Attn.
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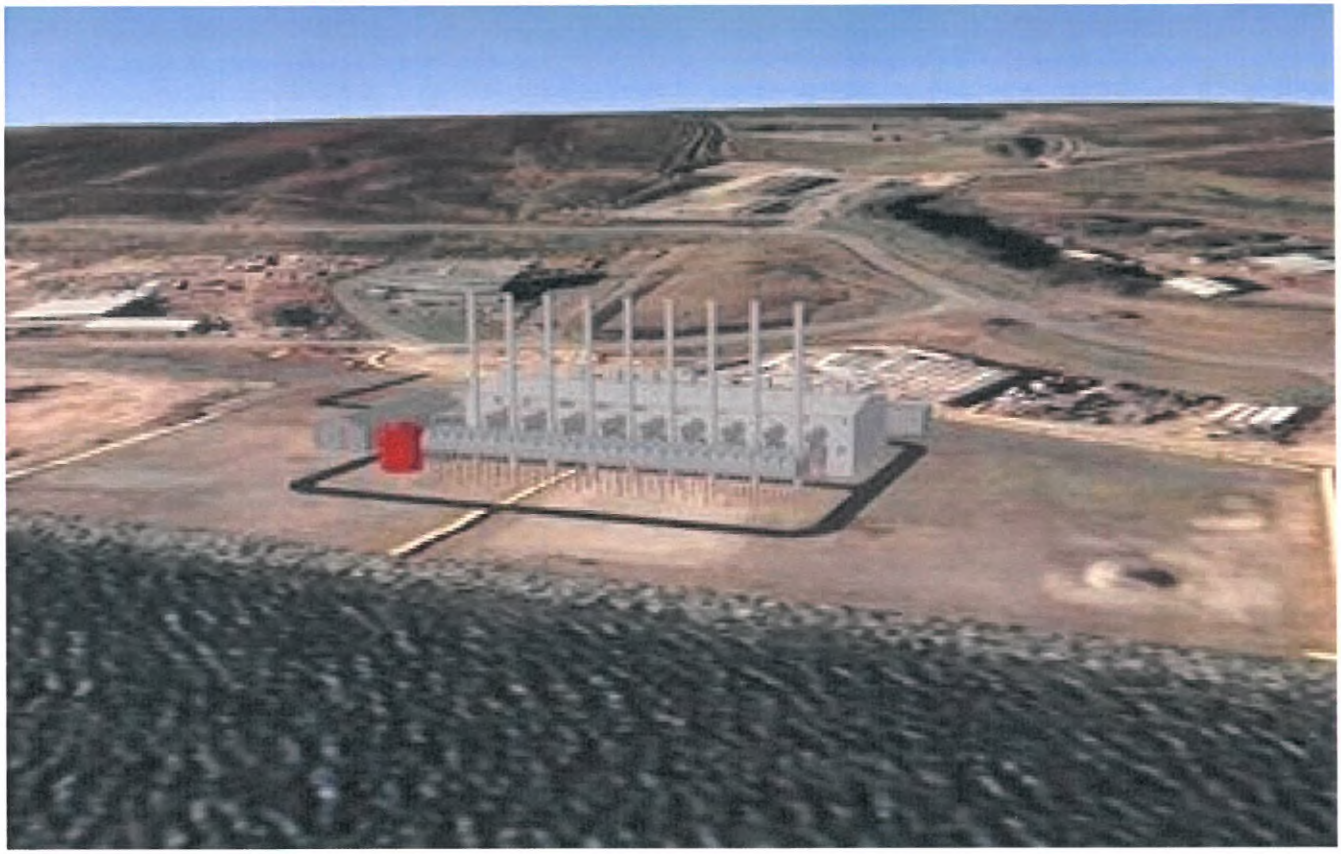
We welcome this chance to participate in this Consultation launched on 23rd April, 2020

PROJECT SUMMARY

The power station

Oil-fired, Sund Power Station, Faroe Islands, BWSC 2019

The suggested power plant is a traditionally gas fired reciprocating engine power station. The envisaged configuration is with the N+2 philosophy normally applied on islands and in electrical island locations to have the high availability secured to supply the peak demand even when major overhauls are performed on the engines.



Artist's impression of the proposed new power station in Lerwick, BWSC

To have sufficient capacity we have selected units with outputs of 7,3 MW and then have 9 units installed where the 7 units will be sufficient to supply the peak demand without relying on supply from wind turbines or from the Sullom Voe Power plant. The power plant is intended to be located in the Gremista port area, and we have got confirmation from the Lerwick Port Authorities that they have sufficient land available for the power plant and the adjacent LNG terminal. The engine units will be located in a powerhouse with noise attenuation to secure that the regulatory noise limits at the power plant fence will not be exceeded.

The LNG fuel will be converted into natural gas in the LNG terminal and the natural gas will be piped directly from the LNG terminal to the power plant, so there will be no truck transportation of fuel for the power plant. The generated electricity will be connected to the existing 33 kV substation adjacent to the Lerwick Power Station (LPS) through a 33 kV cable connection. This eliminates the need for constructing overhead lines between the new gas fired power plant and the existing substation.

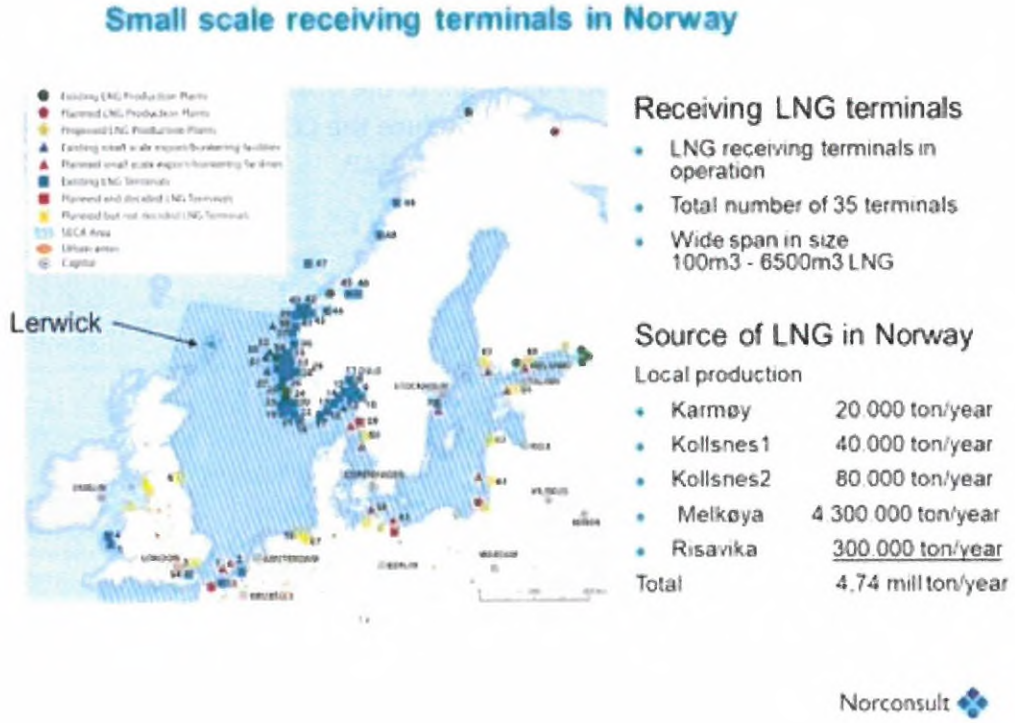
The power plant will be able to operate on future carbon neutral fuels, and also on the already available biogas which is naturally carbon neutral. Already now the shift from oil operation on the old Lerwick Power Station to operation on natural gas on a modern high efficient power plant will reduce the CO_2 emissions from the thermal power generation in Shetland with more than 16.850 tons per year.

The control systems of the proposed new power plant will be able to interact with the influx of renewable intermittent power, and also with possible batteries installed by *Scottish Hydro Electric Power Distribution (SHEPD)* the distribution grid operator on Shetland. The thermal power plant will supply the needed inertia to the grid to stabilize the increasing quantities of intermittent renewable electricity in the system.

Heat recovery from the exhaust gasses can be included in the project and the heat can be supplied to the *Shetland Heat Energy & Power Ltd.* (*SHEAP*) and then to the district heating network, thereby increasing its overall energy efficiency and will further reduce the CO_2 emissions by offsetting some of the heat production from the Peak Load Boiler Station of *SHEAP*.

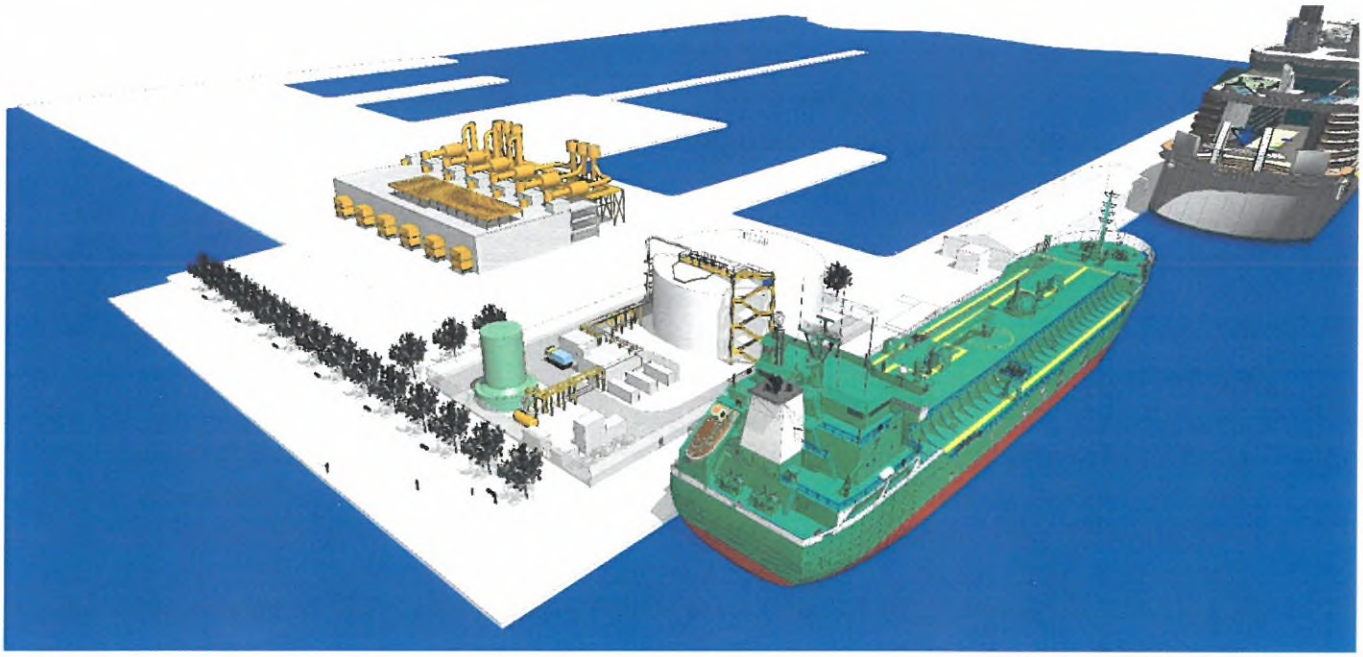
The LNG Terminal

New LNG terminal and new gas-fired power station, Gibralter[1] [2]



Source: Norconsult, 2017

[1] https://d3jf5lxzu67ibn.cloudfront.net/2019/05/lng-aerial-two.jpg?d=1200x600
[2] https://www.man-es.com/discover/gibraltar-builds-a-modern-lng-power-plant



Artist's impression of the LNG terminal suitable for multi-purpose use at Lerwick by Norconsult

The installation shown shall deliver gas to a power plant station to be located on the harbour. The power plant will serve local community with electricity. To support this it includes a configuration for handling of imported LNG through ship loads to a local power plant with ambient air vaporizers. The storage capacity will be about 10 000 m^3 LNG in a full containment tank. The regasification capacity meets the power plant requirements in addition to other local consumers. The LNG is imported through loading arm installation at the quay front. This installation may function in parallel with other activities subject to a setup based on a safety assessment given the operational and technical requirements. The ship shore transfer may alternatively be handled through a cryogenic hose. This installation will also be used for ship bunkering purposes. The pipe from jetty to the terminal itself will be a mix of underground or in air with built in thermal loops.

At the terminal there will be facilities for truck loading and CNG filling.

Everything will be build according to relevant directives, local laws and regulations in addition to industry norms and standards.

Transition from fossil fuel to zero carbon emitting fuels

As mentioned above the suggested power plant will be able to operate on future carbon neutral synthetic natural gas (SNG), biogas is already an available carbon neutral gas which could be used already now. The volumes of biogas are for the time being limited but will also be more common available in the future.

The key element in the production of SNG is the production of hydrogen, the process of converting hydrogen into SNG will need addition of carbon which in the different development projects in the first

phases are to be captured from the exhaust gasses from biomass power plants as the concentration of CO_2 is much higher in the exhaust gasses than in the air.

The UK grants £28m for five demonstration phase low-carbon hydrogen production projects
As part of a bigger £90m package of awards to decrease carbon emissions in heavy industry and homes, the UK is granting £28m for five demonstration phase low-carbon hydrogen production projects. These five proposed projects which obtained funding are:

- Dolphyn project: This concept includes a large-scale floating offshore wind turbine (nominally 10 MW), along with an integrated water treatment plant and electrolysers for localized production of hydrogen. This project is led by Environmental Resources Management Limited (ERM) and involves a contractvalue amounting to £3.12m

- HyNet – low carbon hydrogen plant: A consortium of Progressive Energy, Essar, Johnson Matthey, and SNC-Lavalin will be involved in the project delivery including the development of a 100,000 Nm3/h clean hydrogen production facility for implementation as part of the HyNet Cluster, making use of Johnson Matthey's low-carbon hydrogen technology that allows carbon capture and storage (CCS). This project is led by Progressive Energy Ltd and involves a contract value of £7.48m.

- Gigastack: This project will illustrate the delivery of bulk, cost-effective and zero-carbon hydrogen via ITM Power's GW-scale polymer-electrolyte membrane (PEM) electrolysers, which are manufactured in the UK. The project intends to decrease the cost involved in electrolytic hydrogen significantly. The funding will help ITM to come up with a system which will make use of electricity from Orsted's Hornsea Two offshore wind power project to generate green hydrogen for the Phillips 66 Humber Refinery. The project is led by ITM Power and involves a contract value of £7.5m.

- Acorn Hydrogen Project: This project will assess and come up with an advanced reformation process, including evaluation of Johnson Matthey's low-carbon hydrogen technology. The project is led by Pale Blue Dot Energy (PBDE) and involves a contract value of £2.7m.

- Bulk Hydrogen Production by Sorbent Enhanced Steam Reforming (HyPER): The project proposes to come up with a low-carbon bulk hydrogen supply via pilot scale demonstration of the sorption enhanced steam reforming (SESR) process, built on a novel technology formulated by the Gas Technology Institute (GTI). This project is led by Cranfield University and the contract value amounts to £7.44m.

These investments in developing technologies for producing hydrogen in a carbon neutral and economical feasible manner are not only supported in the UK; but Worldwide.

Investments

Our proposal is based on a model where it will be the private sector who will invest in the power and LNG infrastructure in a normal setup with a special purpose vehicle to become the owner of the assets and holding a long term Power Purchase Agreement (PPA) with the utility SHEPD. Another model would be that SHEPD would be the owner of the assets procured under an EPC tender process.

The estimated total CAPEX for the investment in the power plant as well as in the LNG terminal and based on today costing and the exchange rate of 1 £ = 1.12 €, is approx. 105 million £. The equity / debt assumptions are 30% equity and 70 % debt financing, the debt financing with a tenor of 15 years. The assumption is further that adequate payment security from SHEPD will be available for securing the debt at attractive financing terms.

Time for implementation

The actual implementation period from having obtained financing of the project will be between 18 and 24 months for both the power plant and the LNG terminal.

Resulting tariffs

Based upon the different forecasts available we have calculated on two different productions scenarios for the power plant.

Scenario 1: The Sullom Voe Power plant will continue delivering power into the grid, and there will be power inputs from the existing wind turbines on Shetland. The yearly power to be injected into the grid by the new power plant will be approx. 113 GWh.

Scenario 2: The Sullom Voe Power plant will be stopped supplying to the grid. The yearly power to be injected into the grid by the new power plant will thereby increase to approx. 183 GWh.

Scenario 1	113 GWh/year
CAPEX	£ 105 million
Fuel tariff (pass through)	£ 36/MWh
Variable tariff	£ 11/MWh
Fixed tariff expresses per MWh	£ 175/MWh
Total tariff	£ 222/MWh
Yearly cost of electricity	£ 25.1 million

Scenario 2	183 GWh/year
CAPEX	£ 105 million
Fuel tariff (pass through)	£ 36/MWh
Variable tariff	£ 11/MWh
Fixed tariff expresses per MWh	£ 110/MWh
Total tariff	£ 157 £/MWh
Yearly cost of electricity	£ 28.7 million

The TTF natural gas index was 4.84 €/MWh_{gas}, June 2020, based on the HHV of the gas.

The following assumptions forms the basis for the above calculations of the CAPEX, fuel tariff, variable tariff and the fixed tariff:

Exchange rate	£ 1.0 = € 1.12
Tenor of PPA	25 years
Tenor of debt	15 years
Interest of debt	5% p.a.
Cost of LNG supplied into the storage at Lerwick	£ 14.59/MWh, HHV (June 2020 price level)
Sufficient payment guarantees under the PPA	

As mentioned earlier the above calculations are based on a project structure where a special purpose company will be established, and that company will be the owner of the assets of the power plant and the LNG terminal. The additional benefits of having the project implemented are not included in the calculations such as the possibility to supply low carbon fuel to the shipping and transportation industries as well as for heating purposes. Further it will be possible to supply heat to the Lerwick district heating system by utilizing the heat in the exhaust gasses.

These benefits could, anyhow also be obtained by a project owned by SHEPD, and that might even be a cheaper solution than a private owned project.

The relatively high fixed costs per MWh is due to the high installed capacity compared to the rather low power generation, only approx. 20% of the generation capacity on a yearly basis is utilized in scenario 1, and approx. 36% in scenario 1, further the cost of a new energy infrastructure for the LNG import, which can supply others than the power plant, is only loaded on this project in the above calculations.

We have not been able to identify the Transmission License revenue recovery for the suggested inter-connector and have only an estimate of the CAPEX of a little less than £ 700 million, without the cost for an emergency power station on Shetland. Assuming that the revenue recovery is 7% of the CAPEX per year then the yearly recovery will be in the magnitude of £ 49 million.

To that revenue recovery shall be added the cost of electricity, which will be in the order of £ 50/MWh, i.e. scenario 1 gives an electricity cost of £ 5.6 /MWh, and scenario 2 an electricity cost of £ 9,2 million. Adding the estimated yearly revenue recovery of £ 49 million, then the annual cost of providing power to Shetland be £ 54.6 million for scenario 1, and £ 58.2 million for scenario 2.

Questions

Question 1: What are your views on the generation scenarios developed and updated by SHE-T? We are particularly interested in views on the likelihood of wind generation on the Shetland Isles developing to the levels predicted by SHE-T's scenarios and any further changes or updates since SHE-T's October 2018 Final Needs Case submission that you think should also be considered.

At present, and since 1973, Shetland's electricity demand has been served by 3 power stations.

One of these, originally having a capacity of 100 MW, powered the industrial complex owned and operated by international oil companies is at Sullom Voe Terminal (SVT). Demand at SVT is said to have fallen to roughly 10 MW.

The 25 MW, gas-fired CHP at Shetland Gas Plant (SGP) was built in 2016, solely to serve the needs of the SGP.

The other power station is Lerwick (Diesel) Power Station (LPS) which was established during the 1950s which has since grown organically to its present nameplate capacity of 66 MW. The last diesel generator was installed more than 20 years ago.

It is normally axiomatic that one identifies the generation scenarios from a range of likely demand scenarios.

The document submitted by SHE-T, "*Shetland Strategic Wider Works, Needs Case: Cost Benefit Analysis*", turns this idea on its head. It starts with the assumption that SSE's 100% owned VEWF is inevitably going to be built, whether needed or not, and that therefore its output must be sold. It then poses a series of "what if" questions asking how this can be achieved by imagining various scenarios for exporting power to the mainland and possibly, even to the offshore oil and gas fields around Shetland.

No detail of any discussions with the international oil companies (IOCs) is provided and no indications of any solid support for such plans is given. Accordingly, any solid economic justification for building such a market is absent.

As a general observation, the costs in this so-called cost benefit analysis are so heavily redacted as to make it incomprehensible to any party not privy to the thinking of those SHE-T's employees who are specifically involved in promoting and planning the case for the 443 (peak) MW, SSE-owned, VEWF Viking Energy wind farm and the SSE-owned, 600 MW, HVDC link between Shetland and Caithness in Scotland.

Viking Energy's capacity is based upon the 103 number, 4.2 MW turbines which have been permitted out of the 150 turbines applied for[3]. Presumably, the assumptions of the CBA have been adjusted to fit with whatever SSE has permits to build. If more turbines could have been permitted, we have no doubt that the CBA would have been commissioned to support the larger output and a bigger cable, irrespective of Shetland's actual demand.

[3] https://www.vikingenergy.co.uk/the-project

We also note that the CBA finds that on almost all occasions that when the winning prices in the 2019 CfD auction are applied into the economic models, these return negative NPVs.

Considering that VEWF, if built, will be the most remote wind farm from its market, it will surely be among the first to be constrained. SSE Renewables knows this.

In Ofgem's advice to UK generators dated 17 May, 2017, regarding the TCLC sunset clause, Ofgem wrote[4]

> *TCLC was introduced in 2012 through powers under Section 18 of the Energy Act 2010. It was intended to cover the period of high transmission constraints,* ***which were expected to reduce around 2017, following improvements in the transmission infrastructure****. As discussed in our consultations, transmission constraints are expected to remain a part of the transmission network for the foreseeable future, in particular in Scotland, but also in England and Wales, as a result of the way the system is currently designed. We believe it is important that there is a licence condition in place to* ***deter excessive pricing behaviour in periods of transmission constraint****, and thereby ensure that bills for consumers are not higher than necessary.*

In fact, far from transmission constraints reducing, it is transparently clear that constraint costs have increased and those constrained are gaming the balancing mechanism more profitably than when the wind farms are unconstrained and operating.

We would rather not believe that *Ofgem* is satisfied with this situation. On the contrary, considering how unlikely it is that VEWF will win during the 2021 CfD auction, we challenge *Ofgem* to ensure that *SSE Renewables' VEWF* may not profit at all from being constrained off and that the intentions of the Westminster legislated TCLC are fully honoured.

We further note that the interests of the various other, large, proposed wind farm developments such as Energy Isles, Beaw Field and Mossy Hill are not mentioned at all in the CBA, yet these will equally rely on access to the Shetland Link in the event that this gets built. There may be "side deals" with the owners of these developments which could possibly result in their support for VEWF + Shetland Link. If so, we insist that if these exist, they are publicly acknowledged.

For these reasons, we shall focus next on the likelihood or otherwise, of significant increases in local (meaning Shetland and vicinity) demand and the unquestionable need to fulfill the Islands' domestic, commercial and industrial demand securely and at reasonable cost.

Question 2: What are your views on the demand sensitivity explored by SHE-T?

Overall electricity demand in Shetland, is still mainly supplied by the three main thermal power stations plus roughly 12 MW from several smaller wind turbines. All three thermal plants were sized according to a predictable demand

The thermal power stations are the:

- ☐ Power Station at Sullom Voe Terminal (SVT), for demand mainly inside the terminal fence,
- ☐ Lerwick Power Station (LPS) which satisfies most of the demand on the public grid; its capacity growth has been organic.

[4] https://www.ofgem.gov.uk/ofgem-publications/116290

- ☐ And the 25 MW gas-fired CHP at the Shetland Gas Plant, SGP, commissioned in 2017, satisfies only the demand of the SGP, inside the SGP fence

Demand from the SGP will depend entirely on the success or otherwise of maintaining the production of gas and condensate from Laggan-Tormore and its associated fields NW of Shetland. Demand is more likely to fall than rise as these fields mature.

Demand at SVT has been in long term decline since the peak demand caused by oil production, processing and exports during the 1970s and 1980s. Today, demand inside the fence at SVT has declined to around 10 MW.

In fact, post-Covid, global oil demand and production is more likely to fall, relative to expectations pre-Covid and be dominated by low cost producers, relatively unconcerned by GHG emissions and intent on grabbing market share. Add to this, the focus of the UK, in particular, Scotland, on "post-carbon", "green" economic recovery will result in less focus for and investment into SVT. In summary, oil and gas exploration and production in the Shetland area is more likely to decline than thrive.

As a consequence of now operating only one, 25 MW capacity, gas turbine at such a low load, SVT PS must be one of Europe's most energy inefficient power stations. It will almost certainly need to be replaced before it becomes liable for CO_2 emission taxes.

Yet SVT at present is regarded by SHEPD as an essential supplier to the rather fragile Shetland system, to which it was connected roughly 30 years ago by a 33 kV, 17 MW capacity link, very likely for the inertia that SVT supplies. Delivering reliable inertia into the Islands' 33 kV system without any large rotating generators is hardly dealt with in the received published literature about the New Energy Solution.

Demand for the rest of the Shetland population, outside the SVT fence, has risen only slowly as the Islands have prospered from events at Sullom Voe and from shipping, tourism, fishing and the improving prosperity of the population. Demand is presently around 200 GWh per year.

Subsequent events show that real demand has actually changed very little.

In 2016, Parsons Brinkerhoff advised SHEPD (and the other bidders) that Shetland demand was expected to grow only slowly, increasing to only 232 GWh per year in 2040, with a peak demand of 48 MW.

4.5 Maximum Demand

Using the CADLFs for the domestic and non-domestic sector described in Section 3.3, the maximum demand at consumer level (CLMD) is calculated. The formula described Section 3.4 for calculating power losses shows that they are a function of both energy losses and the consumer level load factor (CLLF). The CLLF is a weighted average of the consumer category CADLFs. Power losses at maximum demand may therefore change even when energy losses do not. The power losses are applied to the CLMD to calculate sent out maximum demand using the formula described in Section 3.4. Table 4-7 below shows the sales forecast, maximum demand at consumer level forecasts and the forecast sent out maximum demand. Figure 4-5 shows the forecast maximum demand for the period 2005 to 2040.

Table 4-7: Maximum Demand$_{SO}$ Projection (2015 to 2040)

Year	Domestic Sales (GWh)	Non-Domestic Sales (GWh)	Total Sales (GWh)	Max Demand at Consumer Level (MW)	Consumer Level Load Factor	Power Losses	Maximum Demand (MW)	Power Load Factor	Maximum Demand Growth
2015	105 8	83 8	189 6	35 9	60 3%	23 3%	46 8	54 3%	2 7%
2016	106 7	86 1	192 8	37 3	58 9%	17 1%	45 0	55 2%	-3 7%
2017	107 8	86 9	194 7	37 7	58 9%	17 1%	45 5	55 2%	1 0%
2018	108 5	85 6	194 1	37 6	58 9%	17 1%	45 4	55 2%	-0 2%
2019	109 0	87 0	196 0	38 0	58 9%	17 1%	45 8	55 2%	0 9%
2020	109 1	89 9	199 0	38 5	59 0%	17 0%	46 4	55 2%	1 4%
2021	109 0	89 9	198 9	38 5	59 0%	17 0%	46 4	55 2%	0 0%
2022	108 7	92 1	200 8	38 8	59 0%	17 0%	46 8	55 3%	0 9%
2023	108 4	91 8	200 3	38 7	59 0%	17 0%	46 7	55 3%	-0 3%
2024	108 4	94 2	202 7	39 2	59 1%	17 0%	47 2	55 3%	1 1%
2025	108 4	95 9	204 2	39 5	59 1%	17 0%	47 6	55 4%	0 7%
2026	108 2	95 4	203 6	39 3	59 1%	17 0%	47 4	55 4%	-0 3%
2027	107 9	96 8	204 7	39 5	59 1%	17 0%	47 6	55 4%	0 5%
2028	107 6	96 4	204 0	39 4	59 1%	17 0%	47 5	55 4%	-0 4%
2029	107 1	96 7	203 8	39 4	59 1%	17 0%	47 4	55 4%	-0 1%
2030	106 8	97 0	203 8	39 4	59 1%	17 0%	47 4	55 4%	0 0%
2031	106 6	97 1	203 7	39 3	59 1%	17 0%	47 4	55 4%	-0 1%
2032	106 7	97 1	203 8	39 3	59 1%	17 0%	47 4	55 4%	0 0%
2033	106 8	97 1	203 9	39 4	59 1%	17 0%	47 4	55 4%	0 1%
2034	106 9	97 2	204 1	39 4	59 1%	17 0%	47 5	55 4%	0 1%
2035	107 1	97 3	204 3	39 4	59 1%	17 0%	47 5	55 4%	0 1%
2036	107 2	97 4	204 6	39 5	59 1%	17 0%	47 6	55 4%	0 1%
2037	107 4	97 5	204 8	39 5	59 1%	17 0%	47 7	55 4%	0 1%
2038	107 5	97 6	205 1	39 6	59 1%	17 0%	47 7	55 4%	0 1%
2039	107 7	97 7	205 4	39 7	59 1%	17 0%	47 8	55 4%	0 1%
2040	107 8	97 8	205 7	39 7	59 1%	17 0%	47 8	55 4%	0 1%

Our assessment of gas use and peak thermal power demand is based upon this assessment by Parsons Brinkerhoff.

The notion that the international oil companies (IOCs) drilling for and developing oil and gas, West of Shetland, wish to break their traditional practice of the last hundred years, of generating just as much electricity as they need, at any time, from on-board gas turbines, in exchange for CO_2-free renewable electricity delivered through specially constructed underwater cables is interesting and novel.

It is being widely discussed among IOCs and regulators at international conferences, mostly from the point of view of reducing the cost of oil and gas production in deep waters.

However, the chances that this developing technology can be proven as fully commercial and able to replace traditional oil and gas field practices in time to deliver significant savings to the hard-pressed IOCs, in a post-Covid North Sea oil and gas industry, is highly fanciful.

The demand scenarios as quoted in the CBA appears as follows:

"2.7 Shetland demand

In addition to the updated wind farm development on Shetland is the impact of potentially significant electricity demand resulting from powering offshore oil and gas (O&G) projects with Shetland renewables. SHE Transmission has indicated an electricity demand of 200MW in incremental phases over the period 2026 to 2034, with a profile shown below.

Table 1: possible demand build-up on Shetland

Year	Demand (MW)
2026	50
2030	100
2032	150
2034	200

This potential demand has been modelled as a variable in the CBA."

In the light of the likeliest scenarios for the global oil industry, post Covid[5], we cannot regard any scenario that foresee very large investments by the IOCs into their North Sea assets as credible during the near future unless there would be commensurately large returns.

Unfortunately, the quite sudden discovery, presumably by *SSEN*, of a new and large market for VEWF's output so close to Shetland, looks suspiciously opportunistic.

Question 3: What are your views on the link options considered by SHE-T? We are also interested in views on the options proposed by SHE-T to mitigate against the risks of a second link being needed.

In the light of the history of failures experienced since the Western Link was finally commissioned, late, in October 2018, we feel emboldened to question whether the UK should immediately embark on any further, long, HVDC links at all, until all the faults in this cable have been identified and fixed.

In other words, no cable contract, for which the UK consumer must end up paying for, should be purchased before all the issues with Western Link's operation have been satisfactorily resolved and the link has been operating according to its specification for (say) at least three years. *Ofgem* would then be able to sign off such a decision, certain that the sharply rising costs of wind power curtailment, funded by UK consumers, has been permanently ended.

[5] https://www.bbc.com/news/explainers-52966609

Balancing Mechanism Wind Farm Constraint Payments

Data last updated : 31-May-20.

Show Totals by : **Year** Month Constraint Dates Wind Farms

Back to REF Website

Year	Cost	MWh	Average Price
2020	£123,207,600	1,680,234	£73
2019	£139,115,513	1,941,183	£72
2018	£124,649,106	1,724,187	£72
2017	£108,247,860	1,542,285	£70
2016	£81,861,075	1,134,627	£72
2015	£90,738,134	1,276,264	£71
2014	£53,261,058	659,350	£81
2013	£32,707,351	379,817	£86
2012	£5,924,231	45,463	£130
2011	£12,826,756	58,708	£218
2010	£174,128	976	£178

Source: Renewable Energy Foundation, June, 2020

During this year (2020) it seems likely that payments made to recompense wind development owners, because they have been constrained off the grid by the UK System Operator, *National Grid*, will jump from £139 million to more than £250 million.

In part, this will because UK electricity demand, post Covid 19, has fallen greatly whereas the UK's weather has continued, more or less as usual, with the normal mix of rain, wind and sunshine. It will be important to carefully review all electricity demand forecasts and adjust these according to the most likely recovery path of the UK economy and the effect this will have on electricity demand.

The huge disparities between the various forward views of SHEPD's advisers in 2012, 2016 and those indicated in the CBAs under discussion for this Consultation reflect a quite sudden optimism of SHEPD/SSEN to with regard to demand, which was completely missing, prior to mid-2017.

National Grid must keep the UK grid balanced and stable. For this to be so, and in the absence of synchronous condensers, it is vital that a minimum number of strategically located, large rotating generators in UK are kept generating. This will continue to be the practice of *National Grid* until entirely new systems are developed and tested that will make this measure unnecessary.

A high fraction of Scottish wind farms output relies on the Western Link to carry power across the Scottish border to UK load centres in England. If the *Western Link* continues to malfunction, as it does now, it could be many years before such unacceptable losses, suffered by UK consumers who must also suffer higher electricity prices, can be rectified.

Getting VEWF's output to England, post-Covid, even if the Shetland Link's cable suffers none of these failures, may be fraught in the light of such sharply reduced demand for the electricity in England.

Its output is evidently surplus to Shetland's requirement. Scotland is almost continuously exporting power to England, whenever the wind blows. Therefore, the overall effect of adding VEWF's output to this surplus will be to add to the inevitable constraints that are already costing UK consumers so much and are enriching wind farm operators for delivering no power at all, for so much of the time.

Question 4: What are your views on the technical design and costs of the proposed Shetland link?

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We are not in any position to comment on the detailed technical design of the Shetland Link, details of which are not published[6].

However, we note that if the VEWF + Shetland Link project goes through as currently planned, Shetland will be among the first substantially sized, fully industrialized and inhabited offshore island system in the World to depend for 100% of all its electricity on an HVDC link. The Scottish Mainland is itself overwhelming supplied by wind power whenever the wind is strongly. During anti-cyclones, Shetland will be depending on England to "keep the lights on". This dependence in Shetland upon HVDC cables, wheeling power over many hundreds of miles, is unlikely to be without fault over the next 30 years, as history is currently demonstrating.

We draw your attention to the fact that the remaining lifetime of large, rotating generators, usually needed for the inertia they provide to the grid and, delivering grid stability are a diminishing resource in Scotland. Hunterston Nuclear power station, with its cracking graphite core, is likely to be retired much earlier than EdF and the ESO would prefer[7].

We can also note that similar issues to those affecting the Western Link are also occurring at present in Scandinavia, between Denmark and Norway. Skagerrak 4[8], is a strategically important, 5 year old, 1700 MW link between Norway and Denmark.

More generally, the upsurge in the demand for subsea power cables and the growth being forecasted according to experts will lead to a significant increase in the cost of repairs arising from damages or complete replacement in the days ahead.

As the industry and the market continues to grow, a decline in the products quality with premature failures might become more rampant. *GCube Insurance Services* reported that subsea cable failures accounted for 77% of the total financial losses in global offshore wind projects in 2015. Subsea cable failures are costly to repair, and may result in a significant loss of revenue due to disruption in power supply. For example, the cost for locating and replacing a section of damaged subsea cable can vary from €0.72 million to €1.87 million.

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[6] https://www.ssen-transmission.co.uk/projects/shetland/#signup

[7] https://eandt.theiet.org/content/articles/2020/06/renewables-let-s-address-reality/?utm_source=Adestra&utm_campaign=New%20EandT%20News%20-%20Automation%20FINAL%20-%20MEMBER&utm_medium=Newsletters%20-%20E%26T%20News&utm_content=E%26T%20News%20-%20Members&utm_term=701362

[8] https://en.energinet.dk/About-our-news/News/2020/04/22/Energinet-and-cable-supplier-take-samples-of-faulty-Skagerrak-4-cable

During the past 7 years 90 subsea cable failures occurred totaling over Euro 350 million in insurance claims. One of the major causes of subsea power cable failure is a resultant effect of joints. Increasing the length of cables is designed to reduce the number of joints that will be required.[9]

The standby power plant that must be available within seconds of any electrical disturbance occurring between Scotland and Shetland and run continuously until the fault has been identified and repaired will most likely be a full-scale diesel power station with an overall operating specification more or less identical to the gas-fired power plant that we are proposing.

We challenge the apparent assumption by Ofgem, that the extra capital cost of this standby power station will be only £24.6 million. It will have to be used, of course, in the course of the "enduring" solution that Ofgem seems minded to approve. Cable failures, when they occur, can take months, even years, to repair.

We cannot see anywhere in the CBA that such risks have been assessed by the SO which is surely unacceptable in the light of the real experience of building and operating the Western Link

Question 5: What are your views on the CBA put forward by the ESO?

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This is disappointing. As mentioned in the foregoing answers related to supply and demand, the assumptions have the feel of being pulled from the air and are loaded heavily in favour of the narrow, pecuniary interests of the SSE Group.

It completely misses any sense that this is a scheme filled with risk, both for SSE and the UK consumers who are expected to foot the bill whether or not SSE makes it work.

The redaction of every cost would make it unintelligible as a cost benefit analysis, even if its assumptions were selected in a less partisan manner.

No attempt has been made to calculate the risks and costs of any faults that might occur during the project's hopefully long lifetime.

During the afternoon of 11 June, 2020, respondents to the Consultation received notice of and links to two more relevant documents for consultation, being:

"A report on the Levelised Cost of Energy produced by the ESO"

and

"A report on the Shetland CBA Tipping Point Analysis produced by the ESO"

As with all the other CBA documents during this Consultation, these are also both so heavily redacted as to make them useless as a means for understanding the economics of the VEWF + Shetland Link.

The VEWF + Shetland Link is a £billion plus project for which, if it proceeds as the developer wishes, will be paid by levies on UK consumers. Ofgem's redaction of all cost/price figures in the documents that we are responding to, on the grounds of "commercial confidentiality", has made it impossible for us to deliver a fully numerate and responsible response.

[9] http://blog.bisgrp.com/reasons-why-subsea-power-cable-fails-ways-on-how-to-reduce-power-cable-failure/

Our request that Ofgem should remove all these redactions and allow us some extra time to analyze the project's economics appears to have been refused. To repeat, the public has every right to demand that these redactions shall be removed and that the economics of VEWF + the Shetland Link can be widely ventilated and understood. After all, the UK Public will bear the whole burden of repaying the expenses that Ofgem needs to permit if SSE's proposal it to proceed

Question 6: What are your views on other approaches we have taken to assess the costs and benefits to GB consumers?

It is our experience that since autumn 2017, *SHEPD's New Energy Solution* team has shown no interest, whatever in any other approaches to keeping the lights on in Shetland, other than VEWF + Shetland Link. It has always been evident that a lower cost and more robust solution is available. We are unaware whether or not this fact has been properly discussed and ventilated in public. The VEWF + Shetland Link is an unnecessarily costly and risky solution, fraught with the risk of un-ending costs for UK consumers.

Question 7: What are your views on our minded-to position to conditionally approve the revised Final Needs Case? Specifically:
i) Do you agree with our proposal to approve a 600MW link subject to Ofgem being satisfied, by the end of 2020, that Viking Energy Wind Farm is likely to go ahead?
ii) Do you have any views on the type of evidence we should expect to see that would confirm that Viking Energy Wind Farm is likely to go ahead?
iii) Do you agree with the factors we have considered to reach our minded-to position?
iv) Are there any other factors that you consider we should take into account when assessing this proposal?

Answers to Question 7

i) Do you agree with our proposal to approve a 600MW link subject to Ofgem being satisfied, by the end of 2020, that Viking Energy Wind Farm is likely to go ahead?

i. No, for the reasons supplied in this document.

ii) Do you have any views on the type of evidence we should expect to see that would confirm that Viking Energy Wind Farm is likely to go ahead?

Yes!

We noted SSE's strategically-timed, public announcement of its intention to proceed with VEWF + Shetland Link, dated 17 June. While it appears from its low cost but heavily publicized recent actions in Shetland that SSE is determined to proceed with the completion of VEWF, we cannot regard these as much more than public relations meant to convince Shetlands' citizens of its "seriousness".

These actions are actually rather "low cost" compared with signing off on the "real thing" of committing to more than £one billion. Wind turbines are a standard purchase for *SSE Renewables,* so any significant purchase of appropriate wind turbine components in not clear evidence of its serious intentions. Those components can be re-directed.

The 17 June announcement was hedged and depends on largely unspecified decisions by (concessions from?) by Ofgem.

SSE Renewables confirmed that it will be physically prepared for a full-scale and lengthy failure(s) of The Shetland Link by announcing early during 2020 that when such a failure occurs, a standby and ride-through solution will take over "within half an hour"[10].

For reasons of "business sanity" *SSE Group* must ensure that VEWF will not lose sales income for the power not generated and sold during such an episode but also *SHEPD* will be remunerated for the extra, possibly huge, costs of operating the diesel power station until the Link can resume sending power south again. In such an event, there is a high risk for the UK consumers that not only will VEWF be requesting remuneration for the unsold wind power but that the UK consumer will be forced to remunerate *SHEPD* for the operation, possibly for months, of the standby, diesel, power station.

We must trust that Ofgem will not to expose the UK consumers to such extraordinary risks or demand that such risks shall be enumerated and discussed in an open forum.

iii) Do you agree with the factors we have considered to reach our minded-to position?

No. We are sure that you have under-estimated the risks of failure and/or wind farm curtailment to the public

iv) Are there any other factors that you consider we should take into account when assessing this proposal?

Yes. These are provided in Answers to question 4

Question 8: Do you agree with the findings of our analysis?

No, for the reasons provided in the foregoing

Question 9: Are there any additional factors that we should consider as part of our analysis and/or decision on whether to apply the CPM for the Shetland transmission project?

Yes. We have enunciated these elsewhere in the document

We see no need to apply the CPM (Competitive Proxy Model) to the gas-fired solution for which cost and price estimates are readily available and the risks of anything going seriously wrong are small.

[10] https://www.sse.com/media/wsjdiz1v/rtss-opportunity.pdf?fbclid=IwAR01B6TVb6sueQxAr4vu0APjG-TUy6zFd9PNdNIMRAwnayV-_Sk6V96GsPE

Appendices

Historical Summary

Scottish Hydro Electric Power Distribution, (SHEPD), a wholly owned subsidiary of *Scottish and Southern Energy (SSE)*, is the principle supplier of electricity to the public network, which it also owns and operates, in the Shetland Islands. *SHEPD* were charged by *OFGEM* to find a competitive, environmentally and economic replacement for the supply of power to Shetland's obsolete, oil-fueled, Lerwick power station in 2013.

Since 2017, after failing to find such a solution that satisfies *Ofgem*'s criteria, *SHEPD* has pursued a single solution composed of the *SSE*-owned *Viking Energy Wind Farm (VEWF)* and the *SSE*-owned *Shetland Link*. *SHEPD* has repeatedly ignored all efforts to engage in any discussion by the development group who back this response. Such refusals smack of a monopolistic attitude dictated by *SSE*, driven by SSE's narrow, financial interests in accumulating Ofgem regulated and approved assets.

Our proposal is for a modular, high efficiency, gas-fired, power station, fueled by liquid natural gas (LNG), imported into Lerwick's 365 day per year port, from Norway's West Coast. The power station and LNG quay will be built in the Lerwick Port area on land that is consented for industrial development.

The power station will be the anchor customer for the financing of the LNG infrastructure. However, a modular, long duration battery, will also be part of our delivery, along with electronic and/or mechanical inertia enhancement. This will allow for more locally sourced, non-synchronous, renewable capacity to be supplied, increasing the renewable mix of power supplied to SHEPD's customers and further reducing CO_2 emissions.

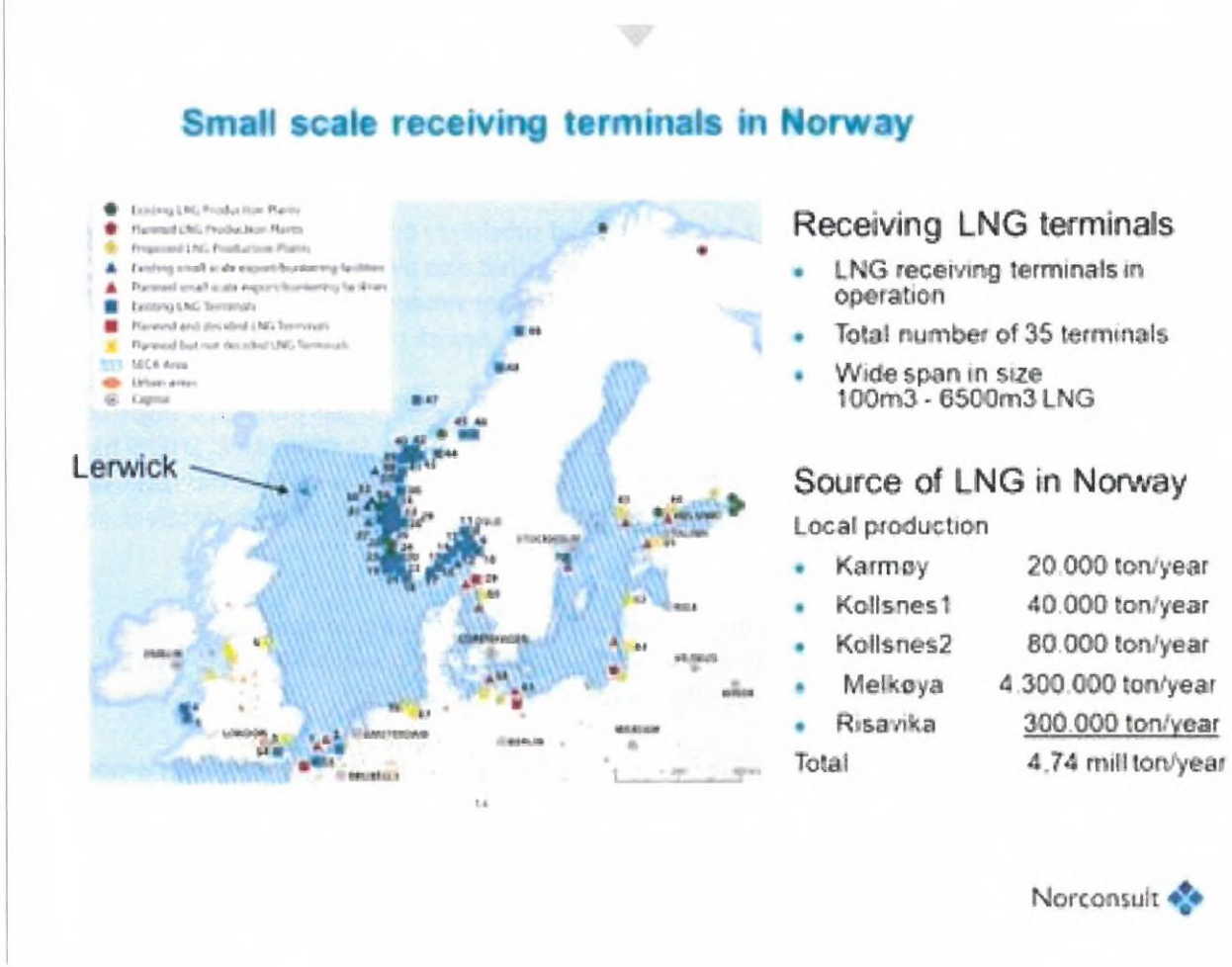
This configuration will address all Shetland's power requirements at fraction of the capex of the *VEWF + Shetland Link*. It will be built on "industrially consented" land within the Lerwick Port area as described in letters addressed by Mr Erichsen of the Norwegian consultant, *Norconsult*[11], to *OFGEM*, dated November 2019 and February 2020. (Enclosed)

Since 2017, at each "minded to" decision, we have repeatedly drawn the attention of *SHEPD's New Energy Solution's* team in Perth to our proposal which we were unable to submit in 2016 for a variety of reasons. All these efforts have been rebuffed, as illustrated by the email exchange between *SHEPD* and *Incoteco*, forwarded to *Ofgem*.

LNG already forms a substantial fraction of marine vessel fuel use in the whole of the North Sea and Baltic area so demand for bunkering vessels at North Sea ports will increase, including at Lerwick. It is expected that when the Shetland Orkney Aberdeen ferries are replaced, lowered fuel cost and CO_2 emissions will be a high priority for the replacement vessels; in truth, LNG is the only known method for delivering such cost and emissions reductions.

LNG is already used in Shetland by a growing fraction of the oil export tankers delivering crude oil from Sullom Voe Terminal (SVT) to oil refineries in mainland UK and Europe. The port, owned and operated by SIC, is planning to increase the use of LNG for the exporting tankers.

[11] https://www.norconsult.com/

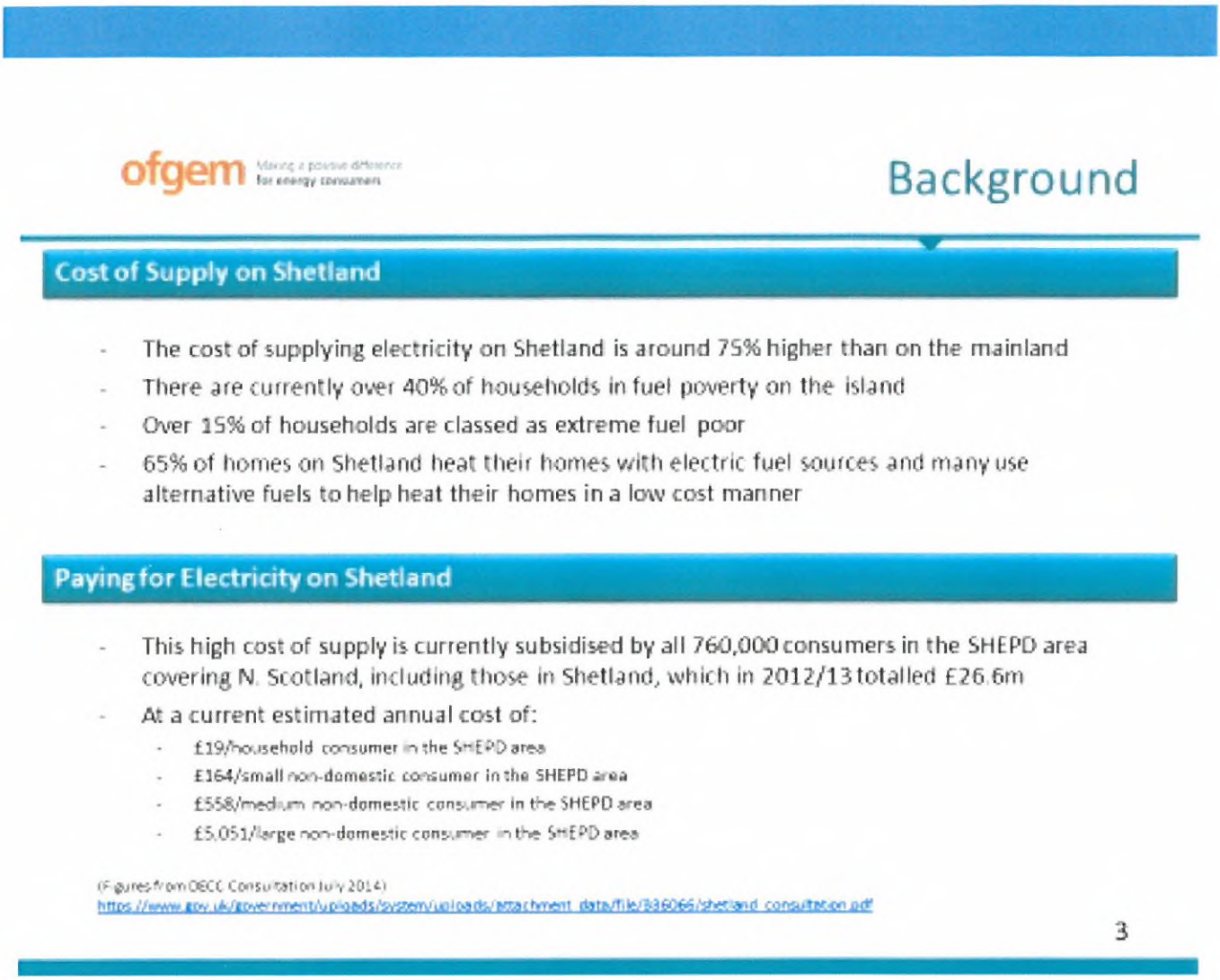


Source: *Norconsult, 2017*

The security of fuel supply will be very high. *Ofgem* is invited to make its own judgement about the security of supply by visiting a representative selection of the Norwegian LNG terminals, listed in the foregoing slide. The sources of LNG are diverse as is the transport infrastructure. For this reason and that Lerwick's port is open 365 days per year and 24 hours per day, there will be no costly requirement for any long term fuel storage

SHEPD is the company that was and remains charged by OFGEM with the responsibility for reaching out to electricity generation specialists to find a competitive solution to replace Lerwick Power Station (LPS). LPS started life in the 1950s and has grown as Shetland Isles' demand has grown. But its operation is costly. Accordingly, supervised by *Ofgem*, mainland consumers have been subsidizing the Shetland Islands' consumers thus enabling its Island consumers to pay for their power supply at rates similar to those enjoyed by UK consumers.

From the outset, it has been *Ofgem*'s primary objective to reduce this subsidy yet maintain the high security of the Shetlands' electricity supply.



Source: Ofgem 2014

In 2012, *SHEPD* proposed to replace LPS with a new, up to 120 MW, diesel power station at Rova Head, north of Lerwick Port. This was considered as unsatisfactorily costly by *Ofgem*, mainly on account of the likely, continuing, and high cost of low sulphur diesel fuel. Apart from the competition between the diesel engine manufacturers implied by this solution, *SHEPD* had not allowed for any other competitive innovation.[12]

Prior to the next step, *SHEPD* carried out an intense investigation of possible new power configurations. These were summarized and listed in the slide No 6 of the presentation that SHEPD delivered in 2014 for participants in their Consultation for the "New Energy Solution, in particular addressing the question of fuel.

[12] From Ofgem 2017 consultation: "1.7. We rejected this proposal as we considered that SSEN had not sufficiently tested the market for an efficient and economical solution. Specifically, we were not persuaded that the costs put forward were the most efficient and ***competitive,*** as SSEN had not provided sufficient supporting evidence to demonstrate this."

Options considered by SHEPD's Integrated Plan

Reliable Provision of Capacity and Energy
Nuclear power station
Coal fired power station
Energy from waste
Biomass/biodiesel fired power station
Peat fired power station
Reciprocating engine power station
Open cycle gas turbine power station
Double circuit cable link w. standby power station
Single circuit cable link w. standby power station
Liquid Petroleum Gas (LPG) fired power station
Heavy Fuel Oil (HFO) fired power station
Light Fuel Oil (LFO) fired power station
Combined cycle gas turbine power station
Hydro generation

Intermittent Provision of Energy
Wind generation

Reduction in Capacity and Energy
District heating
NINES

- Some of these options were discounted
- A shortlist was taken forward for cost benefit analysis
- Majority of respondents have agreed with the range of options that SHEPD considered

Scottish and Southern Energy
Power Distribution

Source: *SHEPD, January 2015, A New Energy Solution for Shetland*

We are surprised that, considering the enormous breadth of options considered by *SHEPD* at the time, that LNG from Norway was apparently not considered at all, even though Bergen is closer to Lerwick than Aberdeen.

BWSC originally determined to put in a bid for a gas-fired power station fueled by a feed from the gas presently treated in the Shetland Gas Plant and re-exported to Scotland in the SIRGE pipeline. At the time (2015-2016) *SSE* owned substantial shares in the gas/ condensate assets (Laggan Tormore) that Total was operating.

However, it eventually turned out that the life of the gas/condensate properties and possibly even the Shetland Gas Plant (SGP) is likely to be less than that of the power station, so *BWSC* turned to Norwegian LNG suppliers somewhat too late in the bidding process to meet the bid expiry date in December 2016. *BWSC* reluctantly had to withdraw from the bid.

*Norconsul*t, representing Norwegian LNG interests, visited Shetland and Perth during March, 2017, where it delivered presentation about Norway's LNG infrastructure to Shetland Council's infrastructure committee and *SSE Generation*. *SIC's* committee members present were unanimously of the view that LNG would be widely used as a replacement for fuel oil, heating oil, diesel and petrol and on the Islands if it were to become available, boosting an entirely new business, lowering fuel costs for Shetland's vehicle owners and reducing CO_2 emissions.

However, lacking a substantial "anchor" client for the LNG, it became obvious that the power station or an equivalent, "base-load", customer would be required if LNG could ever be imported at scale.

During the summer of 2017, Ofgem declared the bid by *National Grid*'s non-regulated subsidiary, *National Grid Shetland Link* and *Aggreko* for a 60 MW HV link between the mothballed Dounreay power station in Scotland and a landing close to Scalloway in Shetland + a full-scale, standby, diesel power station as the bid winner.

During the ensuing consultation, it was obvious that this £40 million per year, £320 million capex proposal was deemed to be unsatisfactory to most of Shetland's population. In November 2017, Ofgem retracted is minded to decision on the grounds that:

- *A document which sits under the IED (EU industrial emissions directive) was published in late July and states that new, tougher emissions targets will only apply to engines on 'small isolated systems' and 'micro isolated systems' from 2030 (as opposed to 2020). The Scottish Environment Protection Agency (SEPA) has confirmed that this later deadline applies to existing engines at Lerwick Power Station.*
- *In October 2017, the Government announced that, subject to receiving State Aid approval, wind farms on remote islands such as Shetland will be eligible to compete for a Contract for Difference (CfD) in the next auction for less established technologies, planned for 2019.*

Ofgem therefore asked *SHEPD* to investigate the remaining options available at which point we pointed out once again, to SHEPD, the merits of our proposal.

A protracted email exchange ensued between the ""*Shetland New Energy team* at *SHEPD* and *Incoteco.* This commenced in autumn 2017 and ended in September, 2019, when the failure of VEWF to win the fore-mentioned CfD auction was announced.

This exchange of correspondence is available for inspection and has been shared with *Ofgem* during the current consultation period (time of writing, May and June 2020).

The correspondence demonstrates that at no point subsequent to November 2017 was *SHEPD* ever minded to consider the proposal for LNG imports and the gas-fired power station. Instead, it insisted that it was wholly focused on the VEWF development and the 600 MW Shetland Link that would be needed to transmit the output of VEWF to the Scottish mainland and further to centres of load further south.

There is a growing risk that the combination of the *SSE*-owned VEWF + the Shetland Link is persuading *Ofgem* and some residents of Shetland that this solution is the only feasible and practical one for keeping the lights on in Shetland at an affordable cost. This is manifestly not so.

BWSC A/S has built over 170 diesel and gas fueled, reciprocating engined power stations in 54 countries around the World, many of them on remote islands. Many of these have maintenance contracts that bind *BWSC* to deliver mechanical and electrical security of supply. As mentioned already, the security of the fuel supply (from Norway) is simply not an issue.

As regards *Ofgem*'s initial concerns for the New Energy Solution, the VEWF and Shetland Link do nothing for these.

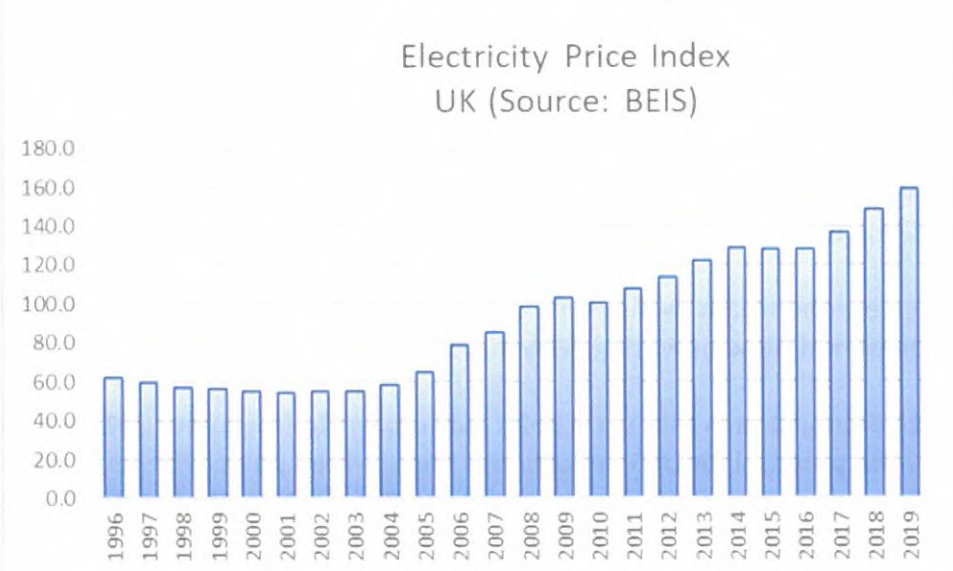
Security of supply

In particular, security of supply will demand that a full-scale, standby diesel power station or some other, "instantly available" electric generating power station equivalent to this, must be built in order to secure supply in the event of any failure of the Shetland Link. No HVDC link, however well-built and safe-guarded can ever be guaranteed to be available at all times.

That this is so, one needs only refer to the UK's relatively new Western Link[13] or the five year old Skagerrak 4 link between Norway and Denmark[14].

The standby power station would need to have all the characteristics of BWSC's proposed power station, including N+2 engine security plus, very likely, a large, full, fuel tank.

Fuel Poverty



Source: BEIS, 2019, Table 2.1.1 Fuel price index

Fuel poverty in the Shetland Isles is among the highest in UK. VEWF + Shetland Link will not result in reduced electricity prices for Shetland's consumers.

Unlike almost all other UK communities, refined petrol, diesel and fuel oil enjoy a virtual monopoly in the transport, heating and industrial sectors. Although bottled LPG is imported from the mainland, the logistics of its supply disadvantage Islanders relative to the mainland.

LNG's availability on Shetland will completely break the monopoly of ultra-low sulphur (and therefore expensive) diesel/fuel oil for Shetland's industrial and domestic boilers and transport applications. Its availability as either LNG or CNG allows for the conversion of petrol-fueled cars, diesel-fueled trucks, inter-Island ferries and other commercial vessels to LNG and CNG. In this way, LNG will seriously address fuel poverty and CO_2 emissions from Shetland.

Looking to the future, as mentioned, we have informed *NorthLink Ferries* that there would be substantial cost and CO_2 emissions reductions if their ferries were to be re-powered and/or replaced by ships fueled with LNG. This possibility cannot even be discussed until an LNG terminal is commissioned.

[13] https://www.current-news.co.uk/news/western-link-hvdc-outage-caused-record-constraint-management-payments-as-wind-power-surged and https://www.ref.org.uk/ref-blog/356-the-western-link-a-new-failure-highlights-the-overbuild-of-scottish-wind-and-raises-new-questions

[14] https://en.energinet.dk/About-our-news/News/2020/04/22/Energinet-and-cable-supplier-take-samples-of-faulty-Skagerrak-4-cable

The proposed LNG import/export terminal, needed to fuel the power station, will allow Shetland to bunker the ever-increasing fleet of LNG-fueled vessels in the North Sea, attracting high quality employment into Lerwick.

Because a growing number of oil tankers that export oil from the Port of Sullom Voe, are already fueled by LNG, it would be rational for SIC to develop an overall plan for LNG logistics and use on the islands.

CO_2 reduction

The Westminster and Edinburgh governments have legislated ambitious reductions of greenhouse gas emissions.

By making LNG and therefore gas available on Shetland, far greater CO_2 emission reduction can be achieved by bringing LNG to Shetland than purely by generating all Shetland's electricity from wind power.

The proposed gas engines are already able to operate in CO_2 neutral operation. It is foreseen that CO_2 neutral, synthetic natural gas will increasingly become available in future. Already now biogas is available commercially as a CO_2 neutral gas. Power to gas fuels are being developed commercially.[15] The proposed solution is ready for these fuels.

The engines are proposed to operate on natural gas, which contains between 85% and 98% Methane (CH_4), depending on source. By switching the power station fuel from fuel oil to natural gas, there is an instant reduction of the CO_2 emission due to the molecular composition difference of the fuels.

Additionally a new gas engine plant has a higher fuel efficiency compared to an old oil fired plant which will help reducing the CO_2 emissions even more.

Specific CO_2 emission created during combustion of natural gas: 0.050g CO_2/kJ
Specific CO_2 emission created during combustion of fuel oil: 0.069 g CO_2/kJ
CO_2 Reduction by simply converting from fuel oil to natural gas is 28%

(The specific CO_2 emissions of fuels are taken from this data link:
https://www.engineeringtoolbox.com/co2-emission-fuels-d_1085.html)

We have in vain sought to obtain specific emission data for the actual emissions from LPS, so we cannot at this stage make a more accurate calculations of the reductions. But using the efficiency of a modern gas engine power plant then such a plant will emit 393 gCO_2/kWh. Assuming the same efficiency for the existing, fuel oil fired LPS, then the specific emission rate would be 542 gCO_2/kWh. In reality, LPS has a much lower efficiency so the CO2 emissions are much higher, of course. So our saving estimate is a conservative calculation.

The electrical power injected into the grid on Shetland is in the range of 223 GWh/year, approx. 70 GWh is coming from the extremely inefficient Sullom Voe power plant and 40 GWh from the existing wind turbines, the remaining power is coming from the LPS, i.e. approx. 113 GWh/year.

[15] https://www.sciencedaily.com/releases/2020/02/200227114523.htm

The difference of 149,15 $gC_2$2/kWh between fuel oil and gas operation will then result in an annual reduction of the CO_2 emissions of 16,850 tons from LPS.

SVT PS's efficiency is much worse than even LPS.

So the new gas fired power plant, fired with fossil gas, provides a significant reduction in CO_2 emissions from Shetland. The introduction of LNG to the islands will further make it possible to shift from oil to gas powered ferries, merchant ships, private vehicles, trucks and buses where the same scale of reduction in CO_2 emissions will be achieved in transport, industry and heating while at the same time greatly reducing fuel costs.

Furthermore, the large quantity of otherwise waste heat generated from the gas power station (roughly 25% of the heat from the fuel) can be captured and used for district heating, greatly reducing *SHEAP*'s costs and therefore the tariffs for Lerwick's businesses, the SIC and Lerwick's district heating connected population. The surplus heat used in this way can allow for SHEAP's network to be greatly expanded and run more economically.

We understand that the mains laid all over Shetland for the district heating system was built large enough to accommodate the distribution of 20 MWth heat but that low cost heat source never became available. The proposed gas-fired power station can be economically modified to capture more than 20 MWth heat at any time of the year, so allowing *SHEAP* to reduce its tariffs and maximize sales, for the first time in its existence.

The inter-connector cannot make any of these improvements possible. In fact, the inter-connector does nothing at all to boost long term jobs nor the Islands' chronic fuel poverty.

During the next few years and decades, the fossil natural gas will be gradually replaced with CO_2 neutral synthetic natural gas (SNG). Hence it has the same characteristics as fossil natural gas, the infrastructure with piped gas and LNG shipping, as we know it today, will be utilized with no changes in the future.

There is much research and discussion taking place about how to converting hydrogen and CO2 dioxide into Methane, so we are confident that, eventually, when SNG becomes fully commercial, the proposed Shetland CHP that we are proposing will be CO_2 neutral.

In any case, our solution takes account of the increasing quantity of wind power that already is generating roughly 40 GWh per year from smaller scale wind turbines.

More appropriately scaled wind power can be introduced incrementally, especially if the Island's electricity can be exported to Sullom Voe along existing infrastructure. *Enquest*'s Environmental Report 2018, revealed that the SVT power station is generating unacceptable quantities of CO_2 and therefore one which must very shortly be replaced or abandoned because of its high costs.

We are not privy to the agreement between *SHEPD* and *Enquest* that extends the old supply agreement between these two power stations. However, we note that the costly cross subsidy needed by *SHEPD* to protect Islanders' power prices to mainland levels must by inference include subsidizing the costly SVT PS.

We are confident that our solution can achieve all OFGEM's original aspirations for the New Energy Solution, including a sharp reduction in generating costs and that we can deliver and commission the LNG terminal and power plant by 2024, in time to allow the decommissioning of Lerwick Power Station by 2025.

The Covid-19 effect

This is crippling the World's and UK's economy. It is likely that Global oil demand, which has fallen by so much during the last 3 months, will recover only slowly this and next year, if ever. The implications for oil and gas exploration and production in and around Shetland need to be faced realistically. There are and will continue to be massive issues and uncertainties for "expensive" oil anywhere that it is produced in the world, not least such as that produced in the North Sea, in particular in the northern part of the North Sea and Shetlands area.

Floating production and storage offloading (FPSO) vessels, operating more or less autonomously from land links, are usually the preferred technology for producing oil in waters like the North Sea. These are always using oil associated gas for their power needs.

We regret the sophistry is being employed by the SSE subsidiaries to boost the notion that the oil production industry can obtain power from on shore renewables. Most crude oil in the North Sea co-produces gas. All over the world, co-produced gas is used to supply the low cost electric power needed for oil production.

Oil companies are famously reluctant to spend lavishly for their utilities. So whatever warm words have been used to placate high level personnel that there will be a long and profitable market for offshore electricity demand, in reality, this will be a tough "sell".

Also, unfortunately, few of the oil and gas fields, West of Shetland will have long productive lives and therefore stable demand, so the business case for believing that a high fraction of VEWF output can be sold to a growing market at Sullom Voe and West of Shetland is highly fanciful.

Even more seriously, during the recent bright and breezy month of May, 2020, National Grid was forced to pay hugely to curtail power production in order to keep the UK electricity system stable. There is a dawning realization that the booming market for wind and PV power plant developments, during the last ten years, that these generators are producing so much power that these must be curtailed on a massive scale and at considerable cost to consumers.

The constraint payments until the end of May this year are detailed in the following table, compiled by www.ref.org.uk

Year	Constraint Payments	MWh	Average price £/MWh
2020	£123,207,600	1,680,234	£73
2019	£139,115,513	1,941,183	£72
2018	£124,649,106	1,724,187	£72
2017	£108,247,860	1,542,285	£70
2016	£81,861,075	1,134,627	£72
2015	£90,738,134	1,276,264	£71
2014	£53,261,058	659,350	£81
2013	£32,707,351	379,817	£86
2012	£5,924,231	45,463	£130

2011	£12,826,756	58,708	£218
2010	£174,128	976	£178

2020 is only 5 months old as we write but already it is clear that at its end, 2020 wind constraint payments will be costing consumers more than double those for 2019, already a record, and could likely cost upwards of £250 million.

The majority of wind curtailment happens in Scotland where the networks are still inadequate to deal with the already high wind capacity in Scotland. The UK grid is 'top heavy' with Scottish renewables.

The over-capacity situation of wind power in Scotland is made worse by the chronic failure, for much of the time, since it was commissioned in 2018, of the Scottish Power/National Grid, Western Link. The problems encountered by the Western Link are being investigated by Ofgem.

Similar problems with HVDC links are commonly encountered in Scandinavia. The most notable recent failure of an HVDC link is Skagerrak 4, connecting Jutland with Norway[16]

In any event, with the reliability of the proposed HVDC link under necessary scrutiny, a fully manned, 24/7/365 standby diesel power station will have to be part of the generating mix of VEWF + Shetland Link. Adding to more wind capacity from the northernmost location in the British Isles is surely tempting fate.

As regards any claim that the UK's transmission system would be strengthened, in any way, by the Shetland Link, we have not seen any evidence to back such a claim.

Danish Experience and trends of moving large wind turbines to the Offshore

Denmark has more experience with modern wind energy than any other advanced nation in the World.

VEWF was conceived in 2005 during the relatively early years of on-shore wind farm developments in UK, with the largest wind turbines then available. The great success of the Burradale Wind Farm, with capacity factors consistently over 45%, confirmed that, if built, VEWF would indeed, be "World beating".

Since then, of course, offshore wind has become the dominant sector of the wind power industry with comparable load factors achieved by ever larger wind turbines, delivering ever lower prices, as CfD auctions in UK demonstrate.

Large, onshore wind turbines in Denmark have been a constant source of irritation and controversy in Denmark for well over 15 years. So much so, that one of the first cross-party agreements made by the newly elected, social democrat Danish Government in June 2019, was to **reduce** the number of on-shore wind turbines in Denmark from 4,500 today to only 1,850 in 2030, setting stricter limits on turbine height and the distance of the proposed turbine to the nearest dwelling.

[16] https://en.energinet.dk/About-our-news/News/2020/04/22/Energinet-and-cable-supplier-take-samples-of-faulty-Skagerrak-4-cable

The Danish political parties have agreed that the future development of wind power in Denmark shall be only with offshore wind turbines, and not just offshore but so far away from the shore that they cannot even be seen from the shore.

The environmental issues with large on-shore windmills are the visual impact as the +150 m tall windmills, which normally also will be placed on the ridges, will be visible from nearly anywhere in the vicinity, causing constant flickering rotating wings and the constant low frequency "humming". These issues have caused serious medical problems for close neighbours.