North Sea Energy 3

Updated data-set description of the North Sea Energy Atlas

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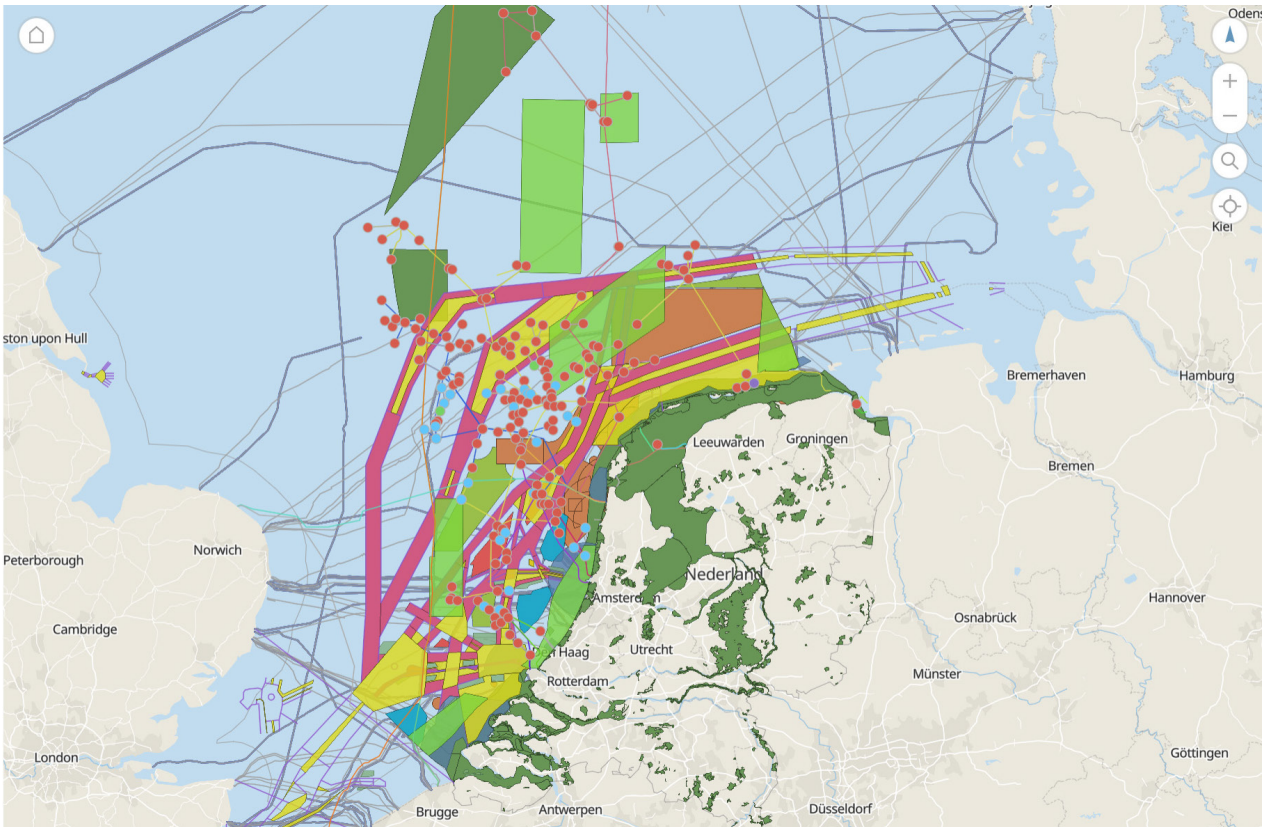
1 Executive summary

In previous phases of the North Sea Energy program, an online North Sea Energy Atlas was developed to support the discussion on offshore spatial planning and the identification of potential synergies between activities at sea. In this 3rd phase of the program, the "look-and-feel" of the atlas has been updated to make it more intuitive and user friendly. Furthermore, the database behind the atlas has undergone major changes to increase its flexibility to tailor content to a specific user type, and to make it easier to add new views to the current atlas.

Also, a set of new layers and views has been added to the atlas, and it has been extended with the latest insights on (offshore) energy storage potential. Finally, in view of the fact that the discussions on an integrated offshore energy system become more and more international, the scope of the atlas has been extended towards other North Sea countries including Norway, Denmark, and the United Kingdom.
Based on the experiences in this phase of the program, several recommendations have been made to further increase and enhance the functionality of the atlas in the next phase of the program, such as the development of an expert mode, improved functionality for analysis of the atlas data, the addition of views on other use functions that influence strategic offshore spatial planning and decision making, and the appointment of an atlas core team to make ensure the atlas contains up to date and high quality information.

The NSE atlas can be viewed online at: https://north-sea-energy.eu/en/energy-atlas/ or https://nse.projectatlas.app/atlas



2 Introduction

Activities on the North Sea vary from fishery and wind energy to the production of oil and gas. Other areas of the North Sea are reserved for shipping routes, defence (military) or are protected nature areas. In the coming years, a lot will change in the energy use functions at sea, due to on the one hand the declining gas production, and the accelerating pace of offshore wind development on the other hand. As is addressed in the North Sea Energy program, smart coupling of energy sectors and infrastructure may help in balancing the spatial claims and has the potential to lower the societal costs of the energy transition.

The online North Sea Energy Atlas will help bringing new perspectives regarding our current and future offshore energy system. In the 1st and 2nd phase of North Sea Energy the Atlas was developed. In this atlas, public data on various use functions of the North Sea such as offshore wind and offshore oil and gas was made available. The aim of the first North Sea Energy atlas was to identify opportunities for system integration, optimize spatial planning and to help balance competing interests of different users, now and in the future.

In order to extend the relevance of the atlas, the current atlas dataset was updated and extended with a specific focus on the growing Power2Gas developments, especially hydrogen. The Atlas was visually optimized in close collaboration with XKP Visual Engineers, with the aim to setup a user-friendly graphical user interface with intuitive user applications and story lines. The dataset was updated accordingly to make the system more easily accessible and updatable.

The set of maps was further developed as well. This was done by developing spatial distribution maps of technical storage capacity and potential future grids for hydrogen and CO_2. Additionally, a start has been made for a geographical scope expansion towards other North Sea countries such as Denmark, Norway and the UK. Finally, strategic scenarios for offshore wind towards 2050 have been included.

The atlas can be found at: https://north-sea-energy.eu/en/energy-atlas/ or https://nse.projectatlas.app/atlas

3 New user interface of the atlas

A new user interface of the North Sea Energy Atlas was developed in close collaboration with XKP visual engineers. Figure 1 shows a screenshot of the new visualization of the atlas. The aim of this new visualization is to gear the atlas better towards the intended target user groups and to make its overall usability more user friendly. In the new visualization, various new map views including information will be added as described in chapter 5.

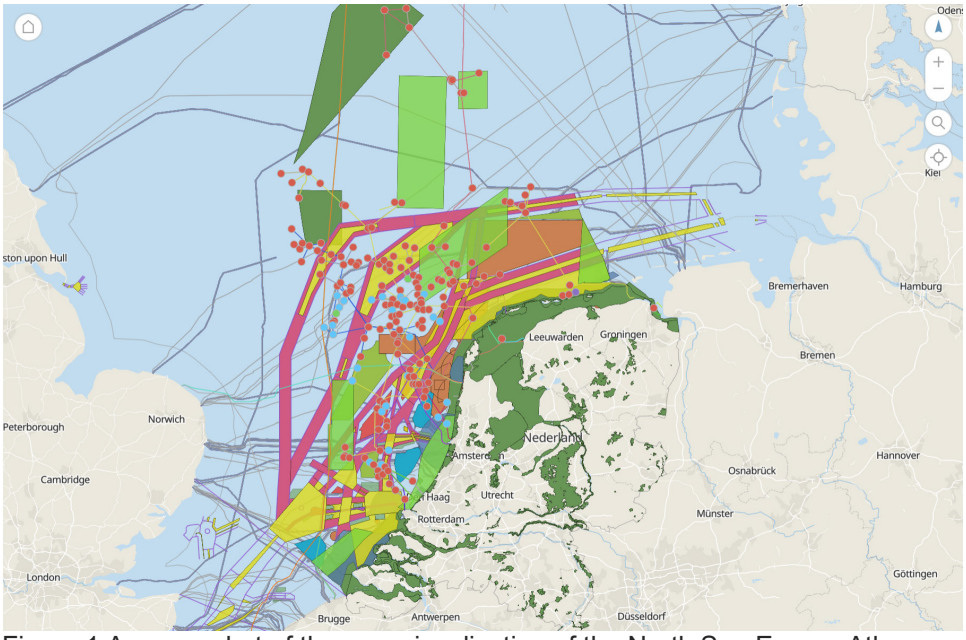


Figure 1 A screenshot of the new visualization of the North Sea Energy Atlas

4 Update of the atlas database

Over the past years the data-set behind the North Sea Energy Atlas has grown, resulting in a slow and hard-to-handle geodatabase. Therefore the data-base was re-evaluated. A new data-set with only data 'relevant' for the online atlas was created. This makes using the data-set and adding new data to it more user-friendly. The format of the data has also changed from shapefiles to geojson to increase the flexibility of the system. One example is the change in attribute name. The new format allows for more flexible naming in the atlas. Table 1 shows some examples of the mentioned format change.

Table 1: Attributes names in shapefile format versus updated attribute names in geojson format

Shapefile attribute names	**Geojson attribute names**
Natural_Gas_capacity_GW	Natural Gas capacity (GW)
nat_gas_Capacity_GW	Natural Gas Transport Capacity (GW)
Cap_GW_2030	Capacity 2030 (GW)
Prod_2016_TWH_yr	Hydrocarbon Production 2016 (TWH)
Gas_used_2016_GWH_yr	Offshore platform fuel gas use (GWh) 2016
prod_GWh_per_yr_2030	Production 2030 (GWh)

As a final addition the data was categorized in three categories:

1. Public
2. Expert
3. Analysis

These labels allow for quick updates in the atlas, as well as easy use of the dataset for a wide range of applications. The data labelled as public (p_) will be visible in the online atlas, whereas the expert data (e_) will only be visible to partners in the future expert mode. The analysis (a_) data is necessary for the design of the maps (e.g. shapes of polygons and coordinates) and includes all relevant information for detailed analysis of the offshore energy system. This was important preparatory work for next development steps for the atlas that will be taken in the next phase of the North Sea Energy program, which is planned for 2020-2021.

5 Overview of updated & new atlas input

Various map views have been updated according to the needs for information as was indicated by the users of the energy atlas during workshops with North Sea Energy partners and during public events. The following paragraphs describe the updated and new sections of the atlas in more detail.

5.1 Update of hydrogen transport capacity

In the first version of the atlas an analysis of the potential hydrogen transport capacity of the existing offshore natural gas grid was added. New insights proved that the old estimates were on the low side, hence the values were updated based on the new insights that were gained in work package 3.3.

5.2 Technical subsurface energy storage potential

As the share of variable, intermittent renewable energy sources increases (solar and wind), the need for flexibility in our energy system will also increase. One of the technologies that can supply this flexibility is large-scale storage of energy in the subsurface, e.g. in the form of compressed air energy storage (salt caverns) or hydrogen storage (caverns, potentially depleted gas fields). EBN & TNO have executed a technical screening of various forms of large-scale storage options in the Dutch subsurface[1]. The technical storage potential for both the onshore as well as the offshore have been added to the North Sea Energy Atlas to provide a first-order insight into how spatial distribution of subsurface storage may offer synergy and flexibility options in offshore energy.

5.3 Expected wind tendering areas towards 2050

While the location and size of a large share of the new wind areas to be developed towards 2030 is already known[2], the distribution of wind areas on the Dutch Continental Shelf in 2050 is not yet fully planned. However, various development scenarios towards 2050 have been published by “Planbureau voor de Leefomgeving”[3]. These scenarios have been included in the atlas to shed some light on how offshore wind energy may develop between 2030 and 2050.

5.4 International expansion of the North Sea Energy Atlas

In order to spatially optimize the energy transition on the North sea, it is important to collaborate on an international level. This translates to the start of a geographical scope expansion of the Atlas towards other North Sea countries such as Denmark, Germany, Norway and the United Kingdom. A desk search was executed to collect publicly available data relevant for the atlas. Appendix 1 shows a list of the data that was found. From Norway, Denmark and the UK there is already a significant amount of data available. This data is mainly on hydrocarbon production and offshore wind development (Table 2). No relevant maps were found to be available in the public domain for Germany. Note that a subset of the United Kingdom data from the Crown Estate cannot be used in online GIS applications.

[1] Ondergronde opslag in Nederland – Technische Verkenning, EBN & TNO 2018,
[2] Kamerbrief Routekaart Wind op Zee 2030, 2019
[3] The Future of the North Sea, PBL 2018

Table 2: Available geodata per topic.

Available data	Denmark	Norway	UK
Offshore/onshore hydrocarbons	Yes	Yes	Yes
Offshore wind/onshore wind	Yes	No	Yes
Offshore pipelines	No	yes	Yes
Onshore pipelines	No	No	Yes
Onshore electricity infrastructure	No	No	Yes
Hydrogen infrastructure	No	No	No
CO_2 storage	No	No	1 site

6 Recommendations

Based on the experiences and input during this 3rd phase of the North Sea Energy program, various recommendations for the next phase have been identified:

1. Extension of the Atlas with an “expert” mode. User feedback has indicated that there is a requirement to enhance the Atlas with functionality to allow users to create and customize their own views, rather than having to rely on the pre-defined static views that are currently included in the Atlas. The expectation is that such functionality will greatly facilitate to the ongoing discussions on synergy options at the North Sea, both nationally and internationally.

2. To fully use the potential of the North Sea Energy Atlas, more detailed analysis of the various energy systems and integration options should be offered. This could be achieved by adding e.g. the ability to draw new infrastructure, algorithms that calculate the potential capacity of this type of infrastructure, and algorithms that optimize the routing.

3. To enable a broader perspective on North Sea spatial planning, it might be of interest to include a broader and more detailed set of North Sea use functions, both from an energy perspective as well as for other functions. This could include e.g. aquatic biomass, fishing grounds, more detailed protected areas, etc.

4. One of the challenges for the North Sea Energy Atlas is to be up to date. The energy landscape is constantly changing and in transition, which means that data has a tendency to be outdated quickly. It is recommended to appoint a small team that has the task to check on this data update in close collaboration with work package leads and the communication working group of the North Sea Energy Program. Thereby it might be useful to open the atlas for user feedback.

Appendix 1 Overview of international data input

Filename	Country	Description	Year	Terms of use
OffshoreInstallations_20151106.shp	Denmark	Offshore oil and gas, gives operator, start production, current status, primary production, water depth, location	2015	Website does not give info
ExpAppWells_20160908.shp	Denmark	Offshore and onshore wells in Denmark, includes wellname, operator, rig	2016	Website does not give info
DenmarkWind2012v2_WGS84.shp	Denmark	Offshore, onshore wind. Includes date of installation, capacity, rotordiameter, manufacturer, production per year.	2012	Website does not give info
Licenses_20160620.shp	Denmark	Oil&Gas lincenses, only gives info on operator and location	2016	Website does not give info
FieldDelineations_20161212.shp	Denmark	Oil and gas fields, location and name	2016	Website does not give info
Blocks.shp	Denmark	Divides Danish sea territories in blocks		Website does not give info
NPD_FactMapsData_v2_0.gdb	Norway	Norwegian geodatabase, layers in database listed below	2017	Can be used with reference
		wlbpoint_ed50utmz32n : offshore wells, operator, purpose, status		Can be used with reference
	Norway, Denmark, NL, UK	fclpoint_ed50utmz32n : onshore, offshore oil and gas facilities, current operator, name, function, design lifetime		Can be used with reference
	Norway, Denmark, NL, UK	pipeline_ed50utmz32n : Norwegian pipelines, from and to which facility, operator, phase, medium, dimension (inch),		Can be used with reference
	Norway	fault_boundaries-ed50utmz32n : faults, offshore and onshore		Can be used with reference
	Norway	Sub_area_ed50utmz32n : offshore areas norway		Can be used with reference
	Norway	structural_elements_ed50utmz32 : detailed structural geological elements in offshore norwegian territory		Can be used with reference
	Norway	seatotal_ed50utmz32n : offshore areas where a seismic survey took place		Can be used with reference

	Norway	quadrant_ed50utmz32n : divides norway offshore territory in blocks		Can be used with reference
	Norway	prlarea2_mrg_ed50utmz32n : offshore production licences, status, company		Can be used with reference
		prlarea2_ed50utmz32n : offshore production lincenses, divides the polygons above into smaller blocks		Can be used with reference
	Norway	fldarea_mrg_ed50utmz32n : offshore oil and gas fields, field name, HC type, status		Can be used with reference
	Norway	dscarea_ed50utmz32n : HC discoveries, status, HC type		Can be used with reference
	Norway	bloc_ed50utmz32n : divides offshore norwegian territory in blocks		Can be used with reference
	Norway	baaarea_mrg_ed50utmz32n : business arrangement area		Can be used with reference
	Norway	apa_open_ed50utmz32n : open production lincenses		Can be used with reference
	Norway	apa_ed50utmz32n : see above		Can be used with reference
	Norway	announced_blocks_ed50utmz32n : blocks		Can be used with reference
	Norway	afexarea_mrg-ed50utmz32n : afex areas, overlaps the fields and discoveries		Can be used with reference
towers.shp	UK	onshore electricity masts, only location and year of build	2017	
OHL.shp	UK	onshore cables, year, location and operating power	2017	
NGS_Pipeline_UK_20170401	UK	offshore pipelines (only contains 4 lines)	2017	
Gas_pipe.shp	UK	onshore gas pipelines in the UK, gives diameter, length and status	2017	
cable.shp	UK	Gives cables in londen and other regions, has to be layered in combination with the OHL.shp. Contains info on the cable type	2017	
TCE_Wind_Farm_All_20170615	UK	Offshore windfarms, names, status (TCE is the crown estate)	2017	The information must not be used in GIS applications (e.g. webGIS) which can be accessed

				from outside the licensee business or over an intra / internet
TCE_wind_export_cable_agreements_20170615	UK	Possible locations for cables for the export of wind. Gives name and status	2017	see above
TCE_wave_export_cable_agreements_20161116	UK	Cable for the export of wave energy, only one location	2016	see above
TCE_tidal_export_cable_agreements_20170401	UK	Tidal export cables, Tidal energy		see above
TCE_offshore_mine_20160919	UK	Location of two offshore potassium mines		see above
TCE_Minerals_Aggregates_20170615	UK	Gives are name and companies that of offshore mineral dredging locations	2017	see above
TCE_meteorological_equipment_20170615	UK	Locations of meteorological equiment, gives equipment type and status	2017	see above
TCE_Lease_wave_20170419	UK	wave energy lease locations, name and status	2017	see above
TCE_lease_tide_20170517	UK	Tidal energy lease locations, name and status	2017	see above
TCE_lease_gas_storage_20170401	UK	Gas storage lease locations, name and status	2017	see above
TCE_lease_carbon_capture_and_storage_20170401	UK	CCS lease location, only one field	2017	see above
substations.shp	UK	onshore electrical substaions, name, location and power in kV	2017	see above
gas_site.shp	UK	gas sites in the uk, site type, name	2017	see above