PRODUCTION

Danish Energy Agency

17 December 2015

PRODUCTION

Oil production in 2014 totalled 9.6 million m^3, a 6 per cent decline compared to 2013. From 2013 to 2014 the production of sales gas fell by 4 per cent to 3.8 billion Nm^3.

Sales gas were forecast to total 4.5 billion Nm^3 in 2014, but several unplanned shutdowns in the Tyra Field and other factors had a negative impact on production, especially gas production. Danish oil production in 2014 largely met expectations for the year, only falling 3 per cent below the forecast.

The steep decline in production since 2006 seems to have been halted in 2014. Activities in 2014 focused on preventive maintenance and well maintenance, at the same time as work proceeded on extending the South Arne Field with a northern platform and new wells.

The Siri Field was closed during the first half of 2014. A crack identified in the tank console under the Siri platform in July 2013 led to a temporary shutdown of the Siri, Nini and Cecilie Fields in the second half of 2013. Production from the Nini and Cecilie Fields was resumed in January 2014, with the production being loaded directly into tankers. In the summer of 2014, the damage was repaired and a planned reinforcement of the platform carried out. Production from all three fields was back to normal by the autumn of 2014.

The northern part of the South Arne Field was further developed in 2014. Consequently, production from the field rose steadily throughout 2014 in step with new wells coming on stream. The drilling of new wells from the northern platform, connected by a bridge to the southern platform, has continued into 2015.

The DUC has carried on production in the North Sea since 1972 under the Sole Concession, and many of their installations are now of a mature age. For the purpose of carrying out extensive maintenance work and replacing equipment, the operator, Mærsk Olie og Gas A/S, has performed planned shutdowns on selected fields during the summer for a number of years. Thus, they closed down production for almost two weeks in June 2014 in order to replace flare stacks and a bridge on the Tyra platforms, among other equipment. In addition, the new unmanned platform at Tyra Southeast, TSB, was installed. This platform can receive production from up to 16 new wells and is connected by a bridge to the existing unmanned platform at Tyra Southeast, TSA.

An outline of all 19 producing fields, including annual production figures, is available at the DEA's website. These production statistics date back to 1972, when Danish production started from the Dan Field.

PRODUCTION FACILITIES IN THE NORTH SEA

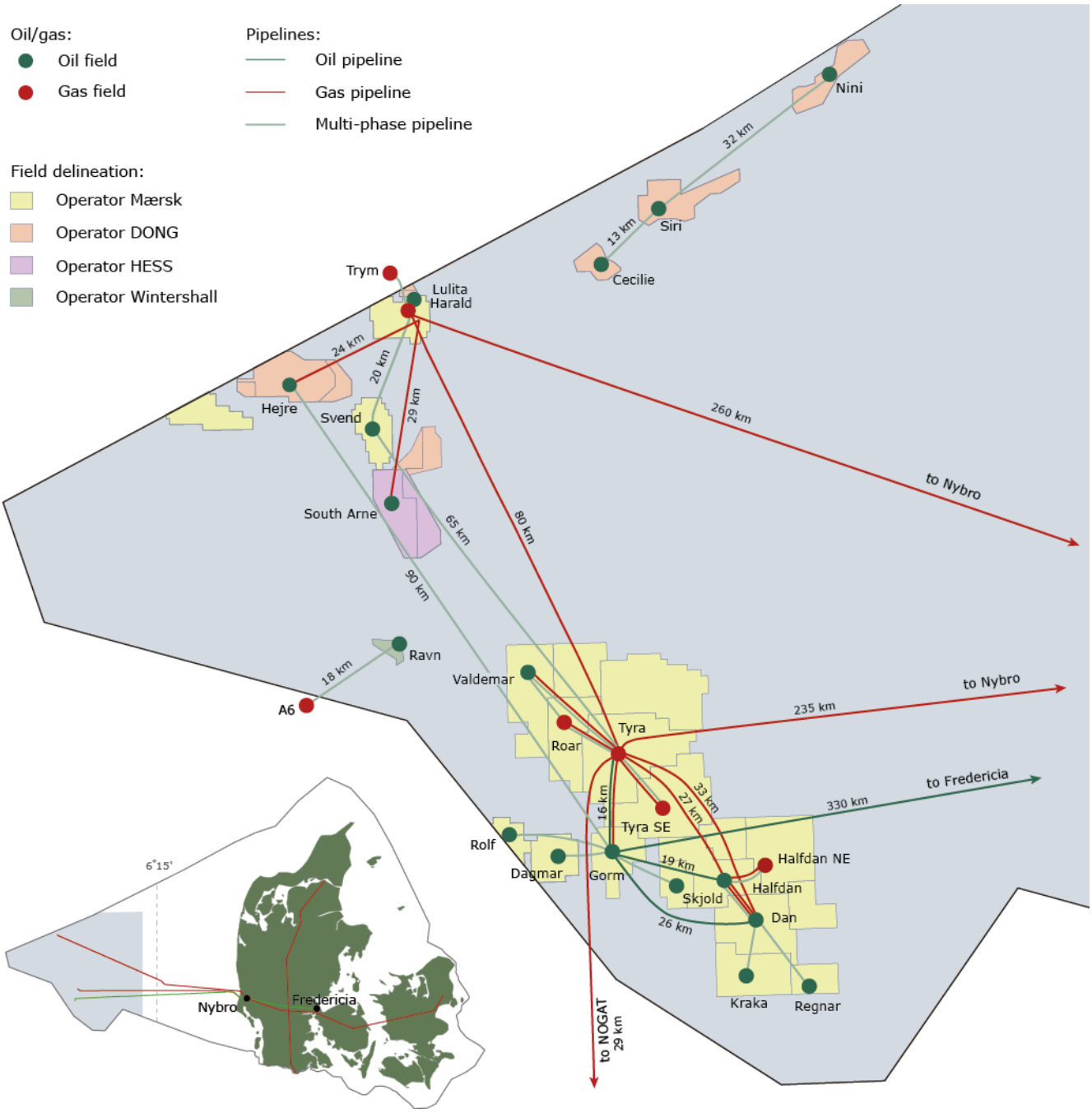


Figure 1. Location of production facilities in the North Sea 2014

All producing fields in Denmark are located in the North Sea and appear from this figure, which also shows the key pipelines. In total there are 19 producing fields, and three operators are responsible for production from these fields: DONG E&P A/S, Hess Denmark ApS and Mærsk Olie og Gas A/S. The fields Hejre and Ravn are under development.

PRODUCTION IN 2014

Oil production in 2014 totalled 9.6 million m^3, corresponding to 165,000 barrels per day, a 6 per cent decline compared to 2013. The production of natural gas totalled 4.5 billion Nm^3 in 2014, of which 3.8 billion Nm^3 of gas was exported ashore as sales gas, a 4 per cent decline compared to 2013.

As expected, production from the Danish part of the North Sea is in general continuing the declining trend that started in 2004. The main reason for this trend is that the majority of fields have already produced the bulk of the anticipated recoverable oil.

In addition, these ageing fields require more maintenance as regards wells, pipelines and platforms. This maintenance work often causes a loss or delay in production, as the wells and possibly even the entire platform must be shut down while the work is carried out.

The development of existing and new fields may help counter the declining production. In addition, the implementation of both known and new technology may help optimize and increase production from existing fields.

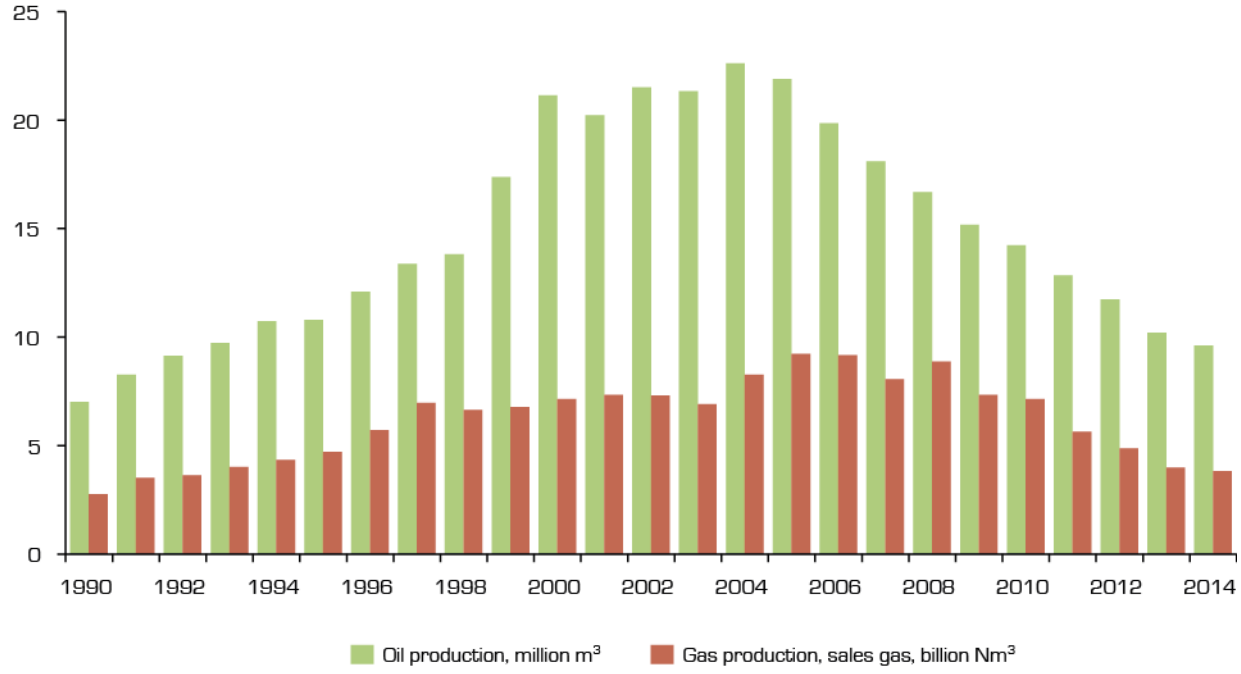


Figure 2. Production of oil and gas 1990-2014

BREAKDOWN OF OIL PRODUCTION BY COMPANY IN 2014

A total of 11 companies participated in production from Danish fields in 2014. DUC is the largest producer, accounting for 85 per cent of oil production and 95 per cent of gas exports. DUC's share of production has fallen compared to previous years, which is due to declining production in DUC's fields and increasing production from the South Arne Field as a result of its further development.

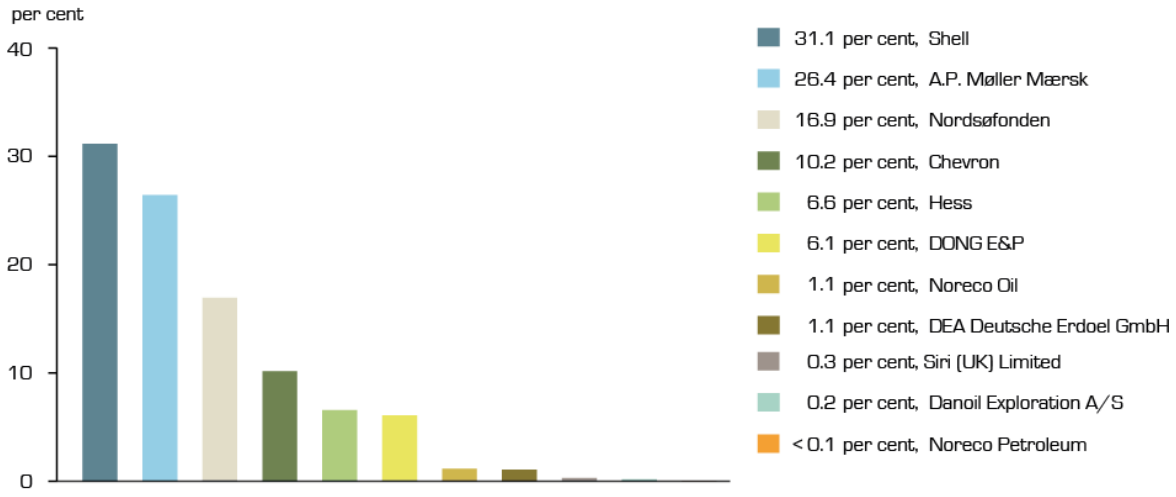


Figure 3. Breakdown of oil production by company in 2014

USE OF PRODUCTION

The production of natural gas totalled 4.5 billion Nm^3 in 2014. 3.8 Nm^3 of gas was exported ashore as sales gas i.e. 84 per cent of the total gas production. The remainder of the gas produced was either reinjected into selected fields to improve recovery or used as fuel on the platforms. A small volume of unutilized gas is flared for technical and safety reasons.

13 per cent of the gas produced was used as fuel in 2014. Flaring accounted for 2 per cent of gas production, while 1 per cent was reinjected into the Siri Field because gas cannot be exported from this field. The general increase in fuel consumption until 2007 is attributable to rising oil and gas production and ageing fields. The reason for the sharp drop from 2008 is falling production combined with energy efficiency measures taken by the operators.

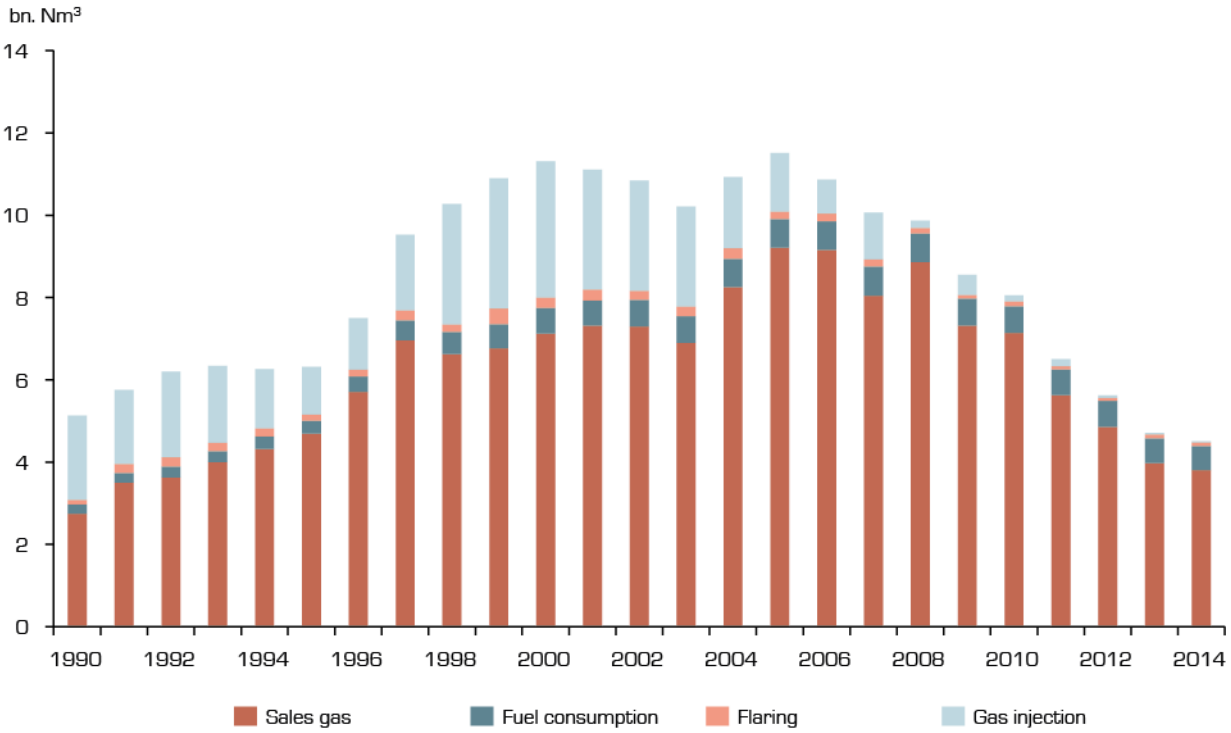


Figure 4. Use of gas production in the period 1990-2014

TABLE 1. OIL PRODUCTION

Thousand cubic metres

	1972-2006	2007	2008	2009	2010	2011	2012	2013	2014	TOTAL
DAN	86,349	4,650	4,241	3,549	2,979	2,474	2,260	2,045	1,794	**110,341**
GORM	54,400	1,639	1,053	924	923	713	593	543	425	**61,213**
SKJOLD	39,556	1,015	989	918	835	778	679	605	587	**45,962**
TYRA	23,450	764	551	415	856	744	626	521	501	**28,430**
ROLF	4,109	103	78	76	60	1	0	0	0	**4,427**
KRAKA	4,602	176	112	37	67	170	129	101	89	**5,483**
DAGMAR	1,005	0	0	0	0	0	0	0	0	**1,005**
REGNAR	930	0	0	0	0	0	0	0	0	**930**
VALDEMAR	3,454	881	1,268	1,410	909	817	844	777	762	**11,122**
ROAR	2,474	35	28	30	24	16	2	4	6	**2,619**
SVEND	6,002	299	278	195	190	145	171	183	160	**7,623**
HARALD	7,493	139	114	65	70	95	79	25	21	**8,101**
LULITA	778	55	47	24	36	36	32	17	26	**1,050**
HALFDAN	29,608	5,785	5,326	5,465	5,119	4,905	4,617	4,150	3,674	**68,650**
SIRI	9,875	508	598	326	286	161	238	131	94	**12,217**
SOUTH ARNE	16,539	1,245	1,139	1,164	1,066	1,004	803	700	1,023	**24,683**
TYRA SE	2,475	377	429	374	225	165	148	98	91	**4,382**
CECILIE	774	88	66	38	33	39	33	17	10	**1,098**
NINI	2,869	323	355	159	544	569	475	268	336	**5,899**
TOTAL	**296,744**	**18,084**	**16,672**	**15,169**	**14,223**	**12,834**	**11,727**	**10,185**	**9,599**	**405,237**

TABLE 2. GAS PRODUCTION

Million normal cubic metres

	1972-2006	2007	2008	2009	2010	2011	2012	2013	2014	TOTAL
DAN	21,075	456	467	364	360	327	330	416	408	**24,204**
GORM	15,056	175	119	109	99	67	52	60	36	**15,772**
SKJOLD	3,274	69	60	58	87	69	62	70	68	**3,816**
TYRA	77,552	3,916	3,130	2,007	1,664	1,320	1,404	1,618	1,474	**94,085**
ROLF	172	4	3	3	3	0	0	0	0	**186**
KRAKA	1,320	28	36	8	12	46	35	20	18	**1,523**
DAGMAR	158	0	0	0	0	0	0	0	0	**158**
REGNAR	63	0	0	0	0	0	0	0	0	**63**
VALDEMAR	1,453	355	593	510	791	579	515	368	343	**5,507**
ROAR	13,322	367	417	398	213	171	24	28	46	**14,986**
SVEND	712	28	24	16	27	24	27	20	16	**893**
HARALD	18,827	781	690	400	592	573	541	174	274	**22,853**
LULITA	503	33	30	15	18	20	19	11	18	**668**
HALFDAN	9,617	2,675	3,104	3,401	2,886	2,343	1,709	1,389	1,309	**28,432**
SIRI	1,011	47	63	44	67	48	48	35	13	**1,376**
SOUTH ARNE	4,191	234	225	271	248	238	194	167	238	**6,007**
TYRA SE	4,577	848	889	939	911	626	610	306	201	**9,908**
CECILIE	57	6	4	2	2	3	3	1	6	**83**
NINI	212	24	26	12	76	57	40	22	35	**504**
TOTAL	**173,154**	**10,046**	**9,879**	**8,559**	**8,057**	**6,511**	**5,613**	**4,704**	**4,502**	**231,024**

TABLE 3. GAS, EXPORT OF SALES GAS PRODUCED IN DENMARK

Million normal cubic metres

	1972-2006	2007	2008	2009	2010	2011	2012	2013	2014	TOTAL
TYRA EAST	105,817	5,720	6,666	5,551	6,228	4,807	3,739	2,808	3,164	**144,500**
SOUTH ARNE	3,656	168	167	212	199	180	130	108	182	**5,002**
TYRA WEST	5,164	2,161	2,032	1,560	715	648	994	1,066	467	**14,806**
TOTAL	**114,637**	**8,049**	**8,865**	**7,324**	**7,142**	**5,635**	**4,863**	**3,981**	**3,813**	**164,308**

TABLE 4. GAS, FUEL*

Million normal cubic metres

	1972-2006	2007	2008	2009	2010	2011	2012	2013	2014	TOTAL
DAN	2,403	222	225	207	206	179	167	178	175	**3,963**
GORM	2,529	132	117	116	111	107	107	105	93	**3,416**
TYRA	3,574	228	233	219	208	188	171	150	149	**5,120**
DAGMAR	21	0	0	0	0	0	0	0	0	**21**
HARALD	95	7	7	4	8	16	17	12	15	**181**
SIRI	157	25	25	19	27	28	26	16	17	**338**
SOUTH ARNE	313	58	53	54	55	41	64	60	55	**754**
HALFDAN	98	39	38	39	36	62	76	77	76	**540**
TOTAL	**9,190**	**711**	**699**	**658**	**651**	**620**	**628**	**597**	**580**	**14,334**

TABLE 5. GAS, FLARING*

Million normal cubic metres

	1972-2006	2007	2008	2009	2010	2011	2012	2013	2014	TOTAL
DAN	1,995	29	25	17	12	13	13	14	15	**2,132**
GORM	1,709	48	41	19	12	14	15	18	22	**1,898**
TYRA	1,092	56	44	32	23	28	25	41	30	**1,371**
DAGMAR	135	0	0	0	0	0	0	0	0	**135**
HARALD	135	2	2	2	3	3	2	11	2	**161**
SIRI	215	7	7	4	58	6	4	3	4	**307**
SOUTH ARNE	223	11	7	7	6	11	5	3	5	**278**
HALFDAN	64	17	8	4	5	6	6	7	8	**124**
TOTAL	**5,567**	**169**	**132**	**85**	**119**	**81**	**71**	**97**	**85**	**6,406**

TABLE 6. GAS, INJECTION

Million normal cubic metres

	1972-2006	2007	2008	2009	2010	2011	2012	2013	2014	TOTAL
GORM	8,164	0	0	0	0	0	0	0	0	**8,164**
TYRA	34,667	1,094	119	451	89	94	0	0	0	**36,514**
SIRI	910	45	61	35	57	74	62	41	21	**1,306**
CECILIE	0	0	0	0	0	0	0	0	14	**14**
NINI	0	0	0	0	0	0	0	0	1	**1**
TOTAL	**43,741**	**1,139**	**180**	**486**	**146**	**168**	**62**	**41**	**36**	**45,999**

* Including Trym

WATER PRODUCTION AND WATER INJECTION

Water is produced as a by-product in connection with the production of oil and gas. The water can originate from natural water zones in the subsoil and from the water injection that is carried out in order to enhance oil production.

The content of water relative to the total liquids produced in the Danish part of the North Sea is increasing and reached 77 per cent in 2014. Energy is required to handle these large volumes of produced water, which is upto 90 per cent of the production for some of the old fields. In 2014 water production totalled 32.5 million Nm^3, a decline of 2 per cent compared to 2013. Water injection in 2014 increased by 3 per cent relative to 2013.

Since 2008 water production has declined mainly due to falling oil and gas production. The water content of total liquid production is increasing for most fields. The operators are attempting to reduce the water production by closing off production from zones in the wells with high water production.

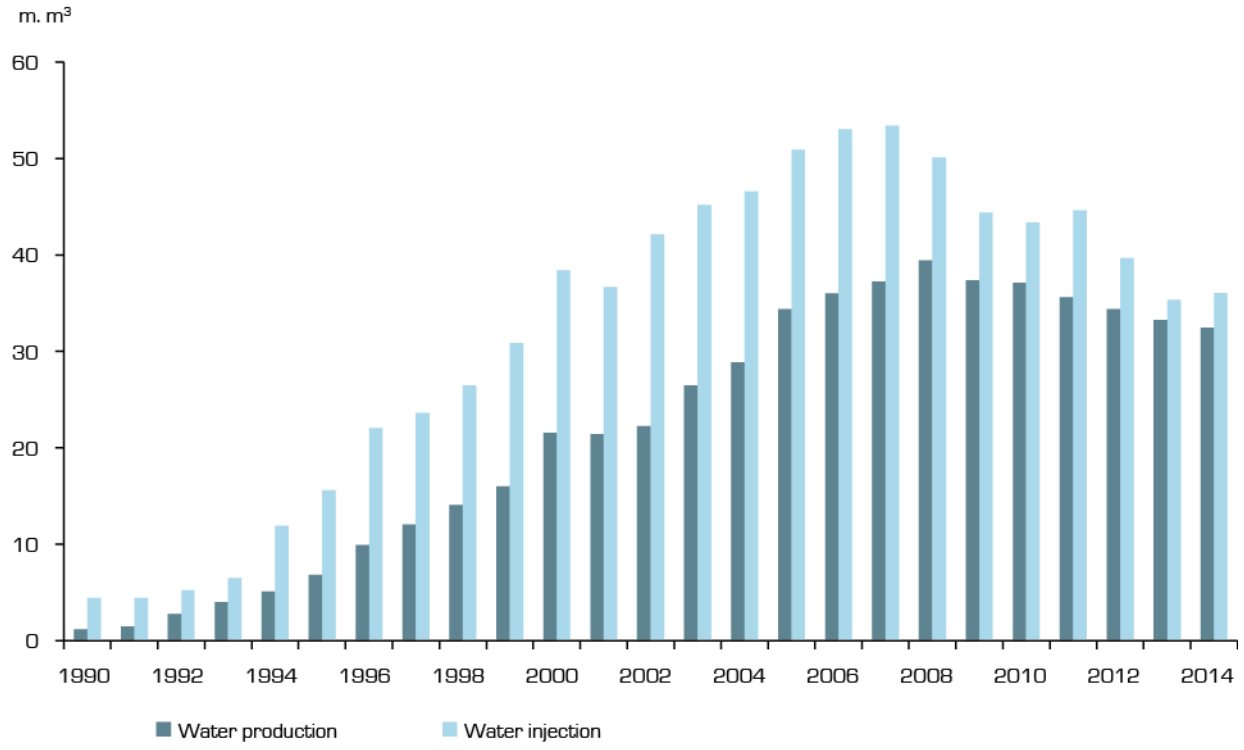


Figure 5. Water production and water injection 1990-2014

TABLE 7. WATER, PRODUCTION

Thousand cubic metres

	1972-2006	2007	2008	2009	2010	2011	2012	2013	2014	TOTAL
DAN	69,190	12,152	13,946	12,889	12,111	11,059	10,468	11,207	11,494	**164,515**
GORM	49,815	4,708	3,976	4,737	4,904	4,654	3,897	3,658	2,833	**83,183**
SKJOLD	43,517	3,885	3,636	3,855	3,895	3,861	3,978	4,023	3,865	**74,517**
TYRA	34,818	2,725	3,103	2,677	1,980	1,811	1,516	2,063	1,678	**52,370**
ROLF	5,460	383	349	381	281	8	0	0	0	**6,861**
KRAKA	4,209	359	436	183	166	358	237	170	214	**6,332**
DAGMAR	3,914	0	13	0	0	0	0	0	0	**3,927**
REGNAR	4,063	1	0	0	0	0	0	0	0	**4,064**
VALDEMAR	3,079	854	925	812	1,207	1,026	893	916	873	**10,583**
ROAR	3,748	560	586	624	275	200	34	59	98	**6,184**
SVEND	9,156	1,200	1,022	804	664	585	685	712	650	**15,479**
HARALD	318	18	21	11	37	113	152	47	20	**737**
LULITA	215	96	91	49	65	73	86	48	76	**798**
HALFDAN	10,149	4,086	4,766	4,814	5,519	6,149	6,139	6,099	6,574	**54,295**
SIRI	16,227	2,528	2,686	1,778	2,868	2,593	2,879	1,481	943	**33,983**
SOUTH ARNE	6,160	1,861	2,174	2,285	2,068	1,883	2,317	2,198	2,369	**23,314**
TYRA SE	2,126	669	602	716	568	485	440	235	286	**6,127**
CECILIE	1,643	576	456	266	317	452	390	179	138	**4,417**
NINI	1,615	619	660	522	195	330	297	166	376	**4,781**
TOTAL	**269,421**	**37,280**	**39,448**	**37,402**	**37,121**	**35,640**	**34,408**	**33,260**	**32,487**	**556,466**

TABLE 8. WATER, INJECTION

Thousand cubic metres

	1972-2006	2007	2008	2009	2010	2011	2012	2013	2014	TOTAL
DAN	187,878	20,230	19,275	16,712	15,148	14,508	11,684	10,148	11,568	**307,153**
GORM	104,003	6,678	5,251	4,777	4,408	5,459	3,709	3,549	2,735	**140,569**
SKJOLD	91,093	6,098	4,989	5,285	4,155	4,374	5,093	4,956	4,624	**130,669**
HALFDAN	34,905	12,107	12,727	11,485	11,945	12,277	10,912	10,921	11,403	**128,683**
SIRI	22,420	3,499	2,695	1,692	2,692	3,201	3,020	1,592	1,788	**42,598**
SOUTH ARNE	27,697	4,296	4,279	3,872	3,427	3,240	4,104	3,660	3,368	**57,944**
NINI	2,412	413	883	501	1,558	1,365	1,151	549	575	**9,407**
CECILIE	322	91	42	97	47	221	35	0	0	**854**
TOTAL	**470,731**	**53,412**	**50,141**	**44,420**	**43,379**	**44,646**	**39,709**	**35,376**	**36,062**	**817,877**

EMISSIONS TO THE ATMOSPHERE

Emissions to the atmosphere consist of such gases as CO_2, carbon dioxide, and NOx, nitrogen oxide.

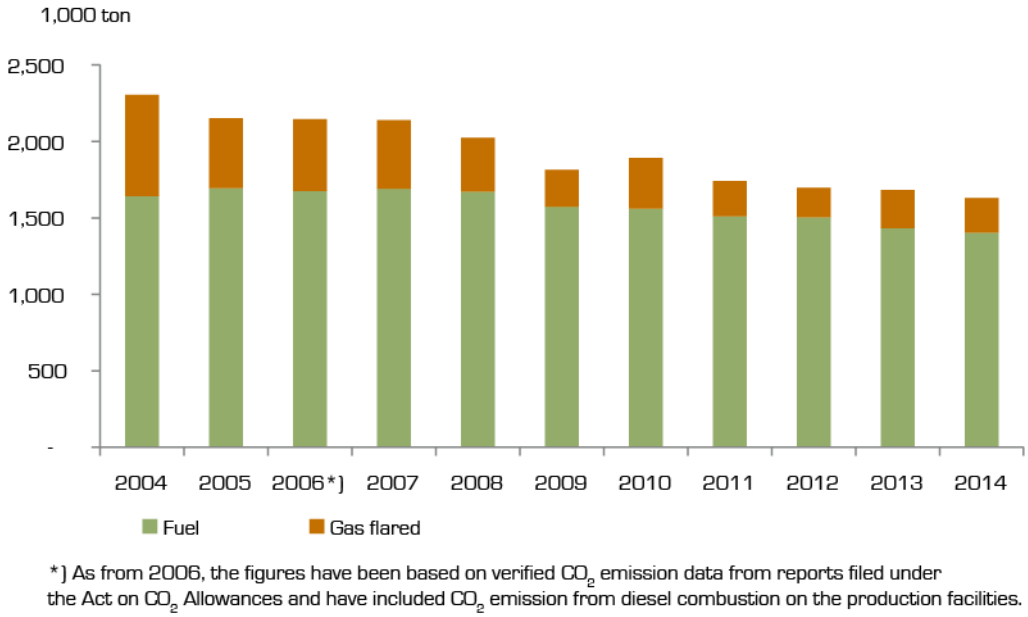
The combustion of natural gas and diesel oil and gas flaring produce CO_2 emissions to the atmosphere. Producing and transporting oil and gas require substantial amounts of energy. Furthermore, a certain volume of gas has to be flared for safety or plant-related reasons.

Gas is flared on all offshore platforms with production facilities, and for safety reasons gas flaring is necessary in cases where installations must be emptied of gas quickly. The Danish Subsoil Act regulates the volumes of gas flared, while CO_2 emissions (including from flaring) are regulated by the Danish Act on CO_2 Allowances.

The volume emitted by the individual installation or field depends on the scale of production as well as plant-related and natural conditions.

Energy consumption per produced ton oil equivalent (t.o.e.) increases the longer a field has carried on production. This is because the water content of production increases over the life of a field. Assuming unchanged production conditions, the rising water content results in an increased need for injecting lift gas, and possibly water, to maintain pressure in the reservoir. Both processes are energy-intensive.

CO_2 emissions from the production facilities in the North Sea totalled about 1.630 million tons in 2014, thus confirming the falling emissions trend over the past decade.



*) As from 2006, the figures have been based on verified CO_2 emission data from reports filed under the Act on CO_2 Allowances and have included CO_2 emission from diesel combustion on the production facilities.

Figure 6. CO_2 emissions from production facilities in the North Sea

Gas flaring totalled 85 million Nm^3 in 2014, a 13 per cent decrease on 2013. The volume of gas flared depends in part on the design and layout of the individual installation, but not on the volumes of gas or oil produced.

Generally, the flaring of gas has declined substantially in the past ten years due to more stable operating conditions on the installations, changes in operations and focus on energy efficiency, such as the use of flare gas recovery systems at South Arne and Siri. However, flaring may vary considerably from one year to another, frequently because of the tie-in of new fields and the commissioning of new facilities. Moreover, when platforms are shut down temporarily, the pressure must be vented and the gas evacuated from the inter-field pipelines must be flared.

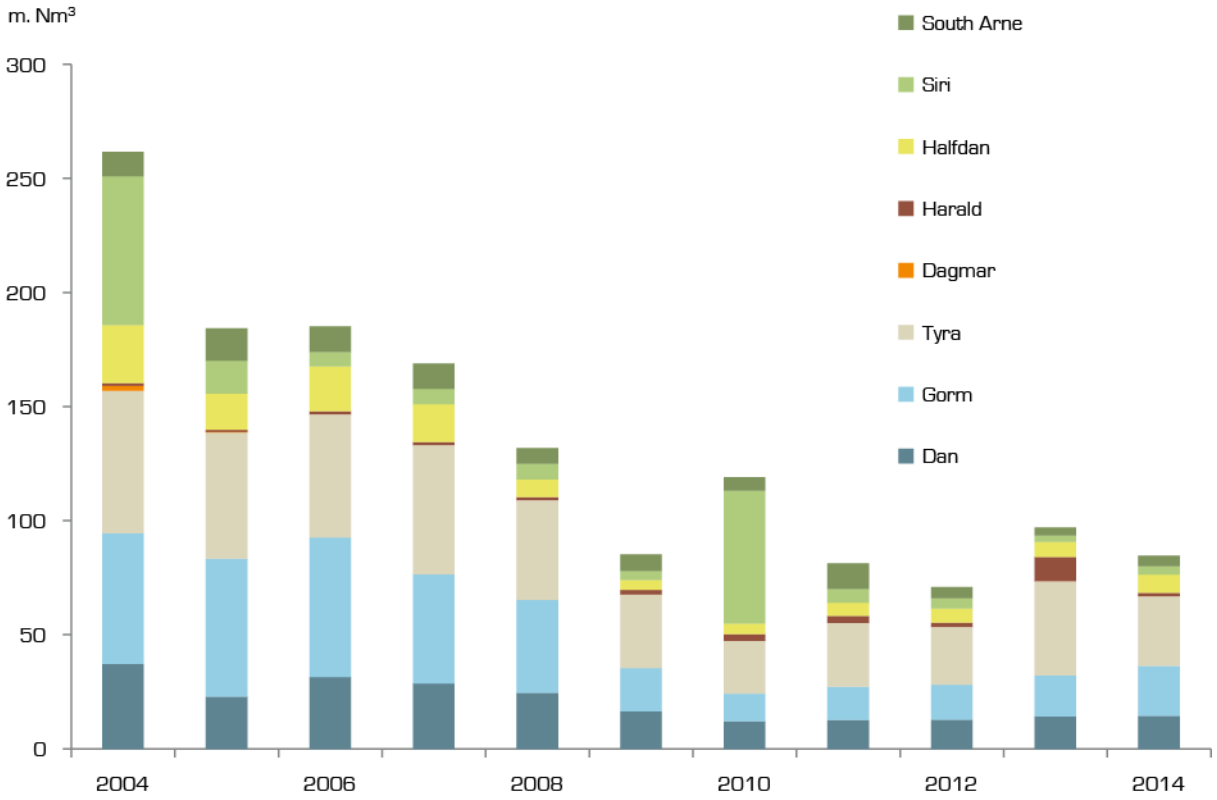


Figure 7. Gas flaring