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Abstract

NER 300 is an EU funding programme for the demonstration of innovative renewable energy technologies at the pre-commercial stage. Projects have to submit annually to the European Commission relevant knowledge gained, which is assessed with a view to establishing whether the project has adequately complied with its obligations. This report summarises the key lessons learnt so far and the recommendations of the JRC on the knowledge gained and the lessons learnt.

1 Introduction

NER 300 is an EU funding programme for the demonstration of carbon capture and storage (CCS) and innovative renewable energy (RES) technologies at the pre-commercial stage. The programme aims to support a wide range of CCS and RES technologies. NER 300 also seeks to leverage a considerable amount of private investment and/or national co-funding across the EU, boost the deployment of innovative low-carbon technologies and stimulate the creation of jobs in those technologies within the EU.

NER 300 is funded from the sale of emission allowances from the new entrants' reserve (NER) set up for the third phase of the EU emissions trading system (EU ETS). 300 million allowances are reserved for the financing of commercial-scale CCS and innovative RES demonstration projects according to Art. 10a(8) of the EU ETS Directive [DIR 2009/29/EC].

Knowledge sharing requirements are built into the legal basis of the programme as a critical tool to lower risks in bridging the transition to large-scale production of innovative renewable energy and CCS deployment. The legal basis obliges project sponsors to submit annually to the European Commission relevant knowledge (RK) gained during that year in the implementation of their project (see Annex 2 and 3 of the Award Decision [C(2012) 9432 final]).

The knowledge sharing element of NER 300 requires the European Commission to collect and assess the relevant knowledge with a view to establishing whether the project has adequately complied with its knowledge sharing obligations. The disbursement of annual payments is conditional to the positive assessment of the Commission on the fulfilment of the KS obligation.

The NER 300 programme differentiates two types of relevant knowledge to be collected and shared. These are defined by the level of sensitivity. Level 1 (L1) knowledge is only to be shared with other projects in a particular technology category. One L1 community will be set up for each technology category. Level 2 (L2) knowledge is of general interest and includes aggregated and anonymised L1 knowledge. The target audience for L2 is the general public, industry, research, government, NGOs and other interest groups and associations.

DG CLIMA is in charge of managing the NER 300 programme for the European Commission. The Institute for Energy, Transport and Climate of the Joint Research Centre (JRC) supports DG CLIMA in the implementation of the knowledge sharing from under two Administrative Arrangements (N° 071201/2013/666129/CLIMA.C.1 and №340202/2016/737812/SER/CLIMA.C.3) between DG CLIMA and DG JRC for the project entitled "NER 300 Knowledge Sharing: Assessment and Dissemination" that were successfully executed respectively from 1 December 2013 to 31 December 2016 and 1 January 2017 to 31 December 2019. With the administrative arrangement, DG CLIMA continues to enlist the support of DG JRC for the implementation of NER 300 knowledge sharing from 1 January 2020 to 31 December 2022.

This report provides an overview over the state-of-play of the knowledge sharing of the NER 300 programme so far, in particular the Knowledge Sharing process (Section 2), the aggregation method performed (Section 3) and, most importantly, the results obtained (Section 4).

We summarise the process of the Knowledge Sharing reports from NER 300 projects in 2020. On top of that, we describe the technical assessments and outline the outcomes of them both for L1 and L2 levels. Then, we describe the key aspects of the method used and the communication process with the projects and the national contact points. Moreover, we highlight the needs discovered for a possible update of the knowledge sharing templates that may be applied for the next knowledge sharing cycle.

2 Knowledge Sharing process

In 2019, six projects submitted relevant knowledge. Five of these projects are Wind Energy projects and one of them is a Bioenergy project. Compared to 2018, there is one less Bioenergy project and one more Wind Energy project. **Table 1** depicts the six projects assessed this year for the relevant knowledge shared this year.

The VERBIO project is affiliated to category BIOh (lignocellulose and/or household waste to biogas, biofuels or bioliquids via chemical and biological processes with capacity 6 MNm^3/y of Methane or 10 Ml/y of the final product). The Blaiken project refers to category WINf (On-shore wind turbines optimised for cold climates (compatible with temperature lower than -30°C and severe icing conditions) with nominal capacity 25 MW). The Handalm project is a WINe (On-shore wind turbines optimised for complex terrains (e.g. forested terrains, mountainous areas): with nominal capacity 25 MWe). The Nordsee One and Veja Mate projects are affiliated to category WINa (Off-shore wind (minimum turbines size 6 MWe) with nominal capacity 40 MWe). The VERTIMED project is a WINd (Floating off-shore wind systems with nominal capacity 25 MWe) project. **Table 1** summarizes the projects and relevant details.

Table 1 Overview of NER 300 projects that have submitted relevant knowledge in 2019

Project	Country	Technology category	Date of entry into operation	RK Template
VERBIO	Germany	BIOh	01/01/2017	RK/RES/BIO
Windpark Blaiken	Sweden	WINf	01/01/2015	RK/RES/WIN
Windpark Handalm	Austria	WINe	01/01/2018	RK/RES/WIN
Nordsee One	Germany	WINa	31/12/2017	RK/RES/WIN
Veja Mate Offshore	Germany	WINa	01/07/2017	RK/RES/WIN
VERTIMED	France	WINd	18/07/2019[1]	RK/RES/WIN

This report summarises relevant knowledge for the following years:

- for VERBIO during 2017, 2018 and 2019;
- for Windpark Blaiken during 2015, 2016, 2017, 2018 and 2019;
- for Windpark Handalm during 2018 and 2019;
- for Nordsee One during 2018 and 2019;
- for Veja Mate Offshore during 2017, 2018 and 2019 and
- for VERTIMED for 2019[2].

The assessment of the RK submissions was performed by the JRC from 10 February 2020 to 29 June 2020 — due to a delayed submission. Like in previous years, the developed methodology worked well and no significant problems or concerns stemming from the application of the methodology arise. However, we observed that valuable knowledge, especially regarding the wind energy projects, can be gained if the RK templates are updated. We plan to update the templates for the upcoming 2020 knowledge sharing cycle for all technologies and not exclusively for wind energy. These can possibly include an excel file in addition to the current template in order to harmonise and automate the gathering of numerical information.

In general, the RK assessment process has tight deadlines. Since only six submissions had to be assessed in 2019, this did not pose a problem. The only delay refers to VERTIMED where the project was submitting the RK assessment for the first time and within the COVID 19 pandemic. We have communicated with both the project and the national contact points and believe that the following year no delay will be observed. Consequently, it shall always be ensured that RK submissions from projects shall be submitted by the project sponsor on time, otherwise there could be a delay in the RK assessment process and the JRC might not be able to conclude the annual cycle by 15th of May each year.

[1] Report shared but project not operational in 2019.

[2] The project submitted the Knowledge Sharing report but was commissioned in 2019. The assessment of the report was at this stage preliminary for further experience.

As a result, in this annual report we analyse the aggregated knowledge shared for the operating year 2019 with information on one bioenergy project and four wind energy projects. In the following section we discuss the aggregation method used.

3 Aggregation method

This report discusses the relevant knowledge of general interest as well as potentially some specific relevant knowledge from projects, provided the latter is collated and/or duly anonymised. The target community of this report is the general public, industry, research, government and non-government organisations and any other interest groups and associations.

In addition to providing a picture of 2019, this annual report on aggregation of shared knowledge and lessons learned also traces over time key tendencies and the evolution of projects and relevant knowledge gained. As a result, this report especially focuses on the lessons learnt in the two technology areas covered by NER 300 projects — bioenergy and wind energy.

Due to the specific circumstances of 2019 and 2020 — the reporting year — the bioenergy section refers to one project. However, the wind energy section is richer with four fully operating projects and a new addition where knowledge was provided by the project but not a full year into operation has been completed and thus the project report has been assessed with a view to provide feedback to the project for future reports.

Projects, regardless of the technology they refer to, provide information on five subject areas:

- Technical set-up and performance
- Costs
- Project Management
- Environmental impact and
- Health and safety.

These subject areas are chosen based on the Knowledge Sharing template that the projects have to fill in. In each of these sections relevant information, evolution of activities or problems faced and solved are shared with the European Commission.

The Bioenergy section has only one project reported in 2020 for the year prior. This project is analysed but the aggregation method cannot be followed and, thus, limiting the knowledge that can be shared. In the bioenergy project we are providing information of lessons learnt without photographing the specific technology or project. Therefore, the aggregation method applies especially to the wind energy projects. In the Wind Energy section, we have four projects that reported on time. Here, we apply the aggregation method and report the results in the following section 4.

Annexes 1 to 6 provide detailed information on the assessment and the assessment score of the projects.

Section 4 provides the outcomes and the lessons learned for the Bioenergy project and the Wind energy projects.

4 Aggregated Shared Knowledge

Bioenergy project

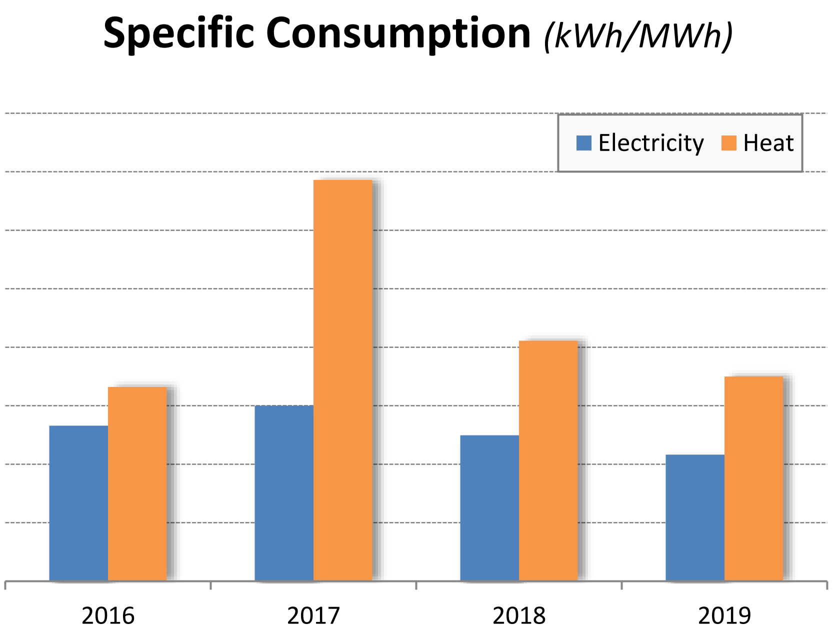
The VERBIO project is affiliated to category BIOh (lignocellulose and/or household waste to biogas, biofuels or bioliquids via chemical and biological processes with capacity 6 MNm^3/y of Methane or 10 Ml/y of the final product) and has been submitting Knowledge Sharing reports since 2018. In this section we, qualitatively, describe the progress made and areas of attention through the five categories, as described in section 3.

The plant is located on the PCK refinery site in Schwedt/Oder in Brandenburg, and it is designed to produce biofuels from lignocellulosic feedstock (e.g. straw). The unit is integrated in an existing bioethanol/biomethane biorefinery on the site. The first biogas, not upgrade to biomethane, was measured on 09.10.2014.

— Technical set-up and performance

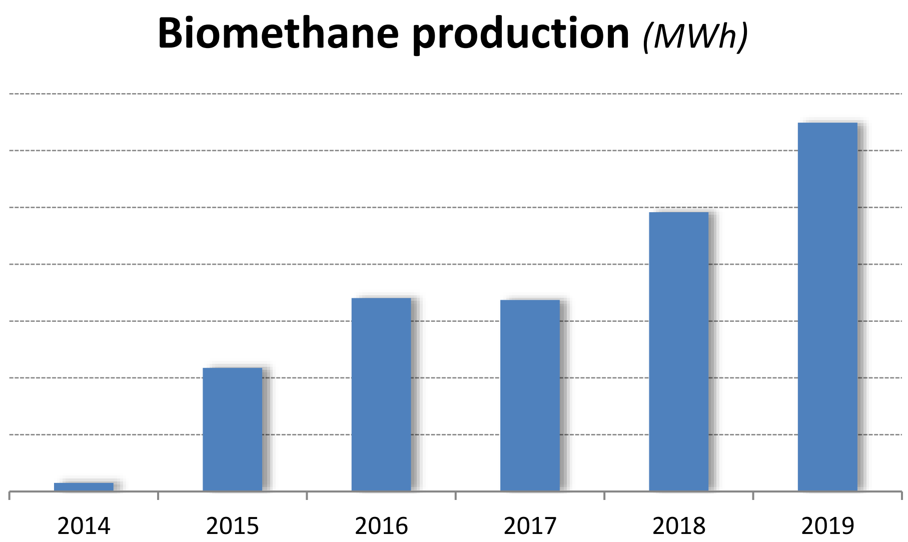
During 2019, several improvements were made in the modules comprising the technical set up of the project. These were aiming at the optimisation of the different processes and the overall procedure with the goal of an increased efficiency and stability of operation. Tests occurred along the project increased specific energy input in certain years, which resulted in higher yields but lower environmental performances. Further optimisation allowed reducing the specific energy inputs, which however have been always lower than planned during the application for grant in 2011: 214 kWh_{in}/MWh_{out} for electricity and 744 kWh_{in}/MWh_{out} for heat.

Figure 1 Trends in specific energy consumptions, reporting until 2019



According to the project and our technical analysis, the raw biogas produced followed an increased trend – compared to 2018, and the resulting biomethane accordingly. This was especially evident during the spring and summer months of the year, when the plant showed the capability to produce the planned output. Put side to side with the initial, 2011, planning and goals for the project the production was approximately 20% lower.

Figure 2 Trend in biomethane output, reporting until 2019

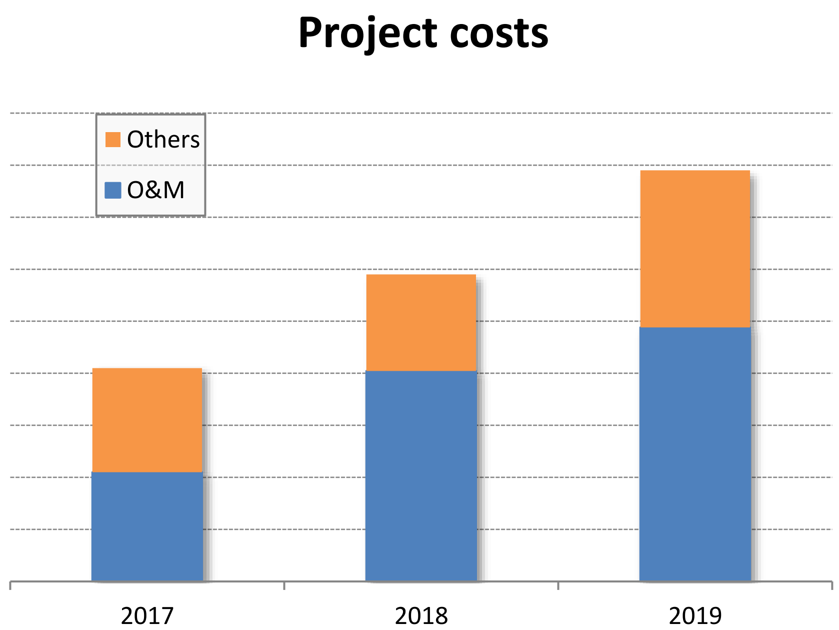


The handling of the material used for the production of biogas, and resulting biomethane, is humidity and weather dependent. Among the reported lessons learned, downtimes occurred for problems with too high humidity, and impurities in the straw. These caused blocking and general mechanical problems in several plant modules. The project showed that with optimisation in the processes they could handle lower quality material better this year.

— Costs

The annual project costs increased along the project lifetime. Among the various cost items (CAPEX and OPEX), O&M represented the major share: services, staff costs, overheads, waste disposal, local rates and taxes, insurance, knowledge sharing, and others). The percentage of O&M over the total changed along the reported years but was always above 50-60% of the total project costs.

Figure 3 Trend in annual project costs, reporting until 2019



— Project Management

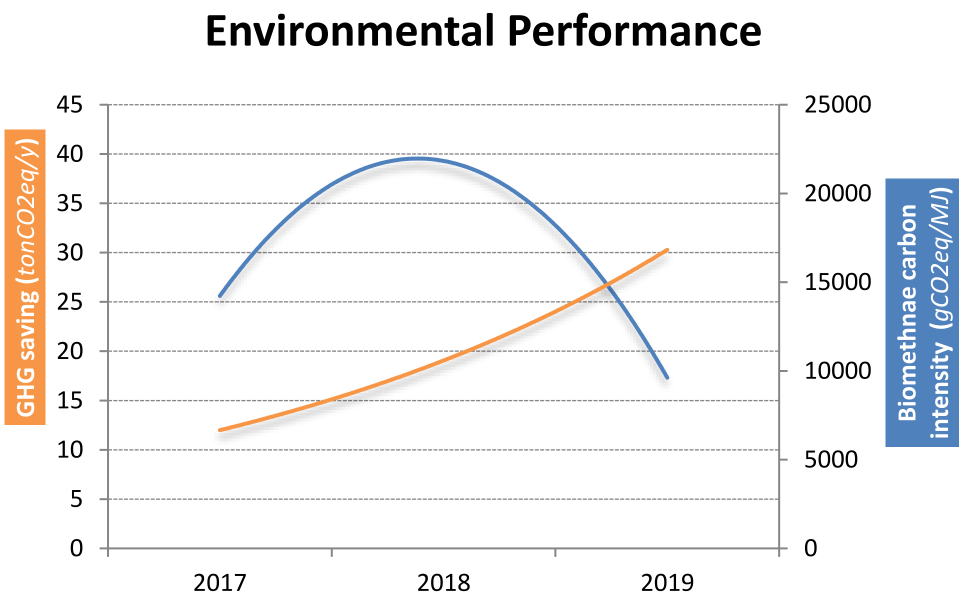
During 2019, and since the beginning of the project, the management has not been further developed. The main lessons learnt are summed up in the following points.

The priority is strong time and quality management especially during planning and construction. Second, the business model should be robust against deviations in the plan. This means quick responses to significant changes in the plan and the consideration of changes before they occur and definition of realistic solutions. Third, it is important to minimize investment costs at the beginning (extension of existing plants). Last, the need of close observation of regulatory developments and fast response on changes is highlighted.

— Environmental Impact

The emissions of the project remain at the same levels of the previous years of operation. The current CO_2 emissions – based on the national methodology – are 17.31 gr CO_2eq./MJ produced. To put this in perspective, in comparison with a fossil fuelled production the CO_2 emissions are reduced by 21,508 tonnes in 2019.

Figure 4 Trend in the environmental performance of the project.



— Health and Safety

In 2019 there were two minor accidents and two near misses. Based on the accidents, the project has identified the following key lessons learned relating to safety:

- There should be a separation between walking areas and straw bale handling areas.
- Visibility of humans should be improved in the straw bale handling areas by additional light installations and reflective wear.
- Introduction of awareness training for the drivers.
- Additional protective equipment is necessary.

Relating to the near misses, that were handled through first aid, the key lessons learned are:

- Awareness of the risk related to falling bales that weigh 400-500 kg.
- Proper usage of tools combined with the correct equipment is of great importance.

The project has taken measures for these accidents and near misses in the form of training, awareness training and the physical separation of walking areas and straw bale handling areas. The reported number of incidents per hour operated results below 0,0003 in the last two years.

Wind energy projects

In the Wind energy category we received four full knowledge sharing reports from the projects running[3]. Two of the projects are onshore and two are offshore.

Following the structure of the Knowledge Sharing templates, we continue in this section with an overview of the progress of the projects in the five main areas.

However, before the results are presented, we need to stress that responses to reporting templates happened at different time scales and level of detail. The original data was screened and aggregated to a level that does not to disclose detailed project specific information. Thus the aggregated quantitative results presented in this section are limited to dedicated aspects of the reporting that can be either compared to some extent among projects or to an international reference.

As innovations of the NER 300 wind projects include targeting the operation and maintenance (O&M) stage, we decided to compare O&M categories and aggregated this information into two main O&M categories. This allows to identify a broad average relation between planned and unplanned maintenance which could be used in the following years (and at a later stage) to potentially identify a learning effect with respect to maintenance throughout the projects lifetime. Currently, this development over time does not yet lead to meaningful results as we could obtain a complete picture only for two consecutive years of O&M data.

A second set of quantitative data presented in this section concerns costs. Similarly as the aforementioned O&M categories, we screened O&M costs during the projects' lifetime. In order to prevent the disclosure of sensitive costs data among NER 300 projects we decided to present NER 300 O&M data in an aggregated form and in comparison to international references (e.g. IEA Wind Technology Cooperation Programme – Task26 'Cost of Wind Energy'). Similarly CAPEX data is aggregated and compared in order to classify them into the international context.

— Technical set-up and performance

The technical set up and performance of all four projects has not deviated or changed significantly from the previous reporting years. In all projects, activities for preventive maintenance have taken place. Still, different innovation aspects regarding the technical set up are unique to each of the projects.

Innovation aspects of both onshore projects (Windpark Blaiken and Windpark Handalm) include technologies that allow operation at high altitudes or harsh and cold climates. In order to allow operation in these climates both projects utilise different de-icing systems and sensors against icing. Innovations in the offshore wind projects (Nordsee One and Veja Mate Offshore) include several technical innovations with respect to components (e.g. XL monopile foundations, bolted flange transition pieces, among others) and installation methods (eg. bubble curtain) which to a large extent became the norm in the fast evolving offshore wind market.

Table 2 presents the technical details — technology category, wind turbine model and capacity — of the wind energy projects assessed. The four projects are anonymised into five different case studies (in the following Case studies A –E), with one of the projects being split into two case studies.

Table 2 Technology characteristics of NER 300 wind energy projects that have submitted relevant knowledge until 2019

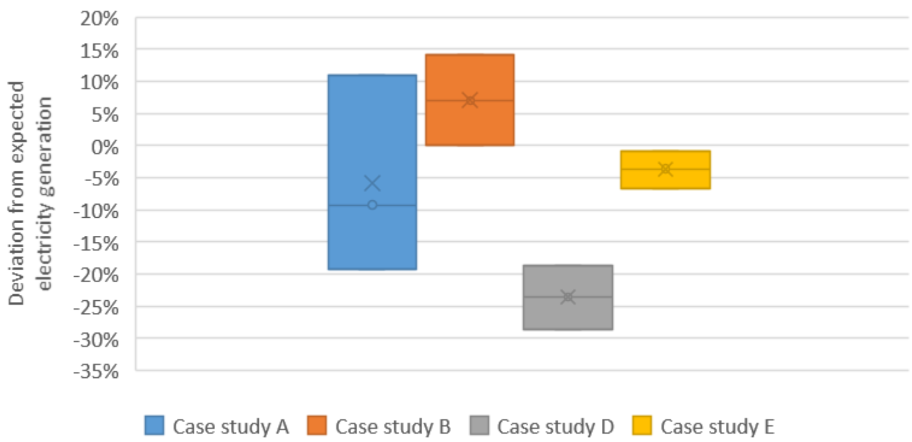
Project	Country	Technology category	Wind turbine model	Capacity (MW)
Windpark Blaiken	Sweden	Onshore Wind	2.5MW Nordex and Dongfang	225
Windpark Handalm	Austria	Onshore Wind	3MW Enercon E-82 E4	39
Nordsee One	Germany	Offshore Wind	6.2MW126 Senvion	334.8
Veja Mate Offshore	Germany	Offshore Wind	6MW Siemens SWT-6.0-154	402

Continuing, we are presenting information, through indicators concerning the electricity generation and the maintenance of projects. **Figure 5** shows the electricity deviation levels of the case studies compared to the expected results.

[3] The received report for the VERTIMED project is not considered here as it was not complete: the project was only commissioned in 2019.

In the first years of reporting, projects showed sometimes a strong deviation from the expected electricity generation for the respective years. A common reason seems to be low wind speeds in these years, particularly in the summer months. Moreover unplanned outages due to component failure or curtailment issues were reported. The levels of deviation from expected electricity generation are ranging from +15% to -30% in the cases assessed.

Figure 5 Deviation from expected electricity generation in NER300 projects, reporting until 2019



Maintenance is a crucial activity in the wind energy projects. Every project has a different way and level of detail in reporting maintenance, depending on the monitoring system used and the turbine model. In specific cases all information comes in much aggregated form, from the turbine manufacturer performing the service, and in other cases there is a better level of detail.

Table 3 shows the reported maintenance categories and the aggregated/clustered categories to allow a simplified comparison. We clustered the reported maintenance categories in two main categories

- Corrective and
- Preventive Maintenance.

We observe that case studies A and C provide more information on the type of maintenance whereas B, D and E. In corrective maintenance, we find planned and unplanned actions. These focus mostly on repairs, faults and replacements. Inspections take place in the planned corrective maintenance actions.

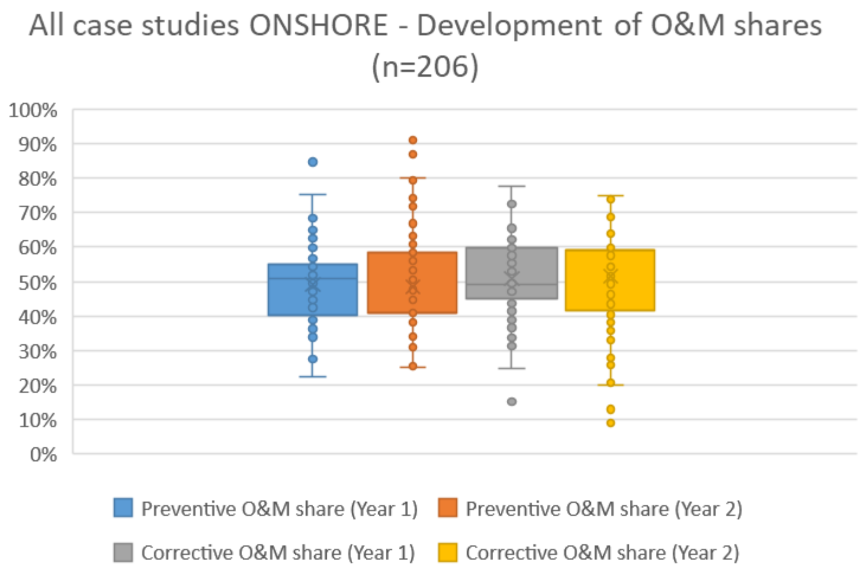
The work performed in preventive maintenance mostly focuses on improving the maintenance, operating work and services.

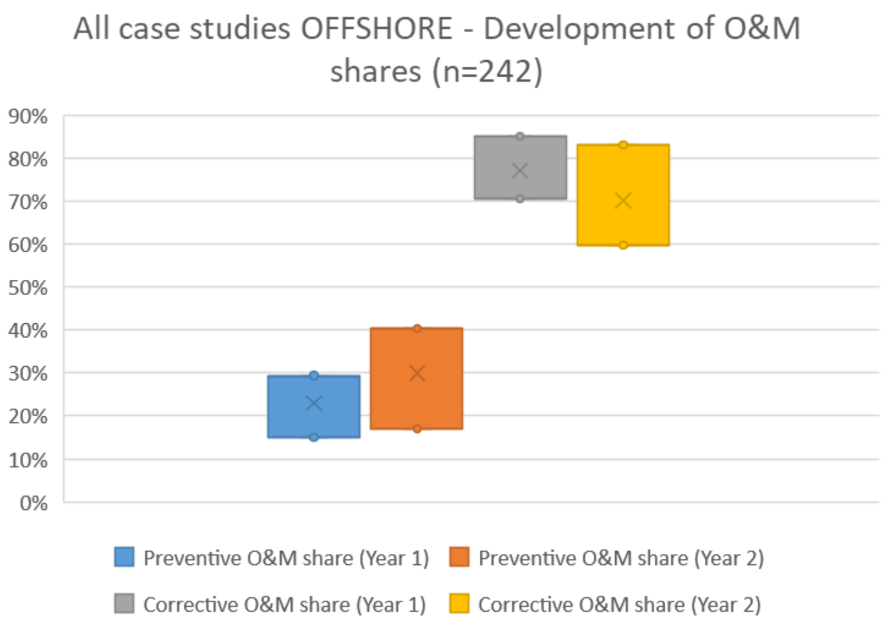
Table 3 Aggregation of O&M categories

Clustered categories		Reported categories		
Main maintenance categories	Subcategories	Case study A	Case study C	Case studies B+D+E
CORRECTIVE	Corrective maintenance (unplanned)	Immediate maintenance	Repair	Corrective Maintenance
			Fault	
			Replace	
	Corrective maintenance (planned)	Planned corrective maintenance	Check	
			Inspection	
PREVENTIVE	Preventive maintenance	Preventive maintenance	Service	Preventive Maintenance
		Operating work, not maintenance		
	Other	Administration	Reform (Improvement maintenance)	
		Improvement maintenance		
		Modify / project not maintenance		
Maintenance data quality/level of detail provided in reporting		HIGH	MID	LOW

Applying this aggregation step (bold categories on the left of **Table 3** summarize the shares of subcategories of the different case studies (right side of **Table 3**)) on the different case studies allows to compare the development of preventive and corrective onshore and offshore O&M shares in two consecutive years (see **Figure 6**). Moreover, maintenance registrations reported in absolute numbers of turbine site visits/interventions (maintenance registrations per year and turbine) were aggregated into relative terms to allow for comparison and knowledge sharing beyond Level1 recipients.

Figure 6 Development of onshore (top) and offshore (bottom) O&M shares in two consecutive years of reporting.





Preventive and corrective O&M shares show a wide distribution across all turbines. Preventive and corrective O&M shares for onshore wind turbines in two consecutive years of reporting average between 48-49% and 52-51%, respectively.

Preventive and corrective O&M shares for offshore wind turbines in two consecutive years of reporting average between 30-23% and 70-77%, respectively.

Whereas onshore projects show minimal decrease (increase) in corrective (preventive) O&M shares, offshore corrective (preventive) O&M shares increased (decreased) noticeable.

Given the limited availability of reported years at this stage, no trend or learning effect in the development can be observed. However, a more consolidated and aligned reporting of data in future submissions might allow conclusions in this regard.

— Costs

In general, cost structure and absolute values of project costs are not comparable between onshore and offshore projects. Thus, given the small number of projects, a comparison between each of the two onshore and offshore projects would give limited insight in the overall development of OPEX and CAPEX costs. We, therefore, decided to present NER 300 cost data in an aggregated form and in comparison to international references.

In this section, we, first present data comparisons on onshore wind OPEX and CAPEX, followed by the corresponding offshore cost figures. This is followed by results on the observed ranges of O&M cost shares during the entire reporting period and the relative change between the first and last year in the reported O&M costs across all case studies, which might be a first indication for the relative performance, gained experience and technology learning in the period of reporting.

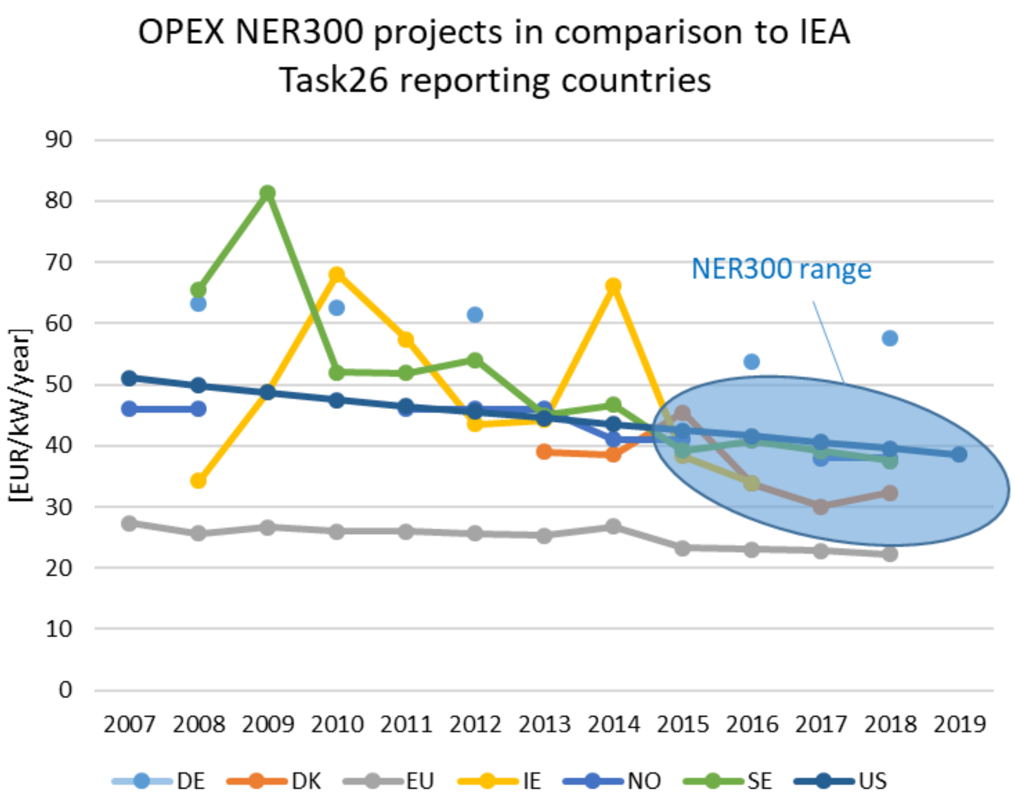
Onshore OPEX and CAPEX are compared against the cost range for onshore wind as reported by the IEA Wind Technology Cooperation Programme – Task26 'Cost of Wind Energy'[4]. **Figure 7** gives the range OPEX costs of NER 300 confirming

a) a decrease in O&M costs since the commissioning of the first project and

b) a general consensus with international data with values ranging between 30 to 50 EUR/kW/year since 2015.

The latter might indicate that innovations affecting the operational life cycle stage of projects in NER 300 projects contributed positively to the decrease of O&M costs over time.

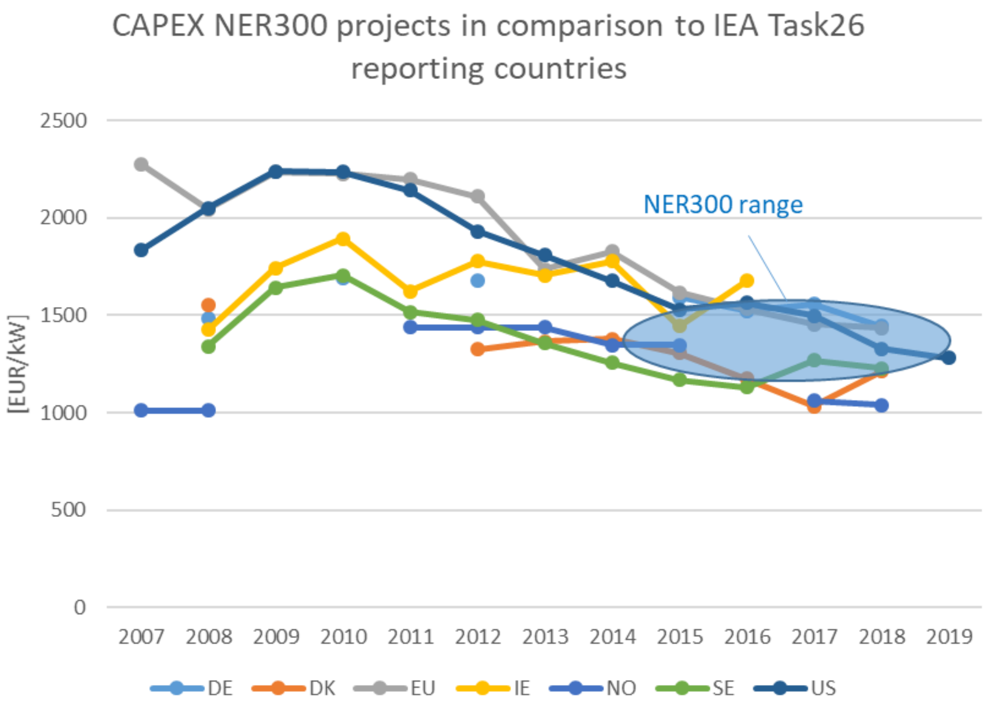
Figure 7 NER 300 onshore O&M cost (OPEX) range in comparison to historic development of onshore wind OPEX (based on IEATask26)
Note: OPEX of NER 300 within the indicated range



[4] For IEATASk26 cost data please see IEA DataViewer at https://community.ieawind.org/task26/dataviewer

Similarly, the broadly indicated CAPEX range of the two onshore NER 300 projects is in line with current international estimates (see **Figure 8**).

Figure 8 NER 300 onshore CAPEX range in comparison to historic development of onshore wind CAPEX (based on IEATask26)
Note: CAPEX of NER 300 within the indicated range

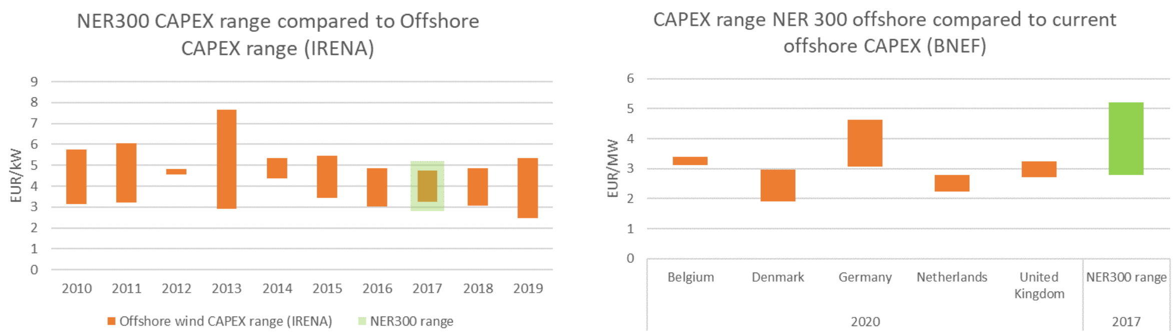


The data reported in NER 300 offshore wind projects did not allow investigating the temporal development of O&M costs (similar to **Figure 7**), given that only two years of reporting preformed at this stage. Moreover, there is some uncertainty on the system boundaries in the OPEX data provided. Current NER 300 reporting does not confirm it, yet, typical offshore O&M costs (e.g. IRENA (2020) reporting a range between 0.017 to 0.025 EUR/kWh).

A comparison with sources providing the international development of offshore CAPEX confirms that the projects' innovative character can be seen as fairly representative compared to the EU or global average as the NER 300 CAPEX range is matching the international figures[5] [6] (see **Figure 9**).

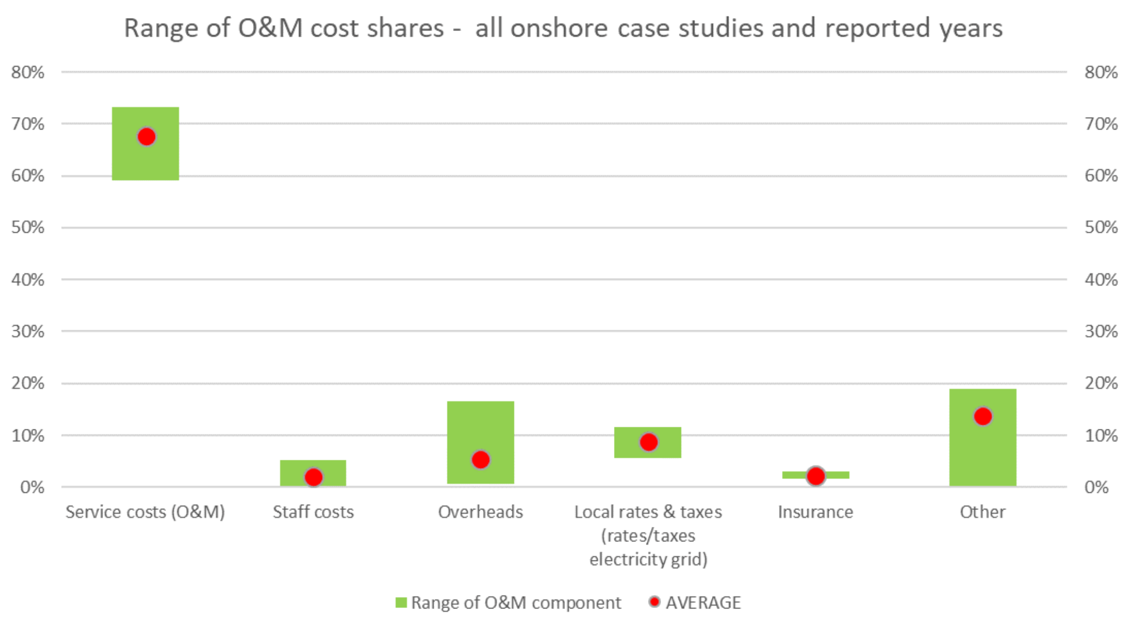
[5] IRENA (2020), Renewable Power Generation Costs in 2019, International Renewable Energy Agency, Abu Dhabi.
[6] BNEF (2020) offshore wind cost data

Figure 9 NER 300 offshore CAPEX range in comparison to historic development (left) and current status (right) of offshore wind CAPEX
Note: CAPEX of NER 300 within the indicated range (but are not MIN and MAX)



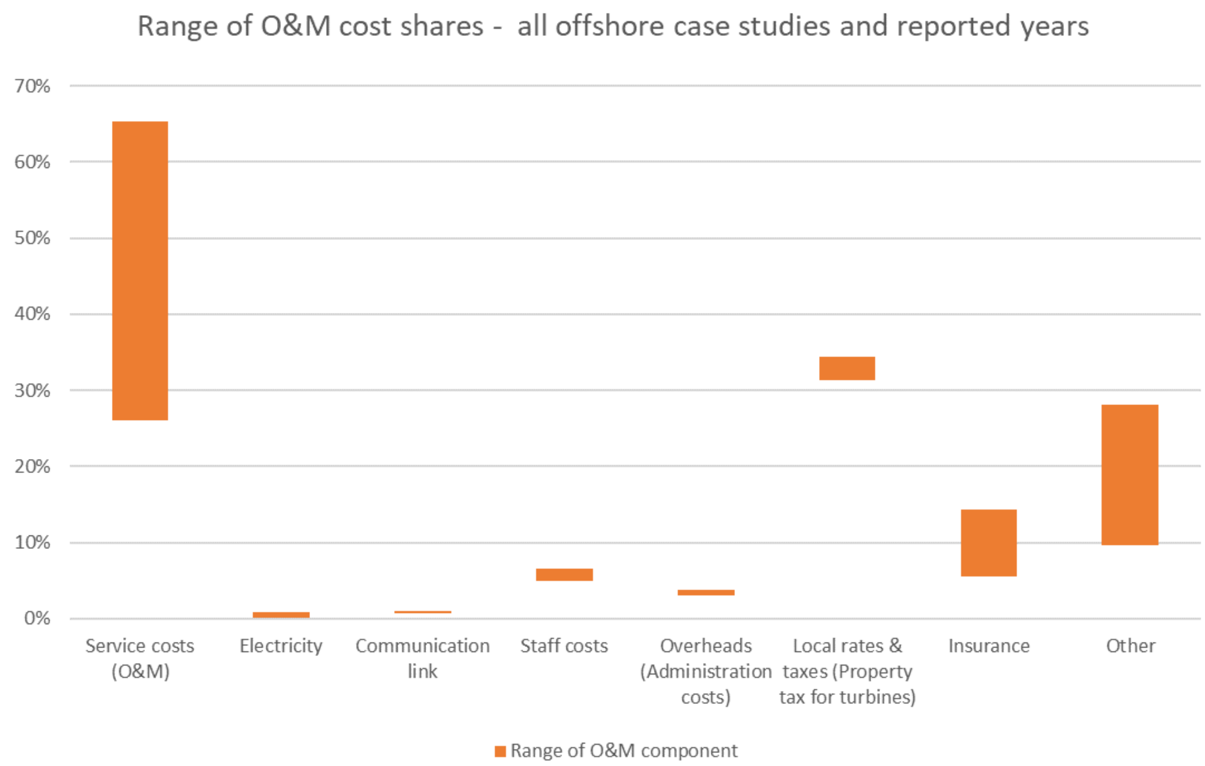
In addition to the overall O&M costs, the different cost shares of O&M costs are investigated. The reported NER 300 onshore data shows a rather low variation and unveils that most of the O&M onshore costs are declared as 'Service cost' ranging from 59% to 73% of the total (see **Figure 10**).

Figure 10 Range of O&M onshore cost shares



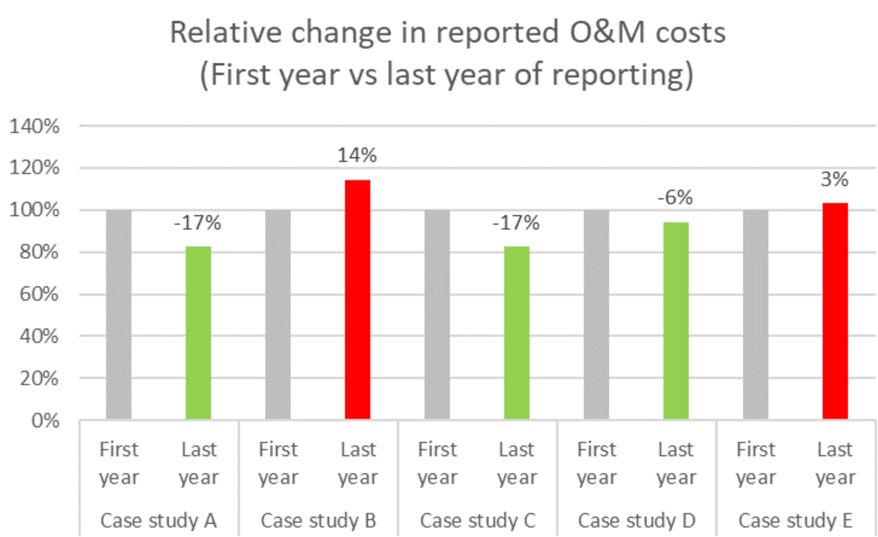
A high variation can be observed in the different reported O&M shares for the offshore wind projects. This is particularly the case for the reported Service Costs (see **Figure 11**) ranging from 26% to 65%. In these cases it seems that the RK template is understood and filled in by the projects in very different manner.

Figure 11 Range of O&M offshore cost shares



Last, a comparison of O&M costs across all case studies (both onshore and offshore wind) at the beginning and the end of the reporting period identifies no clear trend in O&M cost reduction (see **Figure 12**).

Figure 12 Relative change in reported O&M costs comparing first and last year of reporting



— Project management

The most common element in the aggregated shared knowledge analysis that we performed is early engagement of projects in almost all areas concerning project management.

One of the highlights is the continuous communication and early involvement dialogue with the authorities and stakeholders involved. These include financing institutions and advisers, insurance advisers & brokers, direct marketing companies and grid providers/TSOs.

In more detail, the continuous communication with stakeholders and key lessons learnt include the following aggregated elements:

- Good planning at an early stage in the investigation of several alternative designs of the project is one of the key factors for a successful project.
- Oversight of technical and contractual interfaces.
- Ensuring that resources are available during the project and that technical specialists are available during the first years of operation.
- Engagement and employment of experienced personnel for drafting contractual scope and for operation.
- Limitation of the number of contractors as much as possible and clear definition of contractual responsibilities.
- Continuous attention and readiness to adopt to innovative/new-to-market technologies.
- Use of risk management tools.
- Digitalisation of processes.
- Communication with wind turbine manufacturers as this will be crucial for the wind park operation and fulfilment of requirements to the grid provider.
- Preparation for curtailment recording and compensation calculation; special attention should be paid to the communication with the grid provider.
- Provision of information to all parties involved in the project and operation on the measures promised in the environmental permit.

Overall, there is extensive knowledge and experience gathered on a project management level by the projects. The above lessons learnt and knowledge gathered provide a useful guidance to future innovative wind energy and other renewable energy projects.

— Environmental Impact

All wind energy projects are reducing the amount of CO_2 eq. emissions when compared to the mean production by the energy system today.

Regarding the rest of environmental issues — visual impact on the landscape, noise, impact on cultural heritage, impact on designated ecological and environmental receptors and especially birdlife — all projects perform environmental assessments and have advanced awareness that develops through their years into operation.

The measures to reduce environmental impacts include the minimisation of transport to the project areas – especially because they are in the operation phase - technical equipment for bird protection (bird radars) and environmental investigations, turbine shut down measures, meetings with local authorities for impacts on cultural heritage and underwater noise monitoring. On top of that, projects are using Life Cycle Assessment tools and investigations to forecast the lifecycle environmental impacts of the respective ecosystems where the projects are located.

There are no incidents where the environmental impact of these projects has been a serious cause for concern. It is highlighted, however, that the environmental assessments are a useful tool together with the continuous monitoring by Member States.

— Health and safety

No major health and safety incidents or near misses are being reported by the projects. Due to the degree of innovation and the numerous preventive and corrective maintenance events, there is a close observation of health and safety issues of the personnel. It is also generally agreed that the employees of such projects should be highly skilled.

5 Conclusions

Overall, the Knowledge Sharing communication, submission process and technical assessment developed on time and effectively. This is true for the majority of the projects that have prior experience with this exercise.

In 2019, six projects submitted relevant knowledge. Five of these projects are Wind Energy projects and one of them is a Bioenergy project. Compared to 2018, there is one less Bioenergy project and one more Wind Energy project.

The assessment of the Knowledge Sharing Reports submissions was performed by the JRC from 10 February 2020 to 29 June 2020 — due to a delayed submission. Like in previous years, the developed methodology worked well and no significant problems or concerns stemming from the application of the methodology arise. However, we observed that valuable knowledge, especially regarding the wind energy projects, can be gained if the templates are updated.

The aggregation method was applied especially to the wind energy projects. In the bioenergy project we are providing information of lessons learnt without photographing the specific technology or project. All projects, regardless of the technology they refer to, provided information on five subject areas:

- Technical set-up and performance
- Costs
- Project Management
- Environmental impact and
- Health and safety.

In all projects assessed the technical set up and performance does not deviate significantly from the initial proposals. Here, we studied and showed mostly the energy production of these innovative projects and possible deviation from initial plans. This information helps to understand issues on maintenance — preventive and corrective —, weather conditions and their effects on renewable energy production and possible measures to tackle those.

When it comes to costs, in the wind energy group of projects we were able to understand the main composition and shares of preventive and corrective maintenance as well as the temporal development of O&M costs (OPEX) over the first years of operation of the NER 300 onshore wind projects. Moreover, we were able to benchmark the projects OPEX and CAPEX as compared to the international development of onshore and offshore wind costs. Given the small subset of data, no final conclusion can be made on the potential downward trend of OPEX costs over project lifetime or the development of maintenance categories over time. However, a refinement of the Knowledge Sharing template to align the reported data of the projects and especially subsequent data submissions might allow future conclusions on how these indicators develop and the effect of NER 300 innovations.

According to the reports received, project management plays a vital role for the construction, commissioning and operation of the projects. The information received and assessed highlighted two main lessons learnt. The first one refers to the continuous communication and early involvement dialogue with the authorities and stakeholders involved. Among the key points, a strong time and quality management especially during planning and construction is referred to. The second key lesson is communication and proper arrangement early on with all key players including experienced employees, contractors, and project and technical experts. Overall, there is extensive knowledge and experience gathered on a project management level by the projects.

On the environmental impact assessment we found that all projects are reducing the amount of CO_2 eq. emissions when compared to the mean production by the energy system today. Moreover, all projects perform environmental assessments and have advanced awareness on the topic.

Last, when it comes to health and safety no major accidents or near misses were reported. For those that occurred proper measures were taken. These include reassessments of the project setup and training of employees.

The NER 300 projects assessed this year provide valuable information for their continuation and the application of this information to future innovative projects entering the energy market. Here, we demonstrate that even with a small number of projects, when the availability of statistically significant information is scarce, when these are assessed over time and the Knowledge Sharing process is functional, results can be aggregated and the knowledge can be shared with the wider community.

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