

Symposium Sound Solutions

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Report

North Sea Foundation
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The North Sea Foundation wants to thank all participants for their proactive and creative input during our symposium Sound Solutions. We received a lot of positive feedback from many participants, especially on the large variety of experts from different nationalities at one venue, set-up of the day and the positive atmosphere.

There were 80 participants of different countries: the Netherlands, Denmark, Germany, Belgium and even South Africa. There were a lot of different experts from a.o. construction companies, energy companies, universities, research companies, underwater acoustics, ngo's, developers and consultancies. Together we made it a successful day!

In this report, we give a short impression of the day, summarise the several presentations, and give an overview of the input we collected during the afternoon workshops. The presentations are also available at www.noordzee.nl/soundsolutions.

1. Introduction

Sytske van den Akker- North Sea Foundation ([link presentation](#))

North Sea Foundation is working on a project called 'Sound Solutions', in which we are looking for solutions to reduce underwater noise during the construction of future wind parks. Our aim is to limit the impact on the marine life and prevent a delay in offshore wind development. In 2011 we published a report by Zohaib Saleem ([link report](#)) about alternatives and mitigation measures. Moreover, we presented our first results on Offshore 2011 in Amsterdam. Some key findings of the project are:

- There are solutions, but there seems to be not a single best one
- There is a large lack of knowledge
- Cooperation between researchers and developers is needed
- International coordination and collaboration is needed.

These findings formed the basis for the symposium Sound Solutions.

Bopp van Dessel - Boppsolutions ([link presentation](#))

This symposium has an unique starting point; the approach of the symposium is solutions oriented. Today, we all assume that there is a problem (the loud underwater sound levels of piling) and we have to mobilise all creativity to solve it.

The first aim of the symposium is to share knowledge and information. It is already positive that there are many different experts from different kinds of companies and nationalities together at one venue! During this symposium we will discuss best technical solutions, best regulations and best research. This will step by step lead to best practise for the construction and installation of offshore wind farms in the North Sea.

Impact of underwater sound on marine life

Ron Kastelein (SEAMARCO) ([link presentation](#))

Wim Verboom (JunoBioacoustics) ([link presentation](#))

Underwater sound is very important to marine life. It's the primary sense used to find food, mates and for orientation. There are many natural underwater sound sources: sounds made by animals, but also rain and thunder. However, human activities add sound to the marine environment, either on purpose (e.g. seismic surveys), or as a by-product (shipping, sound from piling). The anthropogenic sounds influence the marine life.

**Special
thanks to all
participants**



**Aim 1: limit
impact on
marine life**

**Aim 2: prevent
a delay in off-
shore wind
development**

**Nine solutions
for noise re-
duction**

There is some knowledge on the impact of underwater sound on fish, but more knowledge is available on the effect of sound on marine mammals. The effect of a sound depends on the sound source (energy level, frequencies), the sensibility of a species, recovery time of hearing and the distance from the source.

Piling noise has impacts on marine life. Permanent Threshold Shift (PTS) could occur in harbour porpoises and seals close to a pile, but it is not probable since animals will be dispelled already by the ships. Temporary Threshold Shift (TTS) could occur in a large area (7- tens of km). Behaviour will be influenced in a large area (up to tens of kilometres)

Underwater noise and licensing of offshore wind in the Netherlands
Sander de Jong (Rijkswaterstaat, Dutch Government) ([link presentation](#))

In the Netherlands there are two offshore wind parks operational at the moment. Another three wind parks have a permit and financial support; Nine others have permits, but no financial support. Some large areas have been designated for the development of 'round 3' parks. Key issues in the licensing of the twelve 'round 2' wind parks were shipping, helicopters and environment. It was not clear, what the cumulative effect of these twelve parks will be, because of lack of knowledge. Therefore, there are restrictions to piling in the permit conditions. In other North Sea countries, other permit conditions or management strategies are being applied. Compiling and exchanging information is essential for future wind farms. New information from research will be used to develop permit conditions.

2. Speed presentations

During these sessions nine presenters presented their solution for noise reduction. These solutions can be divided into mitigation (lowering the sound of piling: 1, 3, 5, 7) and in alternatives for pile driving (preventing under water noise: 2, 4, 6, 8, 9).

1 IHC Noise Mitigation Screen- Henk van Vessem ([link presentation](#))

The IHC NMS is a double layered screen, filled with air. Between the pile and screen there is a multi level and multi size bubble injection system. The pile is being guided.

2 Universal foundation- Henrik Lundorf Nielsen ([link presentation](#))

The Universal Foundation is a hybrid of a Gravity foundation, monopile and suction bucket. The foundation support structure is installed to the seabed by suction by pumping water out of the skirt.

3 Hydro Sound Dampers- Karl Heinz Elmer ([link presentation](#))

Hydro Sound Damper consists of a fishing net with small gas filled balloons - tuned to resonant frequencies- fixed to it. It can be applied in different ways.

4 Self-installing wind turbine- Egbert van Blaaderen ([link presentation](#))

Self-installing windturbines is a windturbine on an embraced monopile that is assembled inshore and towed to a site. It is installed by under-pressurizing suction piles.

5 Large Bubble screen- Hendrik Pehlke ([link presentation](#))

A large bubble screen consists of a hose with drilled holes, supplied with compressed air. The hose is placed on the sea bed and the air escaping from the holes forms the bubble screen.

6 Challenges for drilling- Dolf Elsevier van Griethuysen ([link presentation](#))

Drilling can be done within a concrete pile. The drill head can be placed outside the pile if there is resistance. The pile will sink within the drilled hole.

7 Dewatered Cofferdam- Anders Hansen ([link presentation](#))

The cofferdam consists of a rigid steel tube surrounding the pile. Once the pile is stabbed into the cofferdam, the water will be pumped out.

8 Vibro-drilling- Jaap Boor ([link presentation](#))

Vibro-drilling combines a vibrator tandem PVE and a drill head in one unit. The pile is driven into the sea floor by vibrating. Drilling will be applied when there is resistance with vibrating.

9 Concrete Gravity based- Sytske van den Akker (as a substitute for a Gravitass person) ([link presentation](#))

Concrete Gravity Based structures are reinforced concrete structures. These self buoyant structures are towed to a site and directly placed to the seabed.

2.1 Voting top three solutions

After the speed presentations, the participants were asked to vote for three solutions they thought were the most interesting to be discussed in the working groups.

Voting results were generally in the same range indicating that all presented solutions were considered valuable. This was also stressed by the chairman. However, the participants were clearly most interested in:

- 1, Hydro Sound Dampers
2. Dewatered Cofferdam
3. Self Installing Windturbine.



Workshop 1: top three solutions

Key (dis) ad- vantages of techniques



3. Workshop 1- Solutions

In the afternoon, the group was divided in 6 subgroups, each covering different expertises. The discussions were accommodated by a leader. Every subgroup worked towards answering the following questions:

- 1) What are the key advantages of this technique?
- 2) What are key disadvantages of this technique?
- 3) Could this technique be applied at a large scale in the North Sea?
 - a. If not: Why not?
 - b. If so: Which 3 steps have to be taken to implement?

The top three technical solutions were each discussed within two subgroups. The discussions were very animated and interesting. Knowledge about the three solutions was shared and different points of views were discussed. Ultimately, each group prepared a flip-over answering the questions. A rapporteur presented the results at the end of the afternoon in the plenary session.

3.1 Results Hydro Sound Damper

Advantages & disadvantages

The Hydro Sound Damper was considered the cheapest end of the pipe solution. However preventing underwater noise emission was regarded as a better solution. The ability to apply this measure on a large scale was seen as a key advantage. Other advantages mentioned were the greater depth in which the measure is applicable, the fact that little additional offshore installation time and no fundamental changes of the pile driving are needed, the quick manufacturing and the low energy footprint. The participants identified also disadvantages. They were questioning whether the application of a net around a monopile would be safe, if the net with balloons is too fragile and if there is a risk of pollution by foam and plastic lost from the net. Moreover, the group distinguished some practical problems: the technology has not been proven yet, there is a lack of data on the noise dampening effect, it is developed by a very small company and it still interferes with the operation. There were also some questions if the frequency range in which it dampens sound is sufficient.

Applicability

One group considered Hydro Sound Dampers applicable at a large scale in the North Sea, but not unanimously. More research is needed. Firstly on the frequencies which are and can be dampened, but also on the practicality and safety of the use of these nets. The other group considered the measure not feasible to apply at a large scale for now, but maybe in the long run. Therefore, the technique needs a customer, experience is needed and the engineering needs to be optimised.

3.2 Results Dewatered Cofferdam

Advantages & disadvantages

The first group considered some arguments both as an advantage and a disadvantage. The reduction of 22 dB was considered to be an advantage. This reduction makes it possible to comply with the German regulations. However, at the same time it is considered a disadvantage: the noise level is still very high. The continuation of using piling was regarded an advantage, since it is a proven technique; but also a disadvantage because there is no new technology and there will be cumulative effects. As a disadvantage the additional installation time was mentioned, and safety issues concerning larger vessels. The key advantage is that this is a speedy solution which is relatively simple.

The other subgroup drew different conclusions. They considered it as an effective sound dampener, because it makes use of an airlayer. They also considered it as a measure that can be used for other constructions, simply by adjusting the seal. However, at this moment it can be only used for mono-piles. This group saw some large disadvantages. If the wall touches the pile, or if the seal breaks, there will be no noise reduction at all. There were also some questions about the spectrum in which the sound reduction is reached.

Applicability

This technique was considered to be applicable in the North Sea, but further development is needed. To start with, there is clear need for more measurements on noise reduction and stability. Moreover, it should be adjusted to make it feasible for other foundations, like jackets, as well. It should be investigated if it can be applied in combination with other techniques.

The other group considered the use of dewatered cofferdams not applicable at a large scale in the North Sea. As reason they mentioned that a cofferdam only mitigates underwater sound, not preventing it. Prevention of underwater noise emission is considered a better solution. However, for the short time it can be used. Therefore there is a need for reliable sound measurements. The measure should be better integrated in the design, so it will be faster. And there is a need to make the seals more flexible.

3.3 Results Self Installing Windturbine (SIW)

Advantages & disadvantages

Obviously, the low noise emission was considered as an advantage. This also means that there is no need for monitoring effects of underwater sound. A disadvantage however is the construction to the sea floor conditions. If there are cobbles, the suction bucket must be moved, leading to longer installation time. The SIW however is more flexible in installation than a single suction bucket, since one of the buckets can be moved. Other advantages of the SIW are the easy and complete decommissioning and the option of maintenance offshore. Because the construction takes place onshore, the time at sea is reduced. There is no need for many construction vessels, only units to install the structures. Another advantage could be, that aquaculture may be possible between the legs, or it can be a refugium for fish. This however, counts for all kinds of tripods or jackets.

There are also still several disadvantages, like the restrictions due to seafloor conditions and the need for extensive scour protection. It needs deep harbours and a lot of space onshore. Therefore the number of appropriate harbours is limited, leading to longer transport distances and thus costs. Transport is also quite sensitive to wind and waves and one group questioned the suitability for larger wind turbines. Moreover, the foundations are larger, more steel is needed, they are more expensive and take longer to produce.

Applicability

Both groups considered self installing windturbines applicable in the North Sea at a large scale, but only on the right soil conditions. They mentioned the need for deep water harbours for the application of SIWs. One group suggested that this can be solved by assemblage at sea. Although this would reduce the advantage of spending less time at sea. However, the installation will still be silent. Cost reduction would be vital for large scale application, but there needs to be worked on transport and logistics as well. There is a clear need for a pilot.

Applicability in the North Sea



4. Workshop 2 - Regulations and Research

After a short break, the same subgroups discussed either Regulations, or Research.

4.1 Regulations

In three subgroups, regulations were discussed. Every group worked on answering the following questions:

- 1) What are advantages and what are the disadvantages of the different national regulations?
- 2) How will the ideal regulations look like?
- 3) Which steps have to be taken to realize the ideal regulations as described under 2.

Three groups discussed a schedule as provided with an overview of the different approaches in different countries. Soft start ramping scheme is considered as general practice. Most countries use pingers. The first type of pingers didn't work well: it also attracted animals. The new types work well in scaring animals, but sometimes also may attract curious sea mammals.

In the UK monitoring has been conducted. Before and during piling, marine mammal observers and acoustic monitors are observing if marine mammals are present. If so, piling is not allowed at that moment. Advantages are that it is site and time specific. It is restricted to a distance of 500 m and it is not possible at night and is only to prevent PTS. Moreover, there are location specific restrictions, for instance a window from may-november.

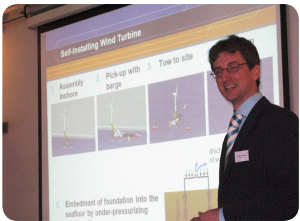
Germany has set a sound level, which has the advantage that it offers a clear goal for the industry to work on. The German strategy has clearly led to innovation, although the threshold itself may be disputable. A soundlevel is only one aspect. It is important to also consider TTS and behavioural aspects. Moreover, the level is species specific: each species has its own hearing sensitivity. There is a need for scientific proof for the threshold. Probably, the German threshold will be lowered to 150 dB. One group considers it a disadvantage that it is difficult to control and it will not challenge the industry to minimize sound emission.

In the Netherlands there is a window in which piling is allowed and only in one area at the time. This could stimulate the industry to innovate. However, in reality this seems to be less effective in triggering innovation, since in the other time other construction activities can be performed. There is also a need for scientific proof for this measure. Theoretically, using more vessels for piling in the same period is allowed, leading to even higher noise levels. A great disadvantage is that it freezes the industry.

Ideal regulations

There is definitely a need for more regional harmonization and permitting conditions. This needs to be discussed with the governments. There are a lot of technical working groups, but regulatory working groups would help in discussing feasible regulations and set conditions for permits. It is important that regulations will be based on ecology and preferably based on research. They can also be based on best technologies or ALARA. Lowering a threshold to 150 or lower could also lead to more innovations. Ideally, an international integrated planning will be conducted. An option could be to have general goals but make the regulations location specific. Research is important. Ideal regulations should take into account cumulative effects (e.g. habitat loss) and the most severe effect (like avoidance at 80 km distance).

Workshop 2: regulations and research



International harmonization is very difficult

A platform to exchange information is usefull

Lowering threshold could lead to innovation

Another group considers as most important step research on a realistic, achievable soundlevel, that meets (some) of the environmental goals. They put forward to use the German threshold to use meanwhile. International harmonization is very difficult. All countries are already building offshore wind parks. Maybe harmonization of regulations is not possible, but instead use best practice.

4.2 Research

In the other three groups, research was discussed. Every group worked on answering the following questions.

- 1) What are the priorities for research? Please divide a budget of 100% over the 4 categories of research. Fill in the table:
 - 1 physical
 - 2 biological
 - 3 engineering-new constructions
 - 4 engineering-mitigation
 - 5 other
- 2) Why are the priorities as described? Fill In the last column in the table
- 3) What needs to be done to conduct the research with the highest priority? Determine the 3 most important steps.

Priorities

One of the groups has put all effort to 'other': a platform to exchange information on all 4 subjects mentioned, being all very important. It was acknowledged that there is a lot of research being conducted on different topics in different countries. The different categories of research can't be considered separately. An international platform, combining different types of research and expertise and sharing information could help to come to an integrated research plan. Sharing information and talking the same language were mentioned as important conditions for a good research plan. A start can be to investigate existing platforms, a second step establish an international platform and the final step to come to integrated research.

In this group, research topics were summed up, important to spend budget on: vibration and the effects of it, effect of noise on populations, on fish (larvae), but also on artificial reefs and operational windfarms. Moreover, budget is needed for developing low sound solutions and for an independent review of the effectiveness of mitigation measures. Another group mentioned the noise of operating wind farms as topic to consider. The other two groups filled in the table. Results of the two groups are shown in the table below, each in a different colour. In outline the assignment of the budget was comparable.

Category	%	Why/what
1 physical	10/20	- There is a need of standardisation of measurements - Research on propagation of sound is needed - There is a need for a way to describe sound sources
2 biological	20/20	- There is need of information on the effect on fish(larvae) - There is a need on hearing related research on marine mammals: behaviour in relation to the ecological framework and translation to population effects

3 engineering-new constructions	50/30	Most money should be spend on a 0-noise alternative. Important subjects are: mass production, certification, subsidy
4 engineering-mitigation	20/15	'yesterday's technology'
5 education/awareness	15	

In both groups, the highest amount was spent on developing new techniques. Pile driving was generally considered as 'yesterday's technology'. For the short term however, mitigation of underwater sound of piling is important. Because measuring and testing is expensive, a rather large budget was assigned to it.

Physical and biological research were assigned smaller budgets, because the research is much cheaper. So, although the budgets are smaller, the groups considered this categories of research important as well. Physical and biological research go hand in hand: you need to know both sides to understand the problem. If a new technique doesn't emit sound, the need for physical and biological research decreases. At the moment, the application of solutions (mitigation or alternative techniques) seems to cost too much. Research effort must be to test solutions in order to reduce costs.

Important steps

According to one group, the first step in research should be biological research to better understand the issue. The costs are relatively low and the importance high. The second step would be physical research. The other group considered the most important steps to be taken are to create a good, integrated research plan, proper management of research by a government or industry and feedback and evaluation of research. Results should be published in peer reviewed magazines. It is important to raise funds and direct the funds to the right companies, institutes and universities. The third step will be matching results from physical and biological research and technical developments and distill policy and regulations from it.

5. Wrap up

Our chairman Bopp concluded that the symposium's aim to work towards a best practise may have been ambitious, but that today's meeting showed it works to bring divers experts together and talk. The symposium did contribute to steps towards a best practise for offshore wind farm development. It was obvious that creativity creates creativity and how important it is to talk with different experts to come to innovative solutions. Coming together also helps in learning to understand each other's 'language'.

It became obvious that making appropriate policy for piling and underwater noise levels is very complex and not an easy task. None of the groups actually answered the question what ideal regulations should look like and what would be required to develop and implement them.

Research seems to be the corner stone for the entire discussion. It is very important to integrate different types of (international) research. With an integrated process everything can be solved more efficiently and effectively! Chris Westra thanked North Sea Foundation for the organisation of the day and acknowledged an unique moment in discussions on piling. A few years ago alternatives for pile driving were not an issue. Today's discussion showed clearly, that opinions have changed. Alternatives for pile driving are definitely an option. It only needs time.



Good contribution towards a good practice

Mitigation today, alternative methods tomorrow

We will keep you updated!

6. Conclusions

All participants were proactive and open for discussions. There has been a lot of networking and exchange of knowledge. Solutions are hard to compare: it is a bit like comparing apples and oranges. Some of them have the aim to reduce the sound of piling. Others are a low noise alternative. Remarkably, in general piling was considered to be yesterday's technology. It is a proven technology, but the underwater sound levels are considered too high. Other techniques are not proven technology yet, but produce low noise. These techniques will be the future. But there is still a lot that needs to be done. Cost reduction is essential. In the short term, mitigation of underwater sound of piling is necessary. Also research is very important in the short term to get a better picture of the sound problem, including better international sharing of data. Besides, more international coordination of government regulations is needed, but it is clear that there is not one best regulation that would be applicable to all regions.

7. Evaluation

At the end of the day, we've asked to fill in a feedback form. We received 40 feedback forms. From these forms it appeared that you were quite satisfied with the symposium. The vast majority had its expectations met, knowledge about underwater sound and solutions was increased and will be used in daily work. A minority (13%) missed some aspects. These were the relative importance of other sound sources and the importance of offshore wind against ecological problems, the actual sound levels and an independent comparison of the different solutions.

The sessions in the morning were considered informative and the format of the speed presentations was mentioned several times as a nice concept. The afternoon workshops were also appreciated for the different points of view in the groups and the discussions. Tips for improvement were mainly focussed on the questions on the flip-overs. 70% considered the plenary feedback valuable, but some considered the feedback too long and not interactive enough.

The vast majority wants to stay updated on this project with new information. Also involvement for instance by attending future symposia, sharing results and participation in a working group, was named. Suggestions for future topics showed a range between other ecological impacts of wind farms (on birds, soft-bottom fauna, fish, long term effects), the ecological impact on not having offshore wind and new items like infrastructure / cables electromagnetic fields and decommissioning. Several suggestions for a follow-up on underwater sound issues were given: short term solutions, progress, sound of operational wind farms and their ecological impact the relation with other anthropogenic sounds and setting standards.

8. Follow-up

We are very pleased with these results and would like to continue our project. We will make use of the given tips for future subjects and also to make future events better. We will keep you updated.

More information:
www.noordzee.nl/soundsolutions

About The North Sea Foundation

The North Sea Foundation (NSF) is a Dutch NGO dedicated to a sustainable use of the North Sea. A clean and healthy sea full of fish, birds, dolphins and other life - this is our dream. Shipping, fisheries, spatial planning and nature conservation are our key areas of focus.

As an expert advocate, we expose problems, lobby at national and international (EU, UN) level, seek out a dialogue with policymakers and those using the sea such as fishermen and wind farm builders, and propose realistic solutions.

More information: www.noordzee.nl



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More information: www.noordzee.nl/support

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