric heating as well as heat pumps and solar energy systems. Various types of heat distribution systems are also being compared. District heating and oil fired systems are being used as reference points. The results of the study are expected to be available in 1983.

Iceland

Iceland has extensive domestic energy resources in the form of hydro power and geothermal energy, but only about 10 % of these resources are currently being utilized. Imported petroleum products account for about half the energy consumed in Iceland. Reducing dependence on oil is therefore an important goal of Iceland's energy policy. However, it was not until 1979 that energy conservation began to play an important role in energy policy. The five main points of the Icelandic energy conservation program are:

- To replace oil for space heating with geothermal heat or electricity.
- To replace oil in industrial processes with domestic energy.
- To achieve more effective utilization of oil.
- To replace expensive petroleum products with cheaper ones.
- To develop processes for production of synthetic fuel from domestic energy resources.

Fig. 6 illustrates the shares of various types of energy in Icelandic energy supplies since 1960 as well as the forecast development until 1990.

Total energy consumption

Space heating and household consumption accounted for about 46 % of total energy consumption in 1979. Geothermal energy was the most important source, providing about 73 % of requirements. Petroleum products accounted for about 18 % and hydro-based electricity for about 9 %.

Industry also accounted for a considerable share of energy consumption, about 25 % in 1979. Energy-intensive industries (aluminium, etc.) accounted for slightly more than half of this amount. Energy for industrial use was supplied in roughly equal proportions (about 42 % each) by hydro power and petroleum products. The remaining 15 % was derived from geothermal energy. Fishing and transportation accounted for 13.5 % and 11 % of total energy consumption and were based exclusively on petroleum products.

Electrical energy sector

Electrical energy has a share of about 25 % in Iceland's total energy consumption. Hydro power generates 98 % of the electricity and the remainder is derived mainly from geothermal sources. Oil-based electrical energy has an insignificant share and is used only in isolated areas or in the event of breakdowns.

Although per capita electricity consumption in Iceland is among the highest in the world (about 12 700 kWh), only a vary small portion of the country's domestic energy potential in terms of both hydro power and geothermal energy has had to be utilized until today.

All districts in Iceland are now connected to the high-voltage grid. The last connection was made in December, 1981. Work is in progress on additional reinforcement of the electric grid in various parts of the country.

Current measures to reduce dependence on oil

An Energy Conservation Committee was appointed in June, 1979. No special laws on energy conservation have yet been introduced, but a number of projects have been initiated to this end, including a broad campaign of information and education. In addition, loans have been authorized for energy conservation in homes. The Building Code has been modified but is still less restrictive than those in other Nordic countries.

The present substantial use of geothermal energy for residential space heating is expected to increase even more. A continuous transition to electric heating is in progress in areas without geothermal energy resources. In the Øst- and Vestlandet regions, where there is no geothermal energy available, the district heating system includes electric- or oil-fired hot water stations and is being expanded.

In certain areas where the temperature of geothermal sources is so low that they cannot be used directly for space heating, the use of heat pumps is planned. An experimental project is under way to determine the economic potential of heat pumps at geothermal temperatures of 16° C.

A geothermal district heating system has been built on the Reykjanes peninsula. This plant produces 8 MW of electricity as well as space heating for the peninsula. An increase in electricity production is planned.

The use of hydro-based electricity and geothermal energy will be increased in order to reduce the dependence of industry on oil. The fish-processing industry is highly dependent on oil and is considered to have a high potential for oil conservation.

The fisheries comprise one of the main industries in Iceland. It is expected that fishing vessels will continue to rely on oil-based energy over the next few decades. However, large fishing boats are being converted from diesel to heavy oil, which is about 40 % cheaper. In addition, attempts are being made to use land-based electricity supplies while the vessels are in port.

The possibility of producing methanol or oil by using hydro-based electricity is under discussion. Hydrogen atoms would be generated by electrolysis of water and carbon atoms from peat, which occurs in large deposits in Iceland, or from lignite, which is also found on the island.

Norway

There were considerable changes in the Norwegien energy market during the 1970's. The share of electricity in total energy consumption increased sharply, while the shares of petroleum products, solid fuels and gas were reduced. Changes were especially large after the oil crisis in the autumn of 1973.

In terms of the theoretical content of the supplies of different types of energy to end-users, between 1970 and 1978

- the share of electricity increased from about 37 % to about 43 %,
- the share of petroleum products decreased from about 53 % to about 50 % and
- the share of solid fuel and gas decreased from about 10 % to almost 7 %.

For many years, low electricity prices have made it profitable to use electricity for space heating. Nevertheless, a large proportion of space-heating requirements are still met with oil. Following the oil crisis in the autumn of 1973 and the subsequent rise the price of oil, there was anxiety about steep increases in the share of electric space heating. The basis for this anxiety was the difficulty anticipated in expanding hydro power production sufficiently quickly. Electric space heating was therefore not advertised. In many areas, there were also certain restrictions on the use of electricity for space heating.

The steep increase in the price of oil since 1979 has made it even more profitable to switch from oil to electric heating, and consumers are now being urged to make the switch.

Electricity consumption in households, trade, etc. increased by approximately 5 % in 1981. Consumption in 1981 was about 2 TWh higher than indicated in the forecast of 1977.

Fuel costs for space heating with light oil in 1981 were about twice as great as for electric heating. Sales of fuel oil declined by slightly more than 9 %. The reduction in the volume of fuel oil corresponded to about 2 TWh of electricity.

While the conversion to electricity is now in progress, a number of industries including the cement industry are switching from oil to coal. There is also some tendency to convert to wood among small consumers who can obtain wood cheaply.

Large annual fluctuations in hydro power production

Hydro power capacity varies considerably from year to year as a result of heavy precipitation (wet years) and light precipitation (dry years). Fig. 7 indicates estimated annual production on the basis of capacity in 1980 and the recorded access to water during the period 1931–1960. Annual production varied between a high of 99 TWh and a low of 75 TWh. The maximum difference between wet and dry years has thus been 99–75=24 TWh, and this will increase as more hydro power is utilized.

Normal supplies and surplus supplies

Normal power supplies refer to deliveries of electricity that power companies are legally bound to deliver to customers. This is the forecast power requirement. In 1980, domestic normal power potential corresponded to 79 TWh/year. This quantity can be increased to 83 TWh/year with reference to the capacity for joint operations with Sweden and Denmark.

As production capacity is greater than needed for supplies of normal power, surplus supplies can be delivered in wet years. As shown in Fig. 7, capacity for surplus supplies in the wettest year would be 99–83=16 TWh. In other years, there would be less capacity; capacity would be zero in the driest year. Surplus supplies are not forecast. It is assumed that they will be used where they are of greatest value.

Markets for surplus power

Surplus power can be marketed within the country or exported to neighbouring countries. The Swedish decision to utilize nuclear power over the next few decades has reduced the possibility of exporting power to that country. In contrast, there are considerable opportunities for export to Denmark, where electricity supplies are largely based on coal-fired production. Potential exports to Denmark total 3.5 TWh/year but can be doubled if the capacity for joint operation between Norway and Jutland is doubled.

The energy-intensive industries (aluminium, ferrous alloys, etc.) and the wood-conversion industry can increase production if they can purchase surplus power at a competitive price. The market for surplus power is estimated at 1–2 TWh/year for energy-intensive industries and about 5 TWh/year for the wood-conversion industry.

Space heating is nevertheless the most interesting market for surplus power. The space heating requirement for large buildings currently corresponds to slightly more than 20 TWh/year of energy. Of this total, 4 TWh/year is derived from electricity, about 15 TWh/year from oil-fired central heating and about 1.5 TWh/year from a combination of electric and oil-fired boilers. This potential market for electric heating thus amounts to about 16.5 TWh/year. In addition, addition of a new stock of large buildings with a heating requirement of about 3.5 TWh/year is anticipated over the next 10 years. The potential heating energy market for large buildings over the next decade thus amounts to about 20 TWh/year. To this should be added oil corresponding to about 6 TWh/year for space heating in one-family houses.

The portion of the space-heating market that is based on light oil bears a cost corresponding to about 35 öre/kWh. It would be relatively easy and not particularly expensive to install electric boilers in connection with existing oil-fired boilers in a large part of the stock of buildings. This would provide flexibility in the form of an option to use electricity or oil. When surplus power is cheapest, electricity would be used for space heating. At other times, oil would be used.

In 1981 prices, a profit of NOK 1 350 million would be generated if oil representing a consumption of 15 TWh/year were replaced with electricity.

Measures proposed

To date, the price of surplus power to domestic users has been based on a comparison with oil. This has had an adverse effect on consumption of surplus power and on increases in output of electric boilers. It is now proposed that the price be based on the market price of surplus domestic power instead. This price-setting principle would stimulate installation of electric boilers in connection with existing oil-fired boilers. The latter should be retained so that it will be possible to use the cheapest form of energy at a given moment. From the point of view of social cost, the space-heating sector should not be based on normal power supplies, which should be reserved for applications where there is no possibility of choosing. The lack of choice can be traced primarily to resistance from environmentalists who oppose the expansion of hydro power facilities to meet normal power requirements.

A considerable amount of conversion from oil to electricity is anticipated for one-family houses. This is considered to be a desirable development despite the problems involved for power companies as a result of increased normal requirements and the need for reinforcement of the distribution network.

Other

In conclusion, it should be mentioned that comprehensive efforts are under way in Norway – although the power companies are not involved in most of them – with respect to heat pumps and alternative energy production. The fact that the stock of buildings is concentrated along the country's extensive coastline means that heat pumps based on seawater as a heat source are an attractive alternative for space heating. In terms of new forms of energy, wave energy is the principle object of study in Norway.

Sweden

Crude oil and petroleum products accounted for about 72 % of total input to the Swedish energy system in 1973. Efforts have been made to reduce dependence on oil, but oil is still the most important component of the country's total energy supplies. In 1980, oil had a share of about 60 %. (The higher percentages that are sometimes given are generated by a different method of calculating the share for nuclear fuel.)

Efforts for further reduction of dependence on oil are in progress in a number of areas. The Government has defined the goal as a reduction of oil imports for energy (i.e. excluding oil for the chemical industry, etc.) from 26 million tons in 1979 to 14–17 million tons in 1990.

The power system's potential for reduced oil dependence

The Riksdag's authorization of the use of nuclear power in Sweden has created a good opportunity for satisfactory capacity in terms of electricity production, primarily during the 1980's. Implementation of the expansion program for 12 nuclear plants is expected to result in such a small requirement for oil for electricity production during the 1980's that only marginal efforts for further reductions would be profitable.

Fig. 8 shows the production resources available under normal conditions for existing and authorized facilities until 1990. Some additional capacity may be built. The figure also includes a curve for forecast loads. This forecast is the result of a comprehensive CDL study which was submitted in the autumn of 1981. It assumes considerable increases in electric space heating, from 11 TWh in 1978 to 28.5 TWh in 1990. A large part of the increase in electric space heating is expected to result from a conversion from oil to electricity in one-family houses. It has been assumed that the proportion of these dwellings with electric space heating will increase from about 33 % at present to 75 % (1.33 million dwellings) in 1990. If the forecast development of space heating occurs, requirements for light fuel oil will be reduced by slightly more than 2 million tons per year.

The energy balances that can be prepared for the 1980's suggest that hydro power and nuclear power will be sufficient in years in which access to water is greater than normal (wet years). A degree of back-pressure production will be necessary in normal years, and in years with reduced access to water (dry years) an addition of condense power will also be required.

Energy balances allow for the use of combination electric boilers (i.e. electrically heated water tanks for production of hot water or steam) which utilize cheap electricity from hydro or nuclear power plants during periods, primarily in the summer, that are determined by the power producers. The Government has authorized tax exemptions for such deliveries in order to stimulate optimal utilization of production resources.

A study has revealed that installation of about 1 300 MW of electric boiler output is planned for the first half of the 1980's. Total electric boiler capacity in 1985 can thus be estimated at about 2 000 MW.

Increased use of solid fuel

The dependence on oil in the space-heating sector is extensive, as about 80 % of the dwelling units in Sweden are heated by oil. A substantially reduced dependence on oil can be achieved by converting district heating systems to solid fuel (coal, peat, wood-chips).

Increased production of heat from solid fuel can be achieved by rebuilding existing oil-fired district heating plants. This has been done in Västerås, for example, where two rebuilt units for a coal-fired output of 90 MW of electricity went into operation in the summer of 1981 and the conversion of a 250 MW block is planned. At the Hässelby district heating plant outside Stockholm, three units with a total electricity output of about 70 MW are now being converted. In the past, these units could be only partially (1/3–1/2) fired with coal. Oil accounted for the rest. The conversion will be completed during 1982.

If the planned expansion of district heating systems is implemented it will create an opportunity to build new, solid-fuel-fired district heating plants. New facilities under construction include a coal-fired district heating plant in Helsingborg scheduled to begin operation in 1983 with an electricity output of about 60 MW. A coal fired boiler has been ordered for the district heating plant in Norrköping, which will subsequently (1984–85) be expanded for production of about 75 MW of electricity. Additional expansion is planned.

In the spring of 1979 the State Power Board submitted a study of the potential for peat-fired electricity and space heating production in the four northernmost provinces of Sweden. Preliminary engineering of several plants has been completed in cooperation with local power companies.

The need for new capacity for electricity production during the 1980's is limited, as mentioned above. A considerable share of the new capacity required for space-heating production should therefore be obtained in the form of solid-fuel-fired hot water stations. An example is provided by the current expansion of a coal fired hot water station in Södertälje.

Development projects for oil conservation

Heat pumps
Good opportunities exist to save substantial quantities of oil by using electrically driven heat pumps for space heating. A number of power companies including the State Power Board and Sydkraft are actively engaged in this field.

Development work is in progress with respect to small heat pumps for one-family houses and large heat pumps. A number of facilities of varying sizes and designs are in operation and are being evaluated. Several more are also being engineered or are under construction. Large heat pumps connected to district heating systems are especially interesting in terms of oil conservation. The State Power Board has recently ordered two large heat pumps with thermal outputs of 10 MW each (about 3 MW of electricity), from which heat will be delivered to existing district heating systems. One of the goals of this investment is to acquire experience of large heat pumps in terms of both technology and economy. If the results of this development project are favourable, large-scale use of similar heat pumps will be possible.

Coal/oil mixtures
Studies are in progress at the district heating plant in Uppsala regarding the technical possibilities of using coal/oil mixtures. These studies cover small- and large-scale experiments and tests. At present, a number of important problem areas can be defined.

These problems must be solved before the technique can be introduced commersially.

Natural Gas in the Nordic Countries

by Arvid Persson, Managing Director, Sydgas AB

Natural gas accounts for close to 20 % of international energy supplies. This means that natural gas accounts for roughly the same share of total energy consumption as electric power.

The only Nordic country which has thus far made use of natural gas as part of its energy supply is Finland, which imports gas from the Soviet Union under an agreement providing for imports of up to 1.4 billion m^3 annually. However, maximum annual natural gas consumption to date in Finland has been slightly more than 1 billion m^3, which corresponds to about 3 % of the country's total energy needs. One billion m^3 of gas corresponds to about 1 million m^3 of oil. The gas is consumed by about 20 industrial companies, above all in the wood conversion industry in southeast Finland. Plans exist for expanding gas distribution to the entire south of Finland and for further transport of gas through pipelines in the Gulf of Bothnia to Sweden.

Considerable deposits of natural gas exist in the Danish, and above all in the Norwegian sector of the North Sea. Natural gas is now delivered through pipelines from the Ekofisk field in the Norwegian sector to Continental Europe, and from the Frigg field to England. In the summer of 1981, the Norwegian Parliament authorized the construction of a pipeline from the Statfjord field to Kårstö, north of Stavanger, and from there out to sea again to the Ekofisk field, where it will connect with the pipeline to the Continent. Another branch from the Heimdal field will connect with the new pipeline. In 1980, Norwegian gas production amounted to somewhat more than 25 billion m^3, which represents an energy content roughly equal to that of Norwegian oil production in the same year. Production of gas will increase through both planned and already authorized expansion. No decision has yet been made regarding the distribution and use of natural gas in Norway.

In 1979, the Danish Parliament authorized the introduction of natural gas in Denmark, based on the existence of gas deposits in the Danish sector of the North sea. This project involves a total of 2.5 billion m^3 of natural gas annually, which will correspond to about 10 % of Denmark's total energy consumption in 1990. A second phase of the project which has not yet been authorized would involve expanding deliveries to as much as 4 billion m^3 annually. A long-term increase in the share of gas used for space heating is expected. A small portion of the gas will be exported to Sweden. The Danish natural gas network is expected to go into operation in 1982 with imports from West Germany. Deliveries from the Danish North Sea fields will start in 1984, when the pipeline to Zealand and Copenhagen has been completed.

The Swedish Parliament authorized the so-called Sydgas (South-Gas) project in 1980. This involves importation of 440 milljon m^3 of natural gas annually, primarily from Denmark, and distribution of the gas in western Scania (the southernmost province of Sweden). The project will generate a reduction of about 2 % in the consumption of oil in Sweden. Oil consumption will decline by about 20 % in the area affected by the Sydgas project. Deliveries from Denmark will start in 1985.

A number of alternatives for increasing the consumption of natural gas in Sweden are now being studied. A cooperative Norwegian-Swedish-Finnish study is in progress regarding the possibility of finding a market for gas in the Tröndelag, Östersund–Sundsvall and eastern Finnish areas. These studies are intended as preparatory measures with a view to possible gas finds in the Halten Bank in the North Sea, where test drilling has been started. The Norwegian Statoil Company is preparing for a possible gas find in the Tromsö Shelf north of Norway, while the Swedish State Power Board (Sw. Vattenfall) and Swedegas are investigating the possibility of transporting gas from the Tromsö Shelf to the Continent via a pipeline through Sweden. Branches from this pipeline would provide a basis for expansion of Swedish natural gas supplies.

Apart from coal and uranium, natural gas is the only technically developed energy source which can be expected to be available for the purpose of reducing oil consumption. Power companies in all the Nordic countries have shown an increasing tendency to become energy companies. Natural gas is thus a promising area of development.

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 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.

The chairman of Nordel is elected for a period of three years. The chairmanship circulates among the countries. The chairman appoints a secretary who is responsible for the administrative functions during the three year period.

Nordel

Nordel, som grundades 1963, är en sammanslutning för nordiskt elkraftsamarbete. Nordel består av ledande personer inom kraftförsörjningen i Danmark, Finland, Island, Norge och Sverige. Det är ett rådgivande och rekommenderande organ med syfte att befrämja internationellt, främst nordiskt samarbete, beträffande produktion, distribution och konsumtion av elenergi.

Nordel har följande fasta arbetsuppgifter:

- att kontinuerligt följa utvecklingen av produktionen och konsumtionen av elenergi i de nordiska länderna, bl a genom publicering av lämplig statistik
- att sammanställa inom respektive länder uppgjorda konsumtionsprognoser och utbyggnadsplaner
- att publicera en årsberättelse, som förutom uppgifter om under året utfört arbete inom Nordel samt statistiska uppgifter angående elkraftförsörjningen i de nordiska länderna även kan innehålla speciella artiklar av intresse för nordiskt kraftsamarbete.

En stor del av Nordels arbete utförs av utskott och grupper. Genom dessa har man tillgång till specialister inom alla områden av elförsörjningen. För insamling av statistik och annan periodisk rapportering finns speciella kontaktmän i de olika landen. Inom Nordel finns också kontaktmän i många internationella organisationer på energiområdet.

Nordels ordförande väljs för en period om tre år. Ordförandeskapet cirkulerar mellan länderna. Ordförande utser sekreterare och svarar för sekretariatet som alltså även det växlar vart tredje år.