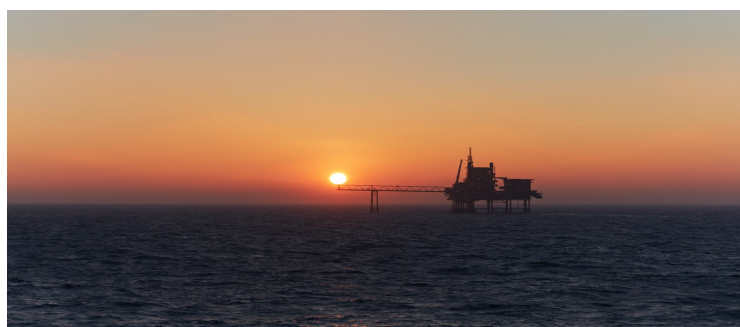


## OFFSHORE METHANE REDUCTION COVENANT 2019 - 2020


### FINAL REPORT 31-03-2021



Job number	: NL-2020-901
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## 1 REVISIONS HISTORY

This sheet must be completed in detail, at each revision once this document has been issued at revision 00.

REV.	SECTION	SUB-SEC	PARA.	CHANGE #	DATE	AUTHORIZED BY
00	-	-	-	-	12/05/2021	R. Rombout
Draft issue						
01	-	-	-	-	12/05/2021	A. Tacoma
Reviewed by NOGEPA						
02	-	-	-	-	14/05/2021	W. Hardeveld
Reviewed by MACH10						
03					18/05/2021	R. Rombout
Reviewed by Operators and EBN						
04					23/06/2021	R. Rombout
Update on title and DANA						

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## 2 OVERVIEW

### 2.1 INTRODUCTION

#### Background

Following the implementation of the measures to comply with NOx legislation, the mining environmental permits regime had to be updated. In consultation with the Dutch State Supervision of Mines (SSM), the Ministry of Economic Affairs and Climate (MEAC) included requirements concerning the source identification, quantification and determination method of methane and benzene emissions. To comply with these requirements, in 2018 the sector subsequently developed a determination and measurement protocol for methane emissions (which is published on the [NOGEPA website](#)) and initiated a ship-based methane measurement programme carried out by TNO.

In parallel a reduction programme for methane emissions was drafted based on a cost efficiency (CE) table. In consultation with Energie Beheer Nederland (EBN) a cut-off of €20/T CO<sub>2</sub> equivalent (CO<sub>2</sub>eq) was established resulting in an estimated 50% reduction. This cost efficiency level matched with the CO<sub>2</sub> price at the time of establishing the covenant. The graphic below shows the starting point in 2018. The quantification of reductions in the bandwidth of €20-100/T CO<sub>2</sub>eq indicates a marginal additional reduction. Yet some Operators elected to implement measures in the €20-40 and €90-100 bandwidth based on synergy with other projects.

#### Offshore methane reduction program NOGEPA

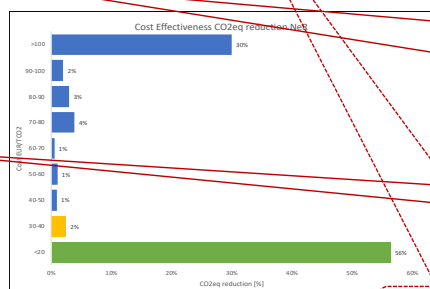


42 Euro/T is the cost of CO<sub>2</sub> for power stations in 2030

Som van Saving Emission Quantity (T/yr)	<20	20-40	40-50	50-60	60-70	70-80	80-90	90-100	>100	EMIV 2017 (T CH <sub>4</sub> /yr)
ONE	13								18	31
Petrogas	1033	20			40					1093
SPIRIT	66	2		56	12			120	145	401
TAQA	265	95		15				38	140	553
TEPNL	921				67		306		261	1555
WINZ	53	76							9	139
NEPTUNE	276						234		318	828
NAM	1815								1473	3288
<b>EMIV 2017 (T CH<sub>4</sub>/yr)</b>	<b>4443</b>	<b>194</b>	<b>71</b>	<b>79</b>	<b>40</b>	<b>306</b>	<b>234</b>	<b>158</b>	<b>2364</b>	<b>7888</b>

< 2018 - 2020 >      < 2024 >

- 56% reduction (4,557 ton CH<sub>4</sub>) is the ambition for the 2019-2023 phase
  - NAM is already implementing 23% (1,815 ton) for € 1,7MM
  - Another 19% (1,528T) can be reduced at marginal investment costs.
  - The remainder of 14% (1,214T) requires a € 2.0 MM investment
- Threshold (no additional high € activities)



Industry commitment to implement CH<sub>4</sub> measures with cost efficiency <= 20 €/ton CO<sub>2</sub>eq (2020-2024)


Will lead to more than 50% reduction CH<sub>4</sub> emissions

Limited reduction potential for measures with poorer cost efficiency  
Further large reductions only with measures > 100 €/ton CO<sub>2</sub>eq

Total costs for the > 50% reduction amounts to 3.7 mln €

Few measures with poorer cost efficiency taken for other reasons



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This draft methane reduction programme was reviewed with SSM, MEAC and EBN in Q1 2019 and formalised in August 2019 as a covenant between MEAC and NOGEPA (on behalf of the eight Offshore Operators) with a 50% reduction commitment by 31 December 2020 compared to 2017 emissions.

## Monitoring of the covenant

Following the end of each quarter MACH10 processed the results per Operator in a progress graph with a brief status update and any corrective actions. After a 1:1 analysis with each Operator, this was then discussed in plenary with all Operators. Based on this, a detailed presentation was made and discussed with SSM six weeks after the end of the quarter. Comments from SSM were reviewed by MACH10 with the relevant Operators. The progress report would then be drawn up and was discussed every quarter between MEAC, NOGEPA and MACH10. SSM and EBN received a copy as well. The report was then shared with the Operators along with any feedback.

To visualize the emission reduction from measures implemented in Q4 2020 this final reporting cycle on Q1 2021 was completed in May 2021.

NOGEPA's Operations Committee and Executive Committee were kept informed on a quarterly basis. This work process created focus and discipline among the teams, and it raised awareness within operations departments. Since March '20, consultations have only taken place via Microsoft Teams due to the Covid-19 pandemic.


## Updates of the underlying data

In Q1-2020 a mid-term correction of emission data proved necessary for some offshore installations which actually increased the joint emission reduction target by 9%. These corrections were implemented through the formal environmental reporting mechanism (e-MJV):

- 1) ONE-Dyas and Wintershall found that emissions in 2017 proved to be higher than reported in the e-MJV. As per the change procedure overseen by SSM the corrected figures were entered into eMJV for both Operators.
- 2) NAM discovered disconnects in their internal reporting process and established a task force to correct this and to carry out offshore measurements as a verification instrument. Subsequently the same change procedure was followed.
- 3) Ameland Westgat (AWG) initially was captured as an offshore installation in the basis of the covenant. AWG actually is governed by the onshore regulation as the location lies within 3 miles of the shore. The eMJV serves as the basis for the international OSPAR-reporting where all offshore platforms are included. This was the reason that AWG initially was captured in the basis of the covenant. This aspect was corrected in the Q1-2020 report.

## Impact from Covid-19

Due to the logistics and availability restrictions on contractors resulting from the Covid-19 measures in 2020, some planned shutdown activities were postponed. Reduction measures had to be

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implemented during these shutdowns. Commissioning activities (start-up, calibration, and testing) were also postponed as a result. This posed quite serious challenges: Operator staff chipped-in and went offshore whenever needed to keep implementation projects on schedule.

## International context

The European Commission (EC) published its strategy for methane emissions on 14 October 2020. A consortium of Wood, TNO, Carbon Limits and The Sniffers has advised the Commission in the form of a report on methane emissions in the energy sector, which includes the EU oil and gas sector. This initiative has also provided input for the EU methane strategy. NOGEPA actively contributes to this process and shares the knowledge gained in the offshore methane reduction programme with the European Commission and the Dutch authorities. The EC recently published a consultation on regulations relating to methane emissions. This will focus in particular on monitoring, reporting, verification (MRV) and leak detection & repair (LDAR) in the energy sector.

## Evaluation of the covenant

Throughout the reporting cycle the progress has been reviewed with MEAC and SSM on a quarterly basis. This final report documents that the joint Operators have exceeded the committed 50% reduction. This would allow for an evaluation of preconditions/ reciprocity that would need to be met to make the electrification of offshore production platforms possible. I.e., how further emission reductions can be achieved beyond 2020 and what will be needed to achieve this.


To provide the context we quote from §6 and 7 of the covenant:

“Based on the established cost effectiveness criterion (CE) of €20 per tonne of CO<sub>2</sub> equivalent, the target referred to in section 2 is achievable. A further increase of the CE to €100 per tonne of CO<sub>2</sub> equivalent would only result in an additional 10% in reduction potential.

Electrification of offshore production platforms is an effective option for further emission reductions beyond a CE of €20 per tonne of CO<sub>2</sub> equivalent, but this will require a connection to the offshore grid. Electrification of these platforms will also be necessary to enable the capture, transport and storage of CO<sub>2</sub> and the production, transport and storage of hydrogen in depleted oil and gas fields in the medium (2030) to long (2050) term. Furthermore, the electrification of these platforms will result in an immediate CO<sub>2</sub> reduction of 0.5-1.0 megatons per year.

The sector will be able to achieve electrification of the key offshore production platforms once the economic and organisational conditions have been met. NOGEPA has identified the key conditions:

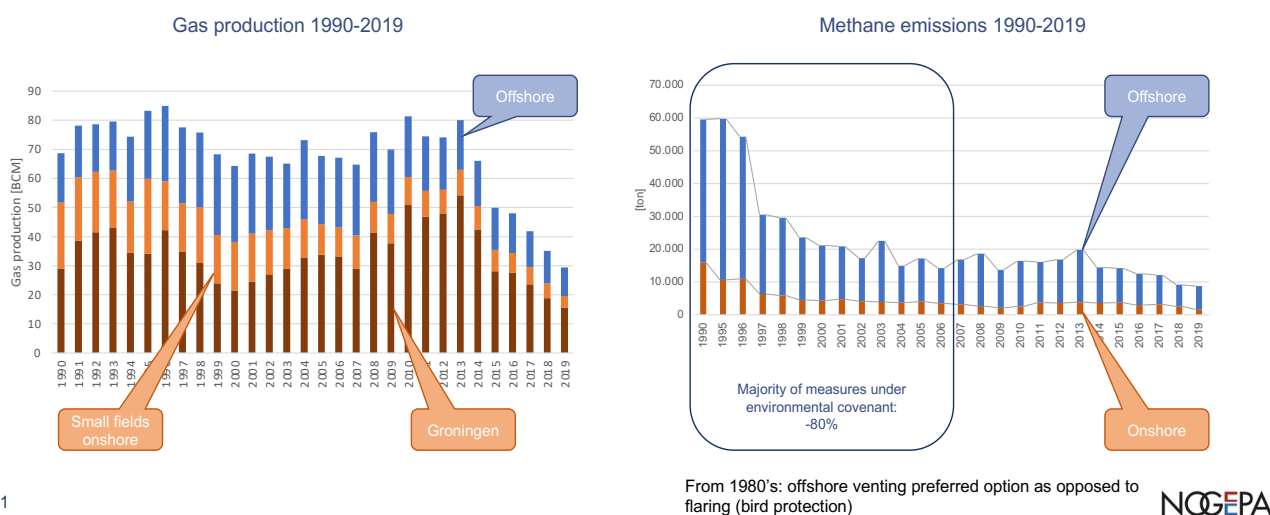
- Generic investment relief of 40%.
- Legislative framework to ensure the connection of offshore production platforms to the offshore energy grid.
- Established connection conditions, including tariffs.
- Compensation for uneconomic costs of electrification.”

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## 2.2 HISTORICAL AND FUTURE PERSPECTIVE

In order to place the current covenant in its historical perspective, developments since 1990 are shown in the chart below; it is important to note that an 80% reduction had already been achieved in the period 1995-2007 through an environmental covenant (1995-2010).

### Historical overview of methane emissions in the Dutch oil and gas industry



In the definition of the objectives of the offshore methane reduction covenant (2019), the commitment is to achieve an emission reduction of 4,281 tonnes CH<sub>4</sub> per year.

As stated in the introduction, this commitment was increased by 9% due to corrections in the emission data for 2017. The benchmarks and results are set out in the table on p.11: The reduction result for the sector on 31 March 2021 is 5,349 tonnes CH<sub>4</sub> per year, 25% above the original commitment of 4,281 tonnes CH<sub>4</sub> per year and 57% of the total CH<sub>4</sub>-emissions from the Dutch offshore sector in 2017.

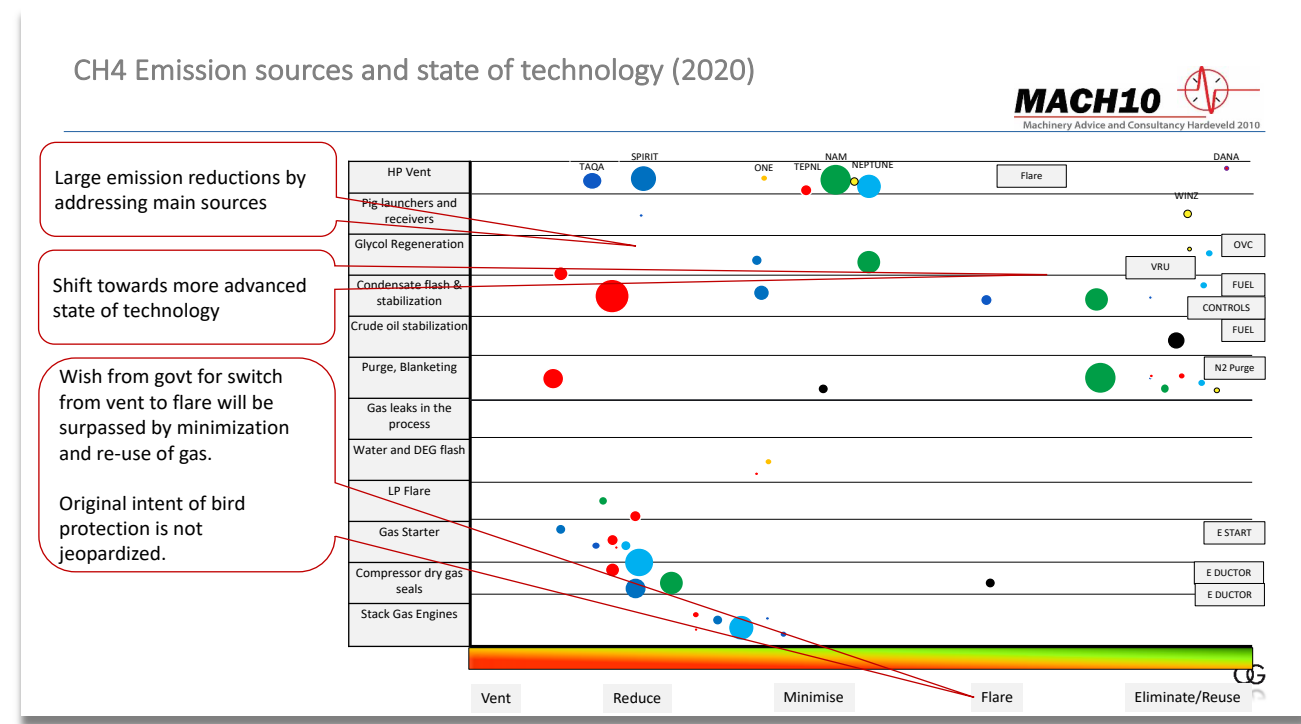
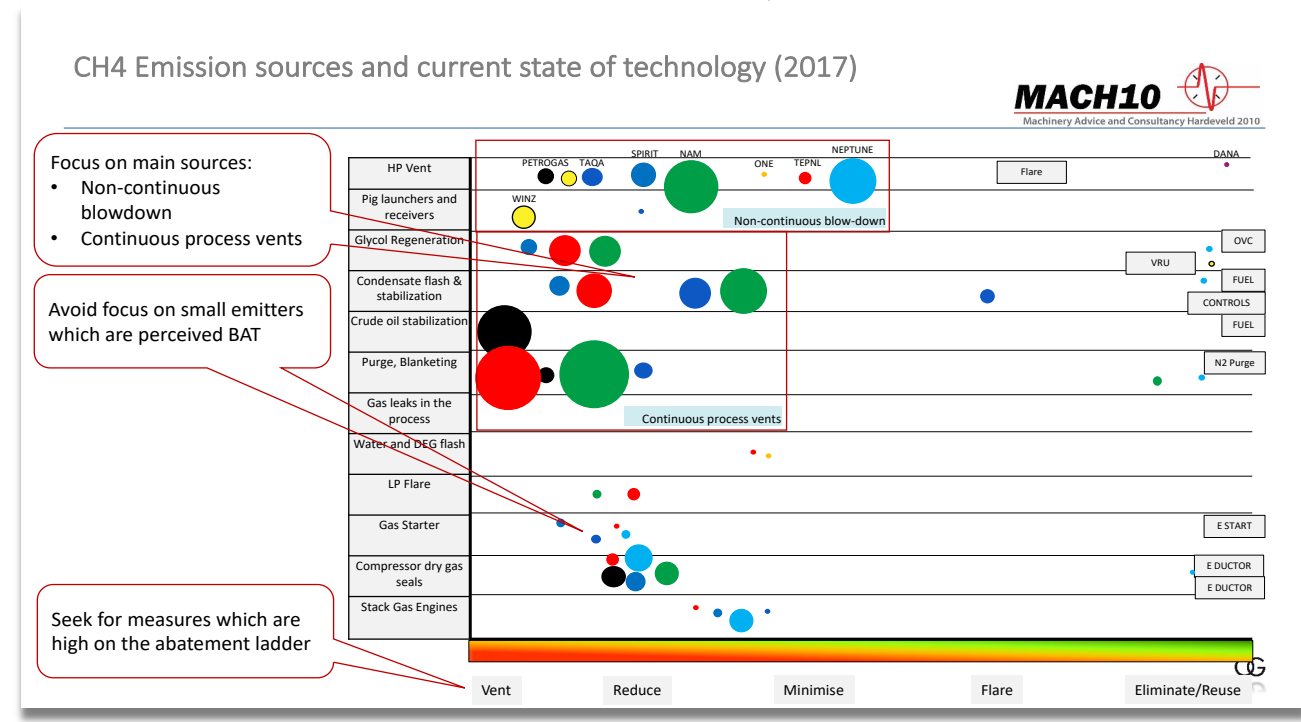
Paragraph 2 of the covenant states the reduction equivalent as 120,000 tonnes of CO<sub>2</sub> equivalent based on the GWP100. On 31 March 2021, this actually stood at 150,000 tonnes of CO<sub>2</sub> equivalent.

Based on the GWP20 (factor 85 for methane), the methane reduction achieved amounted to 455,000 tonnes of CO<sub>2</sub> equivalent. Given the time horizon of Dutch offshore oil and gas production, the relationship with the Global Warming Potential in 20 years' time is certainly relevant. The Environment Defence Fund (EDF) recommends always reporting the GWP20 and GWP100 data side by side (Science, vol. 356, issue 6337, p.492).




## 2.3 STRATEGY

It was decided to choose an economic and result-oriented approach on a two-year timeline, making maximum use of Best Available Technologies (BAT). The graphs below illustrate this by the size of the spheres, which is proportional to the quantity/ volume of methane emission.





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## 2.4 PROGRESS AND RESULTS

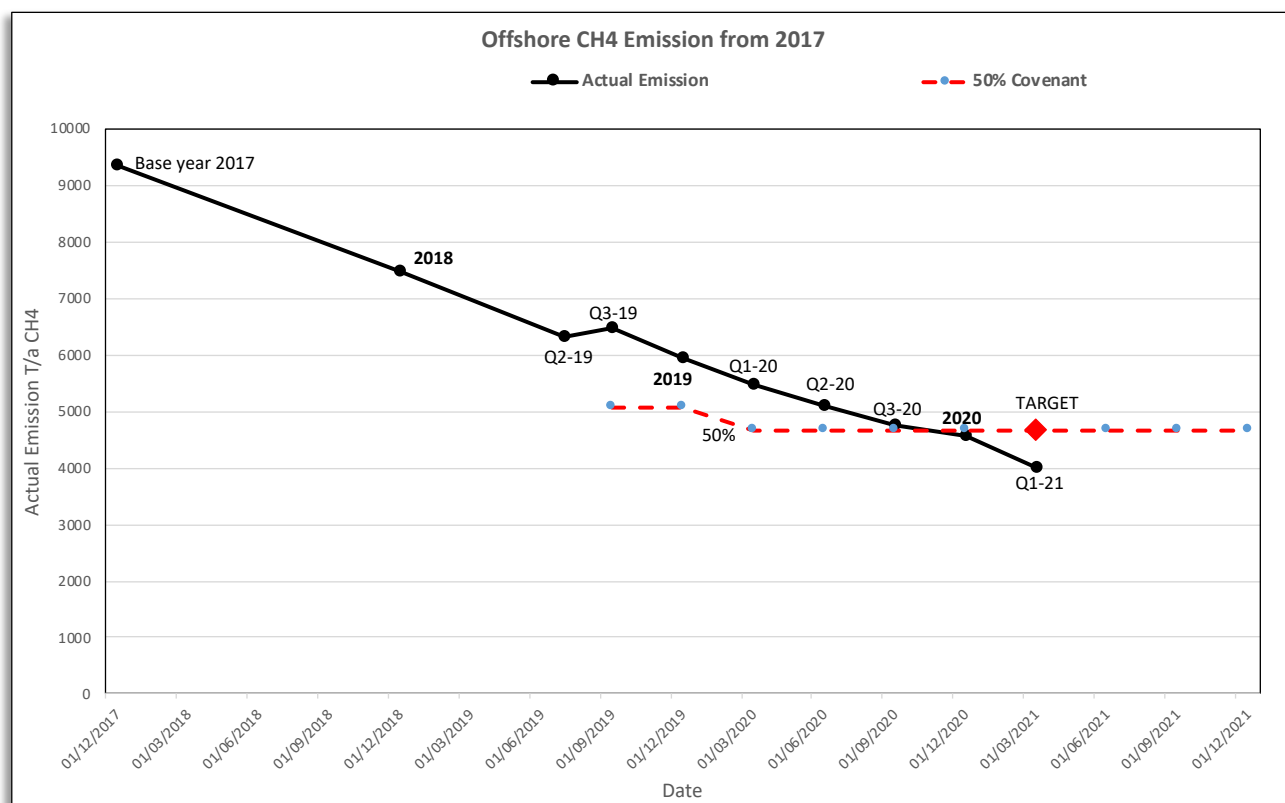
### Results through Q1 2021

The offshore methane emissions reduction programme was established in January 2018 and formalised in August 2019 in a covenant setting out a 50% reduction commitment.

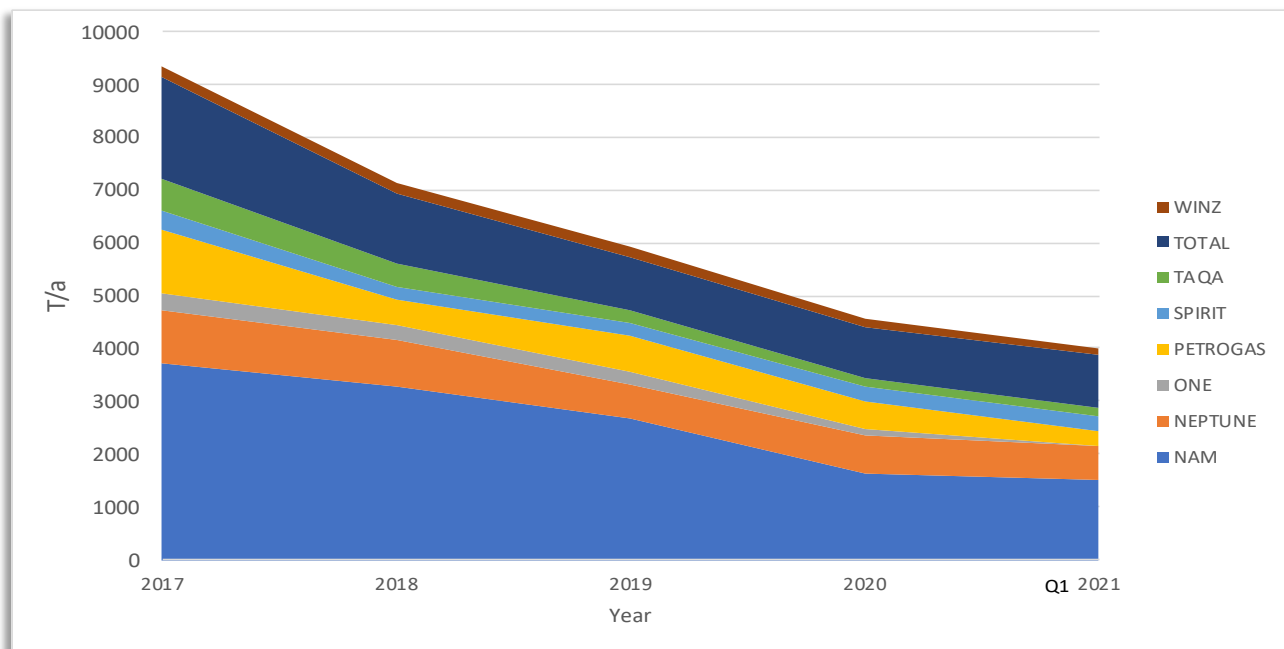
The impact of the resulting efforts can be seen in the chart below, which shows the evolution of the overall sector emissions from 12/2017 onwards. This is the *result curve*.

As explained in the introduction the covenant target was increased by 9% in Q1 2020.

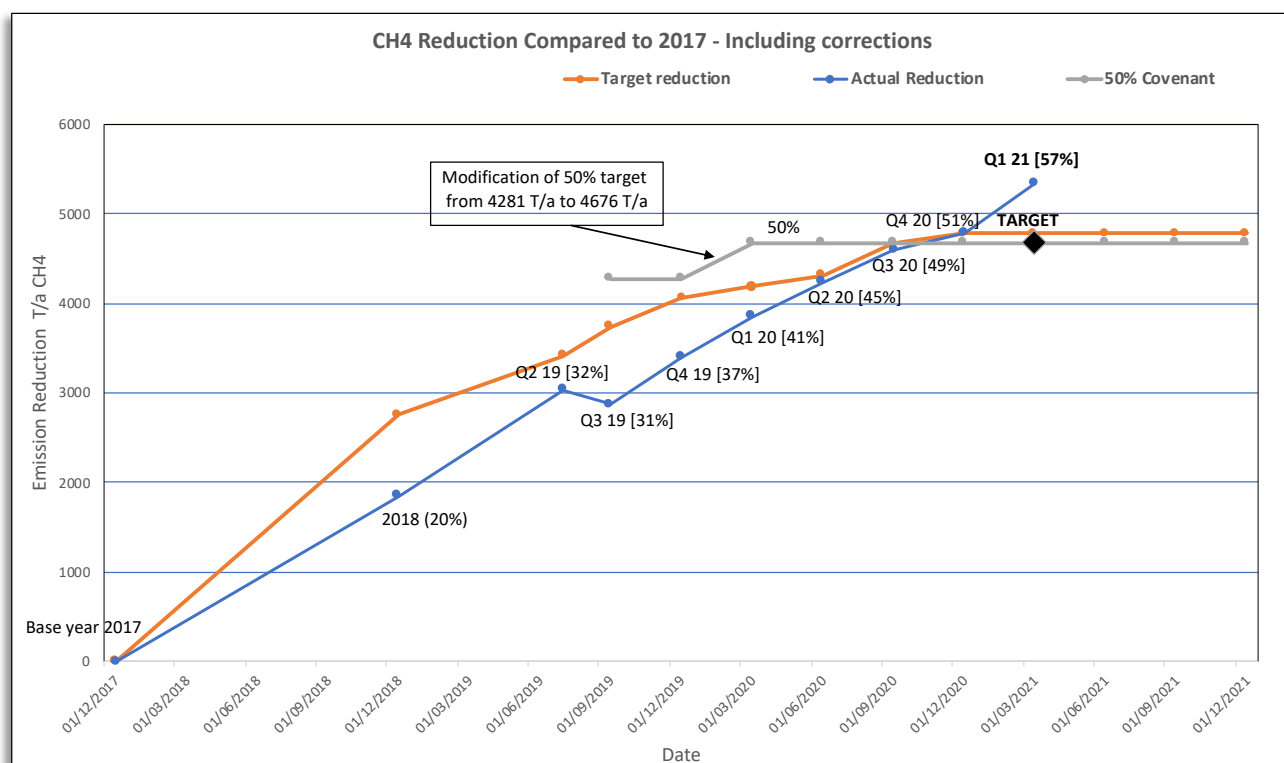
To visualize the emissions reductions from measures implemented in Q4 2020 this final reporting cycle on Q1 2021 was completed.




The graph below shows the *composition of the result curve* from the individual contributions:



Including the 9% increased target, the Operators achieved a joint 57% reduction, thereby exceeding the 50% target of the covenant. Shown below is the *effort curve*.



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The built-up of this effort curve on page 10 is shown in the table below:

Emissions per Operator T/j CH4	Emissions as per 2017 e-filing Covenant base	Emissions as per 2017 e-filing with corrections by DANA, NAM, ONE-Dyas and W'shall*	The reduction estimated in June 2019 for 31-03-2021 (Effectively 31-12-2020**)	Reduction achieved by 31-03-2021 (Effectively 31-12-2020**)
Dana Petroleum	10	0	0	0
NAM	3267	3711	1878	2197
NEPTUNE	1019	1019	276	393
ONE-Dyas	27	325	175	297
PETROGAS	1204	1204	1035	922
SPIRIT	370	370	65	116
TAQA	591	591	305	407
TOTAL	1929	1929	925	932
WINTERSHALL	147	204	129	85
<b>Total</b>	<b>8562</b>	<b>9353</b>	<b>4788</b>	<b>5349</b>
<b>CO2eq [kT/j]</b>	<b>240</b>	<b>262</b>	<b>134</b>	<b>150</b>

#### \* ) Corrections to 2017 e-filing (e-MJV)

Dana Petroleum	Potential measures do not meet the CE criterion of €20/T CO2 equivalent due to small quantities of CH4 in the flaring and in the gas turbine exhaust. Does not therefore participate in the covenant. A later development worth mentioning is: Mid 2020 two new gas engines were commissioned on F2-A-Hanze. DANA applied the US-emission factor rather than the SI-factor to quantify the CH4 emission that was subsequently overstated by a factor 10. The realistically estimated emission by the gas engines is ~ 3 T/a CH4 in 2020 with only 2.5 months of operation. As a result, the emissions increased from 8T/a in 2019 to 11 T/a CH4 in 2020. This allowed the decommissioning of one of the two gas turbines, cutting back the CO2 emission by 15%.
NAM	Ameland Westgat was part of the 2017 offshore e-filing but, according to the definition in the Dutch Mining Act, actually is an onshore installation. Internal reporting methods have also been improved. This has already resulted in several corrections being made to the emissions reported in the e-filings for 2017-2019. These were approved by SSM.
ONE-Dyas	Correction of reference data for the 2017 e-filing requested and obtained.
WINTERSHALL	Correction of reference data for the 2017 e-filing requested and obtained.

\*\* ) Q1 2021 was monitored to capture implementations in Q4 2020

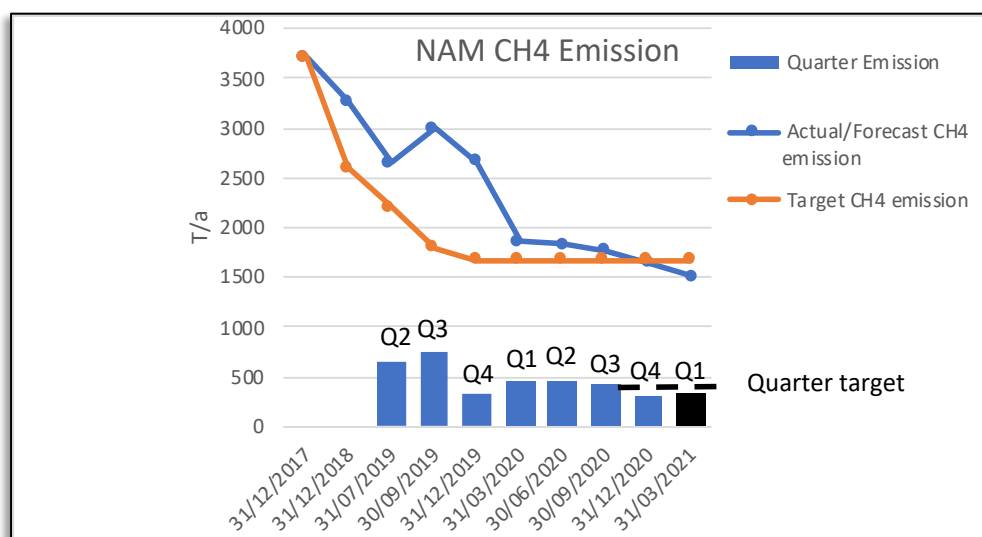
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## 2.5 QUARTERLY PROGRESS AND FORECAST PER OPERATOR

In our consultations with the Operators, we also reviewed the trends for the Q2-Q4 2021: What emissions are expected from shutdowns, pigging, drilling and testing? Is emissions minimisation a KPI in planning these activities? In other words, has the focus that the covenant brought to the operations been safeguarded? Our conclusion is that the current level will be maintained during 2021.

In the slides below the quarterly “journey” is depicted from Q2-2019 through Q1-2021. MACH10 prepared these slides quarterly from the input by Operators, then reviewed the outcomes with the individual operators, thereafter in plenary with all Operators and finally reviewed the set with SSM and MEAC-permitting.

### NAM




Start eMJV2017 : 3711 T/a

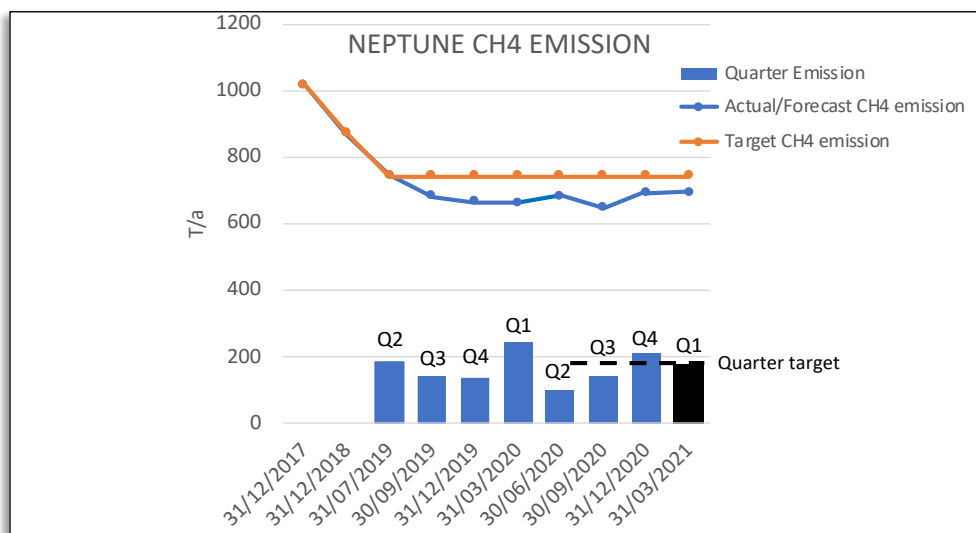
Target end 2020 : 1670 T/a

Reduction Target : 2041 T/a

- Q1 2021 CH<sub>4</sub>-emission is 338 T/a resulting in a forecast reduction of 1373 T/a with a target range of 1200 - 1500 T/a for 2021
- Annual shutdowns as usual in 2021, however with limited emission quantities, so 2021 will show a stable pattern at 1/3 of the emission level in 2017
- All valves have been replaced on K14 in 2020. *L9 will still have some rework on valves and flowmeters in 2021*
- K14C vent emission source has been identified and is expected to be resolved in 2021/22

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## NEPTUNE




Start eMJV 2017 : 1019 T/a

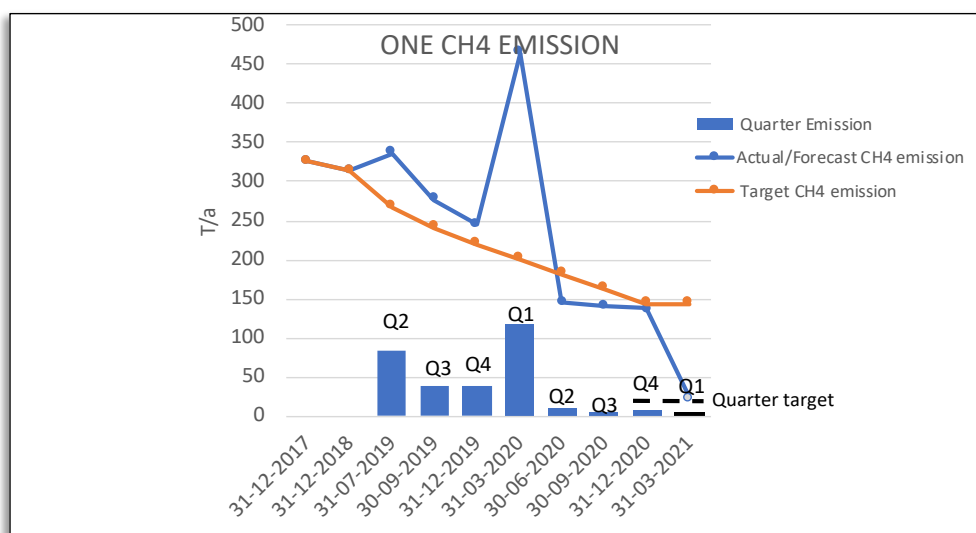
Target end 2020 : 743 T/a

Reduction Target : 276 T/a

- Current emission reduction is on target and Q1 improved relative to Q4
- Emission levels are expected to be flat for 2021, i.e. around 700T/a
- Operations awareness and engagement helps sustaining the minimisation of venting
- Drilling: One well expected to be drilled in Sept 2021. Operations is aware of associated potential venting and is taking preventive measures to avoid this

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## ONE-Dyas




Start eMJV 2017 : 325 T/a

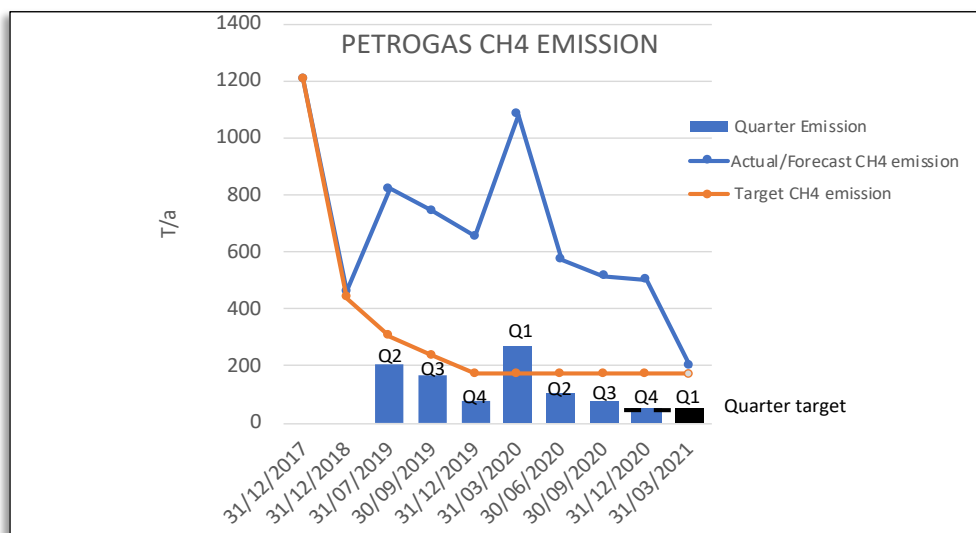
Target end 2020 : 144 T/a

Reduction Target : 181 T/a

- Achieved reduction 2020 (incl. Q1/21) is 297 T/a
- The emission for Q1 2021 is 6T with a forecast target range for Q2-4 2021 of 24 - 60T/a (including possible well drilling in Q3/4)
- P11 wells abandoned, no further emissions, except from diesels (< 1T)
- L11B no extra emissions, no drilling anticipated. A shutdown is scheduled for Q3. L11B: Main emission source combustion installation 65% and some from venting 35%. Compressor problems ongoing with some venting of 0.1 T/event
- Water separation on M7A i.s.o. L9 > vent gas emission < 1,0 T/a in 2021
- Well testing from exploration well will happen for GEMS (N4) in Q2 2021

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## PETROGAS




Start eMJV 2017 : 1204 T/a

Target end 2020 : 171 T/a

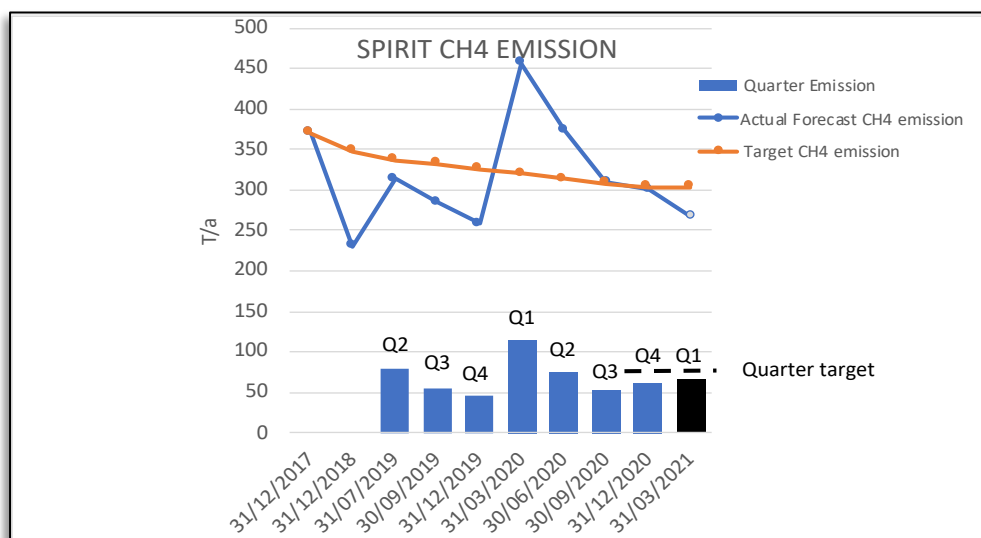
Reduction Target : 1033 T/a

- Q1 2021 emission is 50T, consistent with Q4 2020
- A12 drilling (two wells) is included in the figures with some venting and repressurisation
- The drilling platform is currently at Horizon for a new well (XRD)
- The Hoorn shutdown is scheduled for midyear
- It is expected that the emissions will approach the target of 171 T during 2021, which is an 85% reduction relative to 2017



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## SPIRIT ENERGY




Start eMJV 2017 : 370 T/a

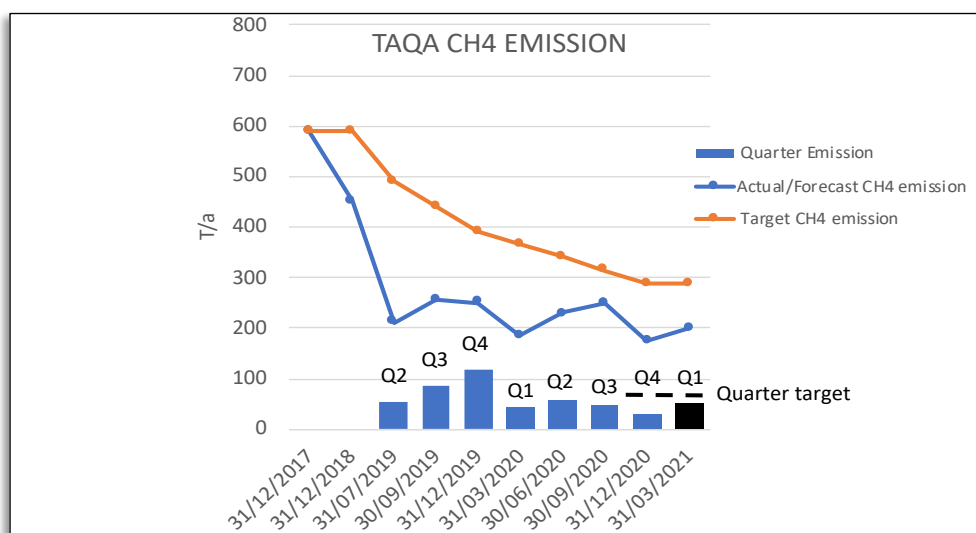
Target end 2020 : 304 T/a

Reduction Target : 66 T/a

- Current emission in Q1 for 2021 is 67 T/a, with some four weeks offline (fuel gas, temporary refuge door, hydrates)
- Three shutdowns planned in 2021: ESD testing, Pigging, MI (4wks)
- Operations is aware of the need to minimise methane emissions
- Potential reduction impact of stripping gas reduction (to be validated in the field - still outstanding)
- Grove NE well is being drilled at the moment and will have extra emissions
- The expectation for 2021 is a sustained 60-65 T CH<sub>4</sub>/quarter emission

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## TAQA




Start eMJV 2017 : 591 T/a

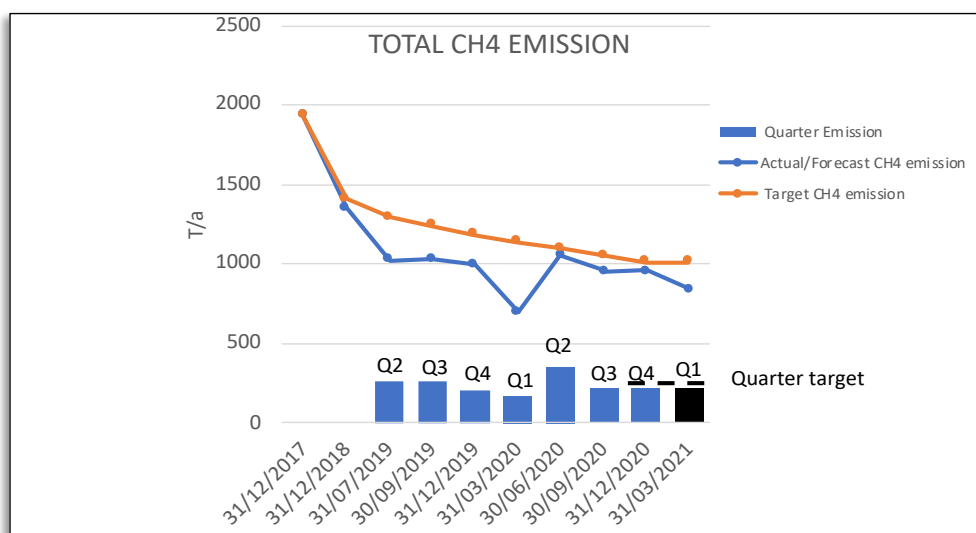
Target end 2020 : 288 T/a

Reduction Target : 303 T/a

- Q1 2021 emission is slightly higher than Q4 2020, due to temporary problems causing a number of compressor trips
- Since early April one compressor is in operation until Q3 2021
- Operation is positively engaged in minimising emissions
- For 2021 it is expected that the future emission levels will stay below the quarterly target level and will hover around 200T/a +/-10T

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## TOTAL




Start eMJV 2017 : 1929 T/a

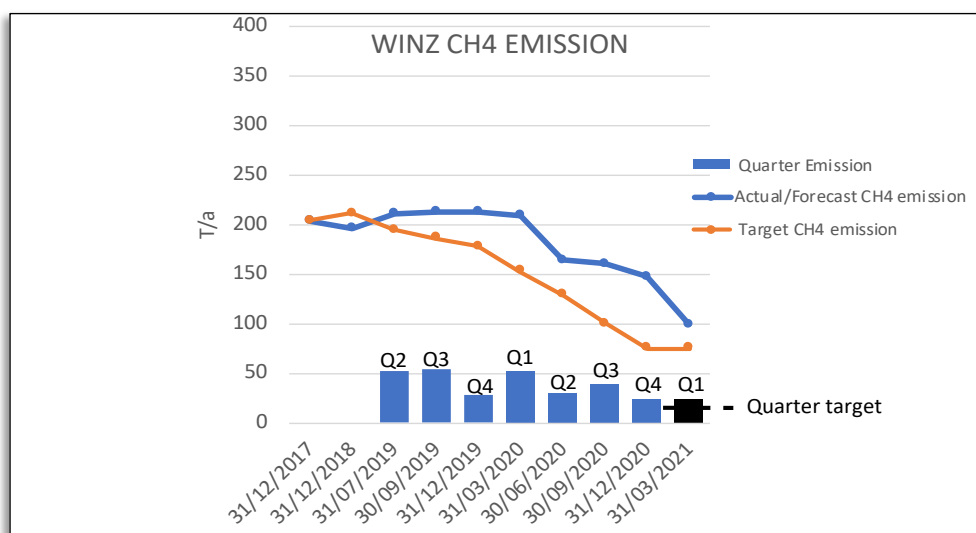
Target end 2020 : 1008 T/a

Reduction Target : 921 T/a

- Quarterly emission is consistent relative to Q4. Outlook for the year is 850T/a
- One pigging operation is planned with a potential of 10T vent gas
- Awareness with operations: Leaking valves are being detected and reported. PI reports (valve positions, look up tables and logics) are useful for life emission reports without stack measurements. In combination with PROII this provides good accuracy (20%)
- K6 will get an ejector on Glycol column overhead system in Q4 to reuse the vent gas as fuel gas. K5 expected in 2022
- No drilling anticipated

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## WINTERSHALL




Start eMJV 2017 : 204 T/a

Target end 2020 : 75 T/a

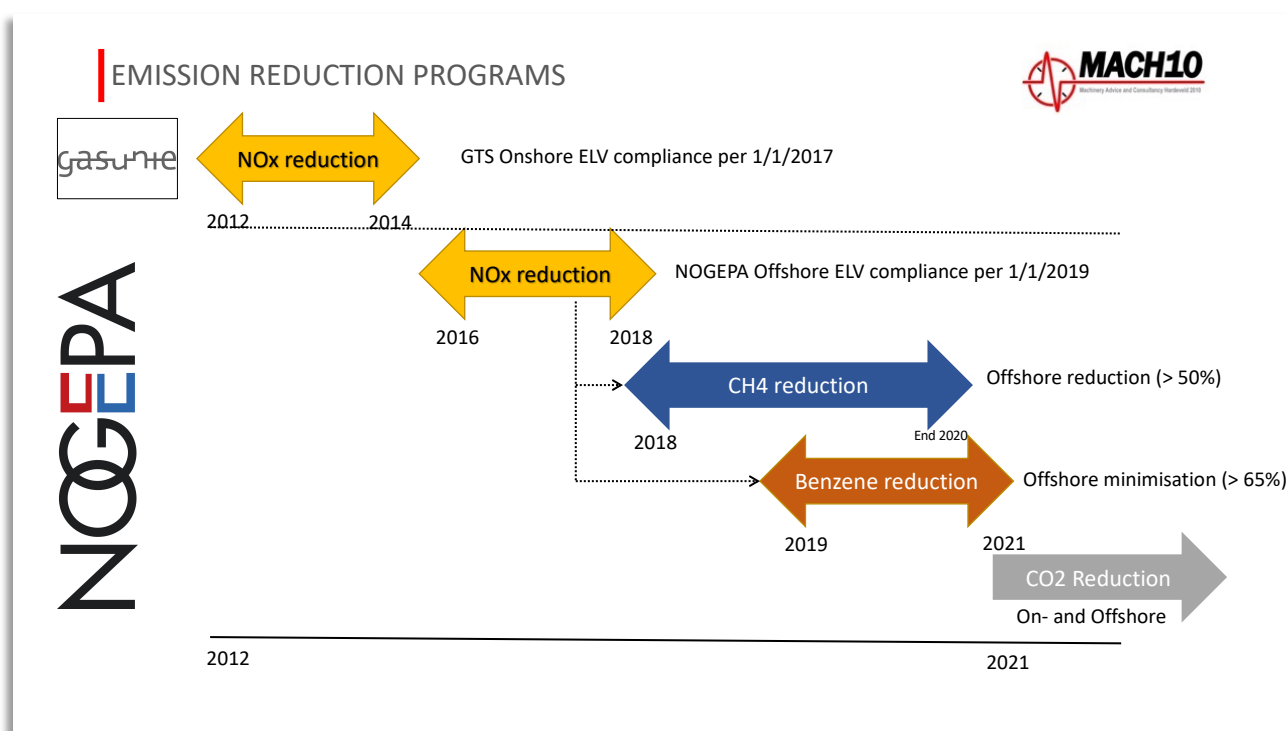
Reduction Target : 129 T/a

- Q1 emission was 25T, same quantity as in Q4 2020
- Expectation for 2021 is 90T/a as P6A COP will have an impact in Q3/4
- K13 vent emission recovery is planned for Sep 2021
- K13 pigging thus far not required
- No drilling anticipated in 2021
- P6A COP in June 2021, will use staged depressurisation and reuse, before releasing the last bit of gas.
- Expected to be on target Q3 2021

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## 2.6 WORK PROCESS AND LESSONS LEARNT


The approach was result-driven (applying best available technologies) and focused on economic viability and implementation according to agreed timelines. Project management by MACH10 ensured discipline, transparency and quarterly reporting to the competent authority. This led to good interaction between the competent authority and the actors in the sector.

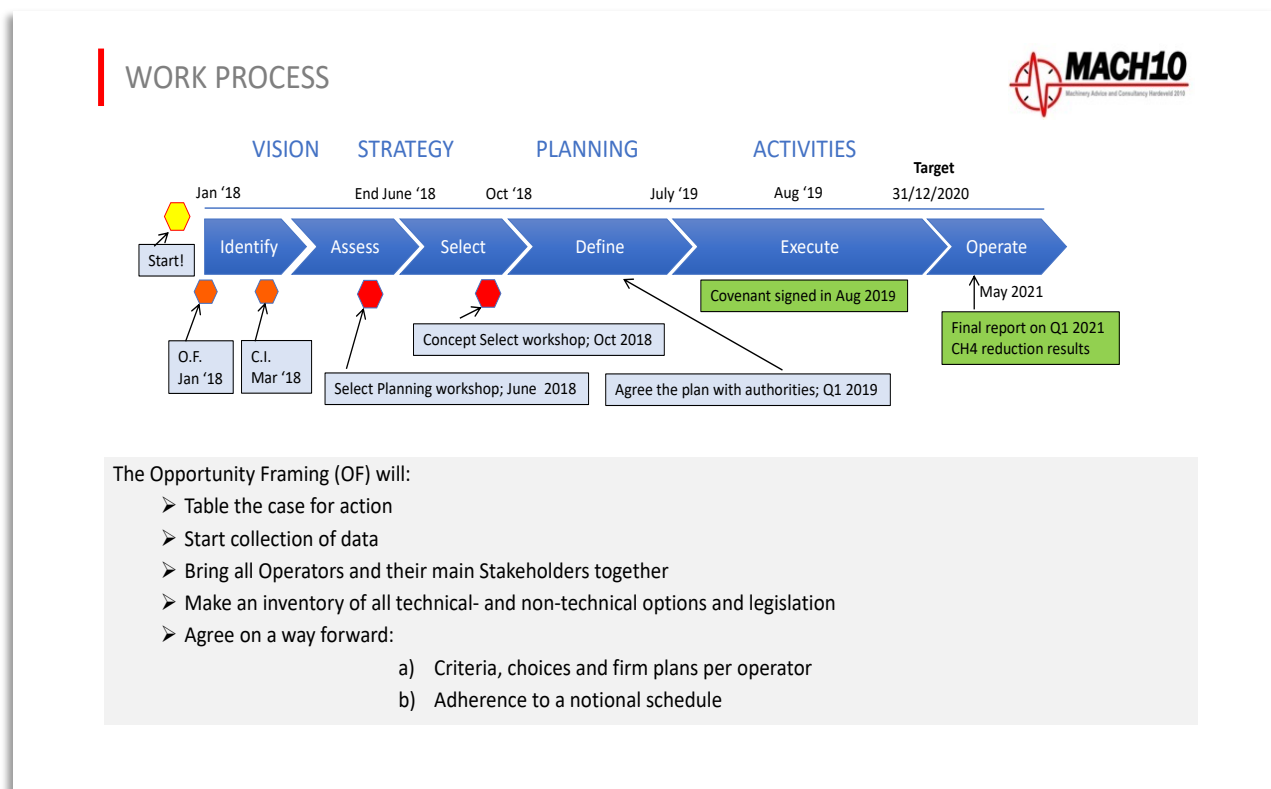


GASUNIE's and NOGEPA's NOx reduction programmes (compliance) were organised in a similar way and so are NOGEPA's benzene and CO2 reduction initiatives.

The work process is shown in the graph below and has been applied in the oil & gas industry since the late nineties: Start with a broad scope, formulate the problem/ opportunity correctly, then identify possible solutions, and only then assess and make choices based on the selected criteria.

And then work in monthly two-hour workshops as a team in a disciplined and predictable way to achieve the agreed objective.


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The developments and lessons learnt from the methane reduction programme were shared quarterly in plenary among all NOGEPA members, but also within international parent companies such as Shell and Total, as well as with the IOGP and the IEA, ensuring they had a greater impact beyond the Dutch offshore sector.

SSM shared the set-up, modus operandi and results of the program in the International Regulators Forum.

The Environmental Defence Fund (EDF) was also regularly updated on developments. EDF regularly used the NOGEPA/ MACH10 approach and summaries and used them to secure stakeholder engagement in other countries.

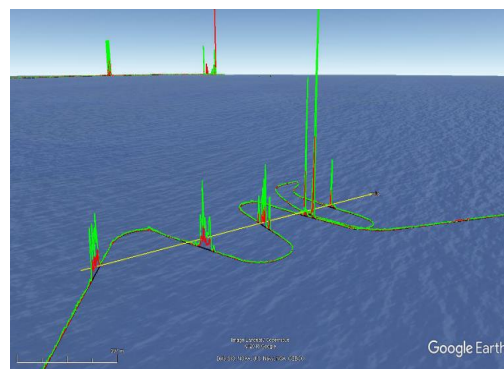
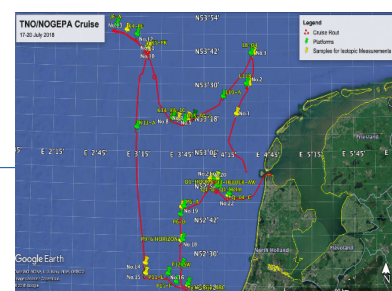
 <b>MACH10</b> Machinery Advice and Consultancy Hardeveld 2010	<b>NOGEPA METHANE REDUCTION PROGRAMME AND COVENANT</b>  <b>FINAL REPORT 31-03-2021</b>	Doc. T-PJ-017-0828
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## 2.7 VERIFICATION OF THE EMISSION DATA FROM OPERATORS

In 2018, TNO conducted two offshore ship-based measurement campaigns on behalf of NOGEPA to substantiate whether the methane emissions figures reported by operators in their annual emission reports were in fact representative. The setup of the measurement campaign and the execution thereof were coordinated with the State Supervision of Mines and the Environmental Defence Fund. Sections 4.1 and 4.2 of the TNO report describe the purpose, method, lessons and conclusions from the measurement campaigns carried out in 2018:

### 4.1 Offshore methane measurement program:

- Two shipborne offshore measurement campaigns in 2018: ECN-TNO
- Goal:
  - Check reliability of data reported by operators
  - Establishment of accurate data set CH<sub>4</sub> emissions from significant number of offshore installations
  - Assess whether shipboard measurements fit:
    - Emission registration and reporting mechanisms from operators
    - Measurement on-board offshore installations (fugitive emissions)
- Measurement protocol: ECN-TNO, SSM, NOGEPA/operators, MACH10 and EDF
  - Round 1: 33 platforms measured (12 selected, 21 ad random)
    - Tracer gas release on two offshore installations
    - Simultaneous on-board measurements (LDAR): The Sniffers
  - Round 2: 22 platforms measured (5 selected, 17 ad random)
    - Lessons learned in round 1 were implemented
    - Tracer gas release on five offshore installations
- Lessons learned include:
  - Tracer gas setup has major influence
  - Influence of meteorological conditions
  - Influence of platform layout (heat sources affecting the dispersion of tracer gas)
  - Plume behaviour offshore differs from onshore: OCD model gave more reliable results than Gaussian plume model



The link below to the TNO website provides a summary of the set-up, execution and context of the measurement campaigns:

<https://www.tno.nl/en/tno-insights/articles/measuring-methane-emissions-at-sea/>


The Vlog summarizing the campaign can be viewed at:

<https://www.youtube.com/watch?v=ghYNbejECko>

The full series of vlogs (14) is available on the NOGEPA website:

<https://www.onsaardgas.nl/meetprogramma-methaanemissies/>



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## Results of the two offshore ship-based measurement campaigns by TNO

One of TNO's conclusions was: "The methane emissions volumes reported by the operators correspond to the volumes measured in the field".

In fact, the results were so convincing that TNO did not consider it necessary to launch any follow-up studies.

In September 2019, the findings were discussed with the Environmental Defence Fund (EDF), the Royal Netherlands Meteorological Institute (KNMI), the SSM and a number of UK universities that had participated in previous independent measurement programmes.

Based on their experience, these parties were also consulted upfront when NOGEPA, TNO, Operators and MACH10 were designing and organising the campaigns.

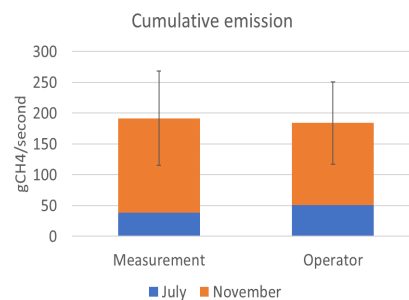
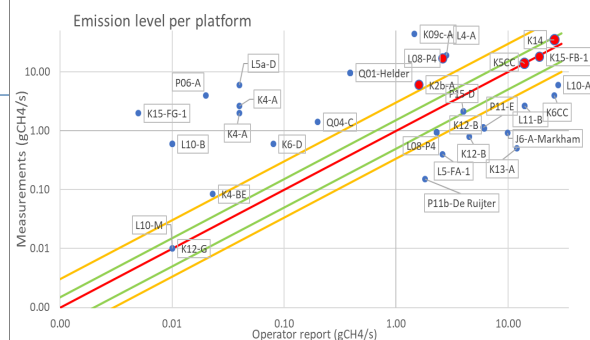
The report number TNO 2019 R10895 has been published on the TNO website:


<https://www.tno.nl/nl/over-tno/nieuws/2019/11/methaanonderzoek-bij-offshore-gaswinning-door-tno/>

## 4.2 Conclusions



- Total estimated emission from 32 platforms:
  - According to measurements: 152 gCH<sub>4</sub>/s
  - According to emission registration operators: 139 gCH<sub>4</sub>/s
- "Given the uncertainty (...) the conclusion is that these two levels are similar."
- Results were discussed with group of experts: ECN-TNO, SSM, EDF, KNMI, University of Manchester
- Report published: [Methane emission measurements of offshore oil and gas platforms](#)
- First in its kind offshore measurements



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### 3 **ACTIVITIES Q2-2021**

#### 15 April – 5 May

- Gathering of Q1-2021 results
- Prepare a detailed presentation for each Operator
- Verification discussions with each Operator
  - Q1-2021 results
  - Outlook Q2-2021
  - Outlook Q3-4 2021

#### 18-21 May

- Plenary meeting with Operators and NOGEPA
- Progress meetings with SSM and MEAC-permitting
- Performance progress and evaluation meeting with MEAC:
  - § 7 : Reduction potential and prerequisites for electrical measures
  - § 8.e: Results and possible future options

#### June

- NOGEPA Operations Committee briefing
- NOGEPA Executive Committee briefing
- Information session with the Environmental Defence Fund (EDF)