Falkland Islands Energy Strategy

Falkland Islands Government

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INTRODUCTION

In order to fulfil the ambitions of the Falkland Islands Environment Strategy 2021 – 2040 and Islands Plan 2022 - 2026, provide for durable energy security, cut pollution risk, and avoid tens of millions of pounds in diesel fuel costs, the Falkland Islands aspires to a fully renewable energy supply by 2045, starting with a significant increase in renewable power provision and energy storage by 2030. This Energy Strategy sets out the intended path forward, and is a key document that will guide the energy priorities over the next 20 years.

This strategy reflects our aspiration for the Falkland Islands to thrive in the emerging global energy environment. A global energy transition is seeing many countries rapidly moving away from fossil fuels to forms of clean, zero-carbon energy by investing in and deploying renewable technologies[1]. These technologies reduce energy-related greenhouse gas (GHG) emissions to mitigate climate change and they typically have better outcomes for public and environmental health by removing the pollution associated with the burning of fossil fuels. These renewable technologies also reduce exposure to volatility in global fuel price and supply, an issue that has been drawn into sharp focus in recent times. The Falkland Islands is at the end of supply chains and dependent on fossil fuel imports to meet its energy needs; to increase energy security and independence it is clear that planning should address fossil fuel and import dependency via concrete infrastructure investments.

This strategy has been developed against a global backdrop of increased fuel costs, elevated cost of living pressures, a need and desire for increased energy independence and security and a global shift towards decarbonisation required to avoid a climate catastrophe[2]. This global context finds its local expression in growing energy security challenges here in the Falklands. Some of our key infrastructure is nearing the end of its useful life, such as the Sand Bay wind turbines which are expected to reach the end of their planned use between 2027 and 2030. These are in the process of being replaced, but without more action, power supply in Stanley will become entirely dependent upon diesel generation in the next decade, at the same time that global fossil fuel costs and risks are growing. Meanwhile, the existing Stanley Power Station has greatly exceeded its intended lifespan. The Falkland Islands Government proposes to address these infrastructure needs, with a focus on a phased build-out of wind and solar generation and energy storage, in a planned and staged way to meet growing demand, providing secure, affordable, clean and sustainable energy to our Islands' community. While a new diesel-fuelled power station is planned, it is intended as a transitional source of back-up power and as a site for energy storage, to be operated consistent with renewable power expansion. It is essential for energy security and will also be cleaner, safer, more energy efficient and away from the populated centre of Stanley than the current power station. Initial plans are under consideration to increase wind energy generation alongside this.

If implemented as proposed, this strategic direction will enhance life in the Falklands by replacing aging and polluting infrastructure with modern facilities – and as renewable power increases, will also generate steadily growing savings in foregone fuel imports. This shift can be complemented by upgrades across our built infrastructure, including increasing the weather-readiness of private and public building stock, replacing aging kerosene and gas appliances with electric appliances that improve indoor air quality, and supporting uptake of low-emission vehicles as these become the dominant global technology.

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[1] Information on global context provided in Appendix 1.

[2] The UN have stated that global CO_2 emissions must be halved by 2030 to avoid climate catastrophe. Source: WEO, I., 2022. Near-Term Macroeconomic Impact of Decarbonization Policies.

Increased relative affordability of innovative renewable technologies can effect positive change for energy security, inclusiveness and sustainability within the energy sector. Globally, investment in clean energy now exceeds investment in fossil fuel-based energy. This trend of growth in renewable energy is expected to accelerate[3]. Every aspect of national energy systems worldwide will continue to be affected by changes in policy, financing, technological advancement and shifts in the supply and demand of energy. It's therefore important that this strategy remain a 'live' document. FIG will periodically update the strategy to reflect changes in emerging technologies, economic and market aspects, and to reflect the findings of analysis in a number of areas where work is ongoing.

Members of the Legislative Assembly 2021-2025

[3] Source: World Energy Transitions Outlook, IRENA (International Renewable Energy Agency), 2022. Accessed at https://www.irena.org/Digital-Report/World-Energy-Transitions-Outlook-2022

1. OUR VISION FOR THE FUTURE

Our energy infrastructure is aging and in urgent need of replacement and demand will keep growing. This creates the opportunity for changing how we do things to create the future we want.

OUR VISION FOR 2045

independent * secure * sustainable * affordable * healthy * resilient

The Falkland Islands has energy independence and security by producing energy through renewable means in a way that builds resilience and reduces external risks. Our energy generation, distribution, storage and use continue to be affordable, equitable and locally relevant. It supports existing and future sustainable development, while fostering positive outcomes for the environment by reducing pollution and using renewable energy systems.

Our people reliably and affordably power their thermally efficient homes and businesses with renewable energy and use sustainable heating, cooking and transport solutions.

TARGETS

Electricity	Energy Efficiency	Heating	Transport	
Primary energy source 100% renewable by 2045	**100% of new buildings & 80% of existing (pre-2027) are thermally efficient to identified standards by 2045**	**100% of new builds and at least 80% of existing builds with sustainable heating solutions by 2045**	**All new vehicles are zero emission vehicles by 2045**	**<20% fossil fuel vehicles in fleet by 2045**

To achieve an energy transition that accomplishes this vision by 2045 we need to start by:

- Installing 6.9 MW onshore renewable power (wind turbines) by 2030
- Installing 8 MWh of battery storage by 2030
- Building a new power station by 2028
- Upgrade power grid arrangements to maximise efficiency of power transmission and use
- Developing a building standard to make all new homes thermally efficient so as to allow effective operation of sustainable heating by 2026
- Retrofitting 200 existing homes to be thermally efficient by 2027

For how we intend to implement our vision turn to Section 6 and see the Energy Strategy Implementation Plan for a full list of actions.

2. PURPOSE & SCOPE OF THE STRATEGY

To fulfil the ambitions of the Environment Strategy 2021-2040[4] and Islands Plan 2022-2026[5], the Energy Strategy sets out the Falkland Islands' energy priorities. It contains recommendations for the necessary infrastructure upgrades related to energy generation, distribution, storage and use sufficient to advance renewable goals in the Islands Plan and Environment Strategy. It is intended to guide infrastructure planning, investment and yearly procurement planning and budgeting over the next 20 years, as well as development of the proposed National Infrastructure Plan, public investment and developments and private-public initiatives and schemes (e.g. those administered through FIDC, implementation of the housing strategy). It is intended to work together with the Pollution and Waste Management policy to reduce pollution resulting from the generation, storage and use of energy. It is also intended to inform offsetting requirements for oil and gas developments that may occur in the Falklands, which may present opportunities to advance the goals of this Strategy.

The Energy Strategy provides a clear, cohesive plan to deliver the vision of this strategy and meet its objectives, including mechanisms for review and update. It provides a clear direction of travel to co-ordinate and accelerate work already underway in government and across the community.

This energy strategy considers multiple aspects of energy: power, heating, and transport. The greatest focus is on the power sector, as renewable transport and heating could be increasingly reliant on this sector in future. It considers all of the Islands: Camp and Stanley. It applies to government investments, developments and schemes, including those achieved through subvention bodies or arrangements with the private sector.

3. OBJECTIVES

We aim to:

1. Provide energy that is reliable, affordable and sustainable to the inhabitants of the Falkland Islands;
2. Ensure our energy security, independence and resilience: reducing our reliance on energy imports like fossil fuels, improving our ability to generate, store and distribute power within the Islands, building resilience to climate change impacts and market shocks on our energy sector;
3. Deliver infrastructure at pace and scale to handle increased capacity as electrification grows;
4. Protect the health of our people and the environment, including by transitioning to cleaner energy sources, increasing energy efficiency and transitioning to cleaner, renewable heating and cooking technologies, especially in our homes;
5. Support the transition to renewable technologies, including by upskilling our community and workforce and by investing in renewable energy generation for our electricity provision and
6. Support sustainable development and economic growth, boosting growth and innovation through our green energy transition.

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[4] One Environment Strategy action is to increase our reliance on renewable energy, with Stanley's primary electrical supply being 100% renewable by 2050. Key objectives of the Environment Strategy include: i) to reduce our carbon emissions through transitioning to using renewable (low carbon) energy sources for power generation, ii) to increase our use of renewable energy sources, with a focus on reliable and appropriate energy with low environmental impacts, iii) to promote energy efficiency and savings, slowing down and stabilising the consumption of energy while ensuring that the needs of people are met, iv) to consider whole of life impacts of measures intended to reduce energy use or of transitioning to renewable forms of energy.

[5] One Islands Plan 2022-26 commitment is to develop and implement infrastructure plans for key utilities, including renewable energy, power supply, water and sewage. It included key actions to implement new sources of power generation, to enable and increase use of renewable energy and energy conservation throughout Stanley and Camp, and to create this Energy Strategy.

4. ENERGY IN THE FALKLAND ISLANDS

Currently, the Falkland Islands rely heavily on imported fossil fuels for energy. There have been good successes in an early start to the transition to renewable energy, such as 30% of Stanley's electricity supplied by wind turbines and the vast majority of rural households generating their primary electricity from renewable sources.[6] However, planned investment is needed to build on these successes. Without this, aging infrastructure and growing demand will cause increased reliance on fossil fuels. Such reliance presents key risks to energy security (e.g. reliance on diesel imports), affordability (effect of fuel price shocks) and environmental pollution (emissions from combustion and potential fuel spills). With energy prices increasing, a volatile petrochemical market and the threat of climate change, switching to cleaner and cheaper energy alternatives that are less dependent on long supply chains is a priority for the Falklands.

To implement the vision of this strategy, section 4 details the current situation, providing the rationale and direction of travel (see also section 6 and the Implementation Plan). In summary:

> Investment for Stanley's energy infrastructure should focus on wind energy (and potentially some solar), with back-up energy storage and back-up diesel generation to compensate respectively for both short and long periods without significant wind and sun. Essential to our energy security and to reduce health and safety risks, a new power station will replace the existing aged one. It will be more efficient and use less fuel, rely on newer technology that is cleaner and safer for workers and the public, and be located away from the residential areas, hospital and school in the centre of Stanley. It is intended that the new station will be incrementally phased out from primary generation to essential back-up power. Over four MW of wind turbines should be installed by 2030 to replace existing turbines that age out of use that year, with more incrementally installed to meet 100% renewable primary supply by 2045. This energy transition will need significant investment, but without it, energy security is at risk and continued reliance on diesel is likely to generate fuel costs of over £100 million by 2045 (section 4.1.1; 4.1.2).
>
> Stanley's aging distribution network and energy storage should be expanded and updated to enable growth in and changes to electricity supply. Changes and formalisation of how private users interact with Stanley's electricity grid are also needed, e.g. current inability to support private individuals feeding back into the grid, planning for unexpected private demand (4.1.2). Energy storage is the best initial investment that can provide energy sufficient to cover short periods without wind. We will continue to monitor development of emerging storage technologies (like hydrogen) for their potential as practical and cost-effective local solutions (4.1.3.).
>
> Choices will need to be evaluated on how Stanley's energy transition is delivered. Provisioning of electricity is currently fully public, but privatisation or private-public partnerships offer trade-offs in terms of the speed of implementation, reliability and cost (4.4). Irrespective of the delivery mechanism, skilled labour will be critical. Upskilling, retention and future-planning for people who will be able to operate and service an increasingly renewable system will be needed (4.5).
>
> In Camp and Stanley, heating and cooking are quite dependent on fossil fuels. Combustion poses an indoor air pollution risk, and draughty or poorly insulated buildings can mean a greater use of fuels to maintain a comfortable temperature. Retrofitting properties for thermal efficiency or renewable heating is likely to take time, because of limited labour on the Islands (section 4.2). As such, a sharp

[6] A detailed report of baseline information related to energy in the Falkland Islands is provided in Appendix 2.

focus should be on an initial target to improve thermal efficiency and cleaner heating and cooking in new builds – stopping the problem at source. At the same time, existing properties can start to gradually be retrofitted to improve thermal efficiency (with lowered energy use and costs) through insulation and draft-proofing before installing less-polluting, more energy-efficient heating and cooking technologies. Financial mechanisms, like FIDC grant schemes for private sector and FIG investment in its housing stock, will help to support this. Targeting of finances to focus on least-efficient buildings or businesses and lower income households first, should aim benefits in costs and health at those who need it most.

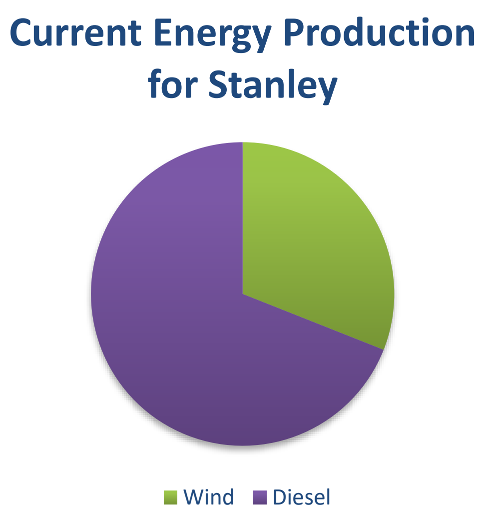
Almost all Falklands' vehicles and plant (machinery) rely on petrol and diesel. A global shift in markets, including the UK's ambition towards zero-emission vehicles[7], means that uptake of electric and non-combustion vehicles and plant over time is inevitable. In Stanley, the grid cannot currently support fast charging. Public charging stations will also need to be carefully sited to avoid burden on the grid. Smart metering or another mechanism will likely be needed in the longer term to encourage charging at certain times to smooth electricity demand. In addition to facilitating uptake of electric vehicles, efforts to promote alternatives to driving offer potential savings on carbon emissions and cost of living – reducing fuel and vehicle costs – alongside public health gains (Appendix 4). In the short term this includes encouragement of active transport, such as cycling (or e-bikes) and walking, and longer-term consideration of public transport in Stanley, such as an e-bus on regular routes.

4.1 POWER

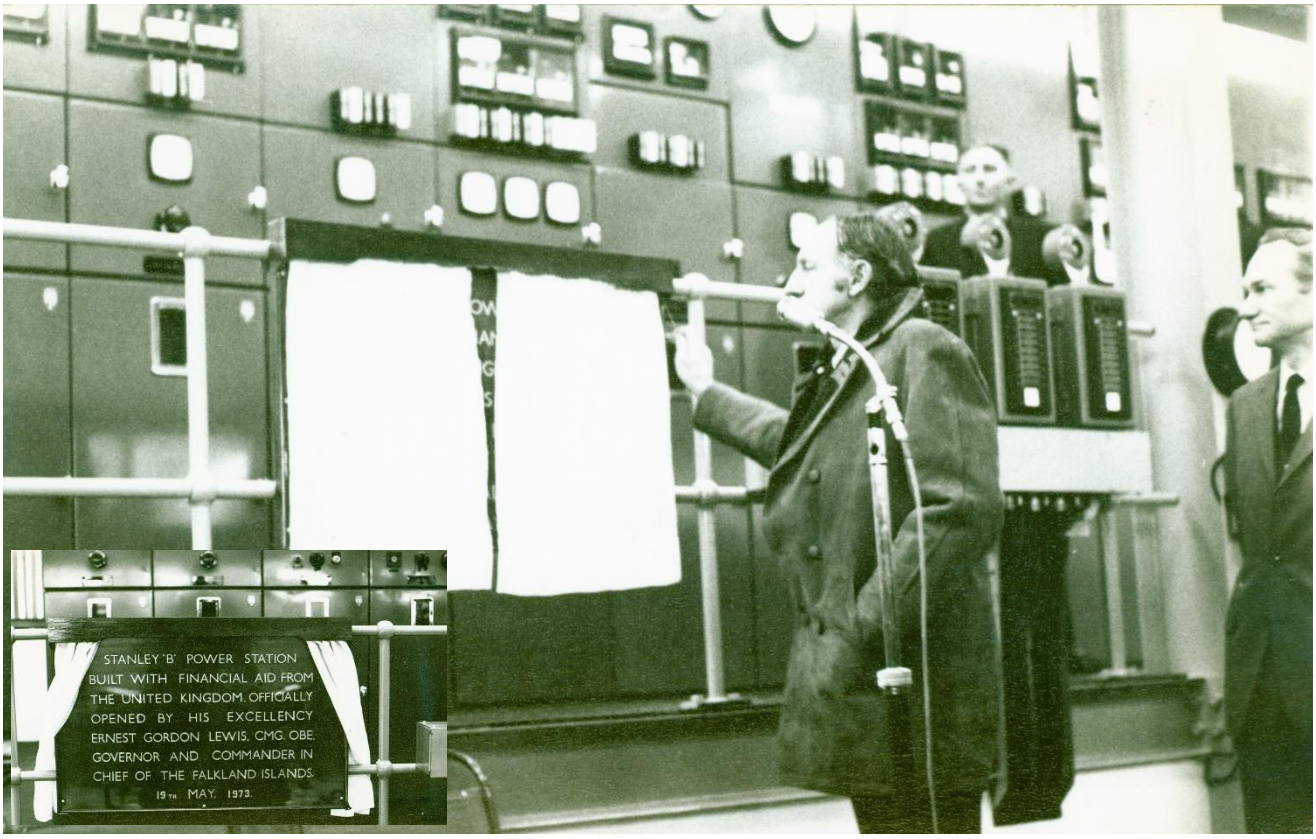
The following sections focus on power in Stanley and Camp (see Appendix 2 for further details). Especially in the case of Stanley, there are four points that are critical to consider for a successful development and transition of electricity provision: 1) generation, 2) storage, 3) distribution and 4) skilled people to support and implement electricity provision. Planning and implementation will also need to consider single points of failure, with prioritisation to reduce or eliminate these based on a risk-impact approach.

4.1.1 Energy Generation in Stanley

Current energy generation infrastructure in Stanley is outdated, posing energy security and human health risks. The current power station has been in operation since 1973, exceeding its original planned lifespan, and is intended for urgent replacement with a new power station. Wind turbines at Sand Bay wind farm are newer (Phase 1 2007; Phase 2 2010), but still are approaching end of life in 2027 and 2030, and will need to be replaced. This means planning and budgeting for replacement of existing infrastructure and expansion of renewables to meet future demand is critical to both energy security and to avoid increasing reliance on



[7] 80% of new cars and 70% of new vans sold in Great Britain are set to be zero emission by 2030 and 100% by 2035. Source: https://www.gov.uk/government/news/government-sets-out-path-to-zero-emission-vehicles-by-2035



Power Station 'B' was opened in Stanley in 1973. Having recently celebrated its 50th anniversary it has performed remarkably well, having exceeded its original intended lifespan. However, it is due urgent replacement. Photo credit: Historic Dockyard Museum.

diesel imports for electricity generation. It will also help to swiftly reduce and remove polluting sources such as emissions from combustion and potential diesel spills, leading to notable benefits for human and environmental health.

Work on reducing reliance on fossil fuel imports, replacing old infrastructure, increasing energy security and reducing emissions, while meeting future demand is already in train. Due to advances in technology over the last 50 years, a new power station, though diesel-powered, will be more efficient, less polluting and designed with space and connections necessary for energy storage to support the expansion of renewable power sources. The new power station is intended to gradually take a back-up generation role. Work was commissioned from specialist consultants[8] on alternative renewable energy generation and storage options for Stanley and the findings of this have informed plans to date and have been incorporated into the current strategy.

The Sand Bay wind turbines are also rapidly approaching their end of life – 2027 for Phase 1 and 2030 for Phase 2.

[8] 2020. Ramboll. Falkland Islands Government power station energy feasibility study.

Electricity provision needs to meet demand drawn at any one time (the load) and the total amount used throughout the year. Energy demand is highest in autumn and winter and between 7 am and 9 pm, with peaks around "smoko" (morning tea break) and lunch time. From 2017/18 data, total load peaked at 3.29 MW. Throughout the year around 18,000 MWh of power was produced and delivered – a daily average of around 50 MWh. Further, it has been observed that demand has increased over time. When wind speeds are favourable (there's wind >2.5 m/s, but not too much <28 m/s), electricity is generated from the Sand Bay Wind Farm – 5,504 MWh generated per year in 2017/18, around 30% of the total for Stanley.

Future projections (Figure 1) show a continuing growth in both maximum load (instantaneous demand) and overall consumption through the year (total annual demand). Future demand includes growth in the number of houses (infill and new residential developments like Bennet's Paddock), larger infrastructure developments such as the waste management facility and could include new opportunities which are yet to be explored, like cold ironing (shore to ship power).

In order to meet growing demand, there will need to be an increase in both the electricity available throughout each day to meet consumer needs at any given moment (e.g. when everyone in Stanley turns on their kettles, or 50 freezer shipping containers are suddenly plugged in and switched on, or a new development goes live), as well as enough electricity generated throughout the year. Having redundancy is important, because if major energy users like the quarry or FIMCO come online at the same time demand can exceed supply, overloading the system.

In short, this means that existing electrical infrastructure needs to not only be replaced, but also extended to accommodate growing needs and keep pace with developments and economic opportunities.

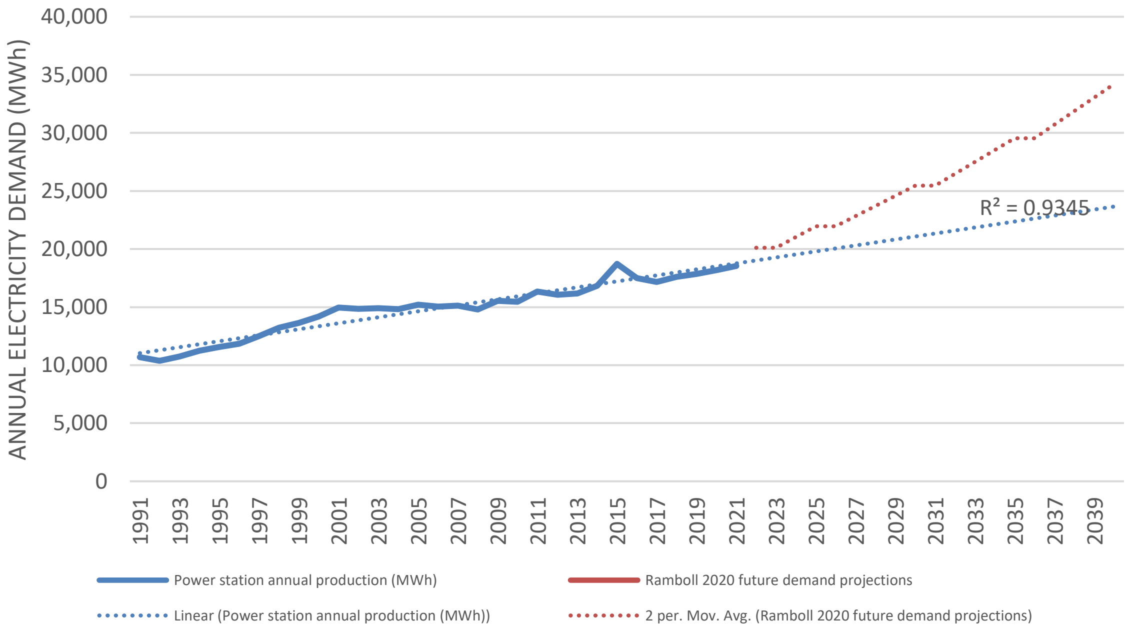


Figure 1: Demand on Stanley's electricity infrastructure is expected to continue to grow through time; to meet it we will need to replace and expand on existing, old infrastructure, and expand it. This is going to mean significant investment in generation, storage and distribution infrastructure. Power station production shows past growth, with a linear regression (with high R2 – i.e. goodness of fit) suggesting future demand, alongside Ramboll's (2020) projections based on 3% annual growth.

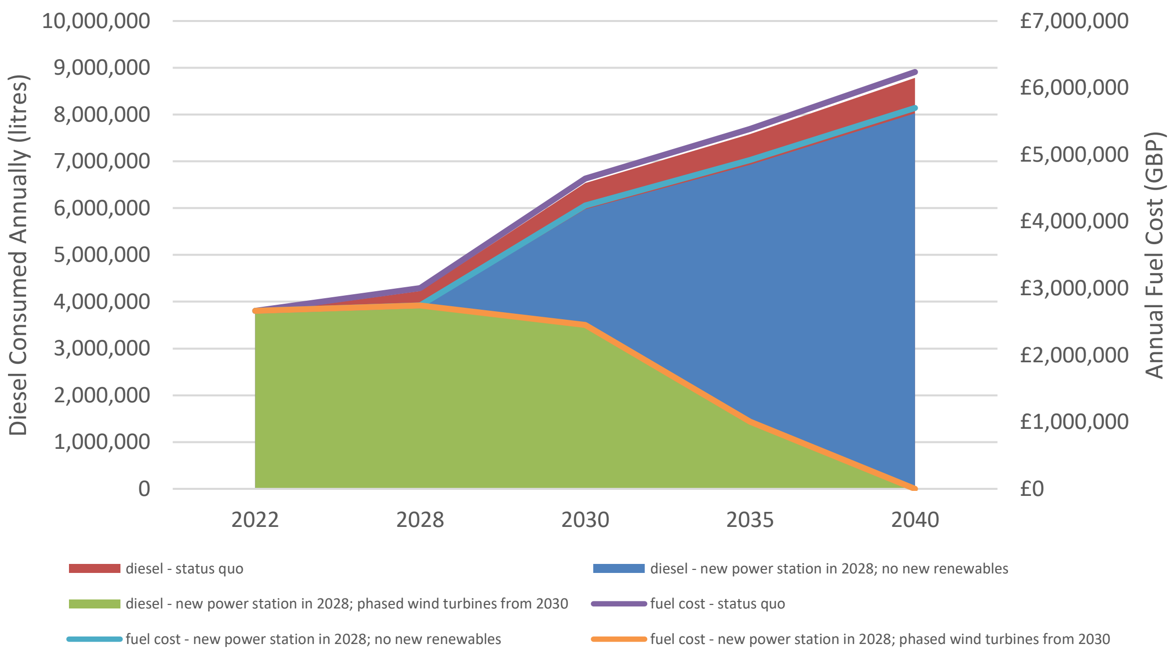


Figure 2: Without transitioning to greener energy forms, diesel use will continue to grow in future. This also bears a significant cost. If no new renewable generation technologies, e.g. wind turbines, are built, the current wind turbines will reach end of life by 2030 and diesel consumption will increase. In this scenario, assuming a fixed cost of 71 p per litre of diesel (price in August 2023), then £110 million could be spent on diesel alone by 2045[9]. Fuel price will not remain fixed, and there are other variables, so this value is for illustrative purposes only. *Status quo*: no new power station is built; fuel consumption remains inefficient. In reality, the existing power station would not be able to meet future project demand growth. *New power station in 2028*: assumes a new, more efficient power station is built to replace the existing power station, however no further investment is made in renewables. *New power station in 2028; phased wind turbines from 2030*: a new power station is built and additional wind turbines are installed as per the phased approach suggested in Ramboll's 2020 report. In all scenarios, existing wind turbines reach end of life by 2030.

Wind, Sun or something else?

The next logical questions are: 1) when should these electrical infrastructure upgrades happen and 2) should they be additional wind turbines, solar (photovoltaic – PV) panels, fossil-fuel based generators, or something else? The answers, as the following section details, are as soon as possible and wind turbines. The next steps should be to, as soon as practicable, 1) assess the best available wind technology suitable for the Falklands before the procurement of new turbines to replace the capacity that will be lost due to turbines reaching end of life in 2030[10], 2) to assess the condition of the current turbines and the possibility to extend their life, and 3) consequently plan for Phase 4 purchase and installation of wind turbines (possibly with solar) to expand current generation capacity, i.e. increase the amount of electricity we get from wind turbines. Advances in this area have already been made since the creation of this strategy; Phase 3 of increased wind generation was approved by ExCo (168/26) in November 2023 and the procurement of the wind turbines commenced during 2024, all of which is reflected in the Energy Strategy Implementation Plan.

Without investment in renewable technologies, diesel consumption will vastly increase by 2030 when current wind turbines reach end of life and will continue to grow with increasing energy demand. Apart from increasing dependence on diesel imports and increased emissions, there is also a large cost to diesel consumption, which adds up over time (over £100 million by 2045, with several million pounds per year more in diesel cost where wind turbines are not replaced and phased in; Figure 2). Renewable energy infrastructure has significant up-

[9] Based on Ramboll 2020's future energy demand scenario.
[10] Proposals have been taken to ExCo in November 2023, alongside the creation of this strategy.

front capital costs, as do new diesel generators, but renewable energy will save on fuel costs and emissions and boost energy independence with a reliance on occasional parts and specialist maintenance rather than monthly fuel imports.

A variety of renewable energy sources exist globally (Appendix 3). The choice of which proven technology to invest in must be based on whether they are feasible and practical for the Falkland Islands and how well the energy they produce matches demand through time. A good fit between supply and demand means electricity is available when it's needed and less money needs to be spent on storage (e.g. batteries). Wind and solar energy are proven technologies. Wind turbines have successfully provided significant power to Stanley for almost twenty years while solar and wind have worked well in Camp. A trial of solar PV panels is currently underway at Sand Bay, which will allow the opportunity to test its integration with the existing system.

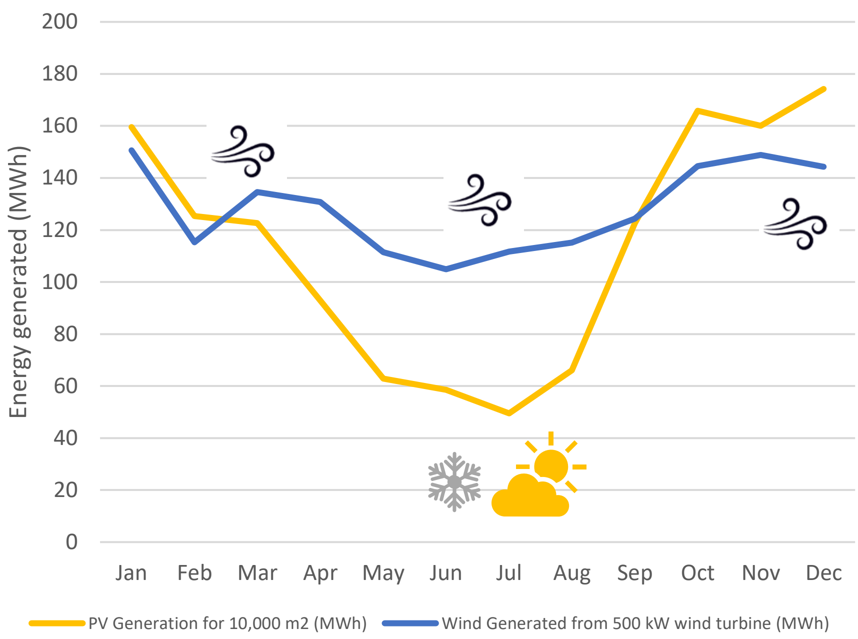


Figure 3: Wind energy generation (blue) is consistent across the year, while there is a major drop in solar energy generation (yellow) in the darker 6 months of the year as there is little light. This makes wind a better fit to consistently meet demand.

Solar radiation varies strongly through the year, with winter sunlight levels only 12.5% of what is available in summer; an almost eight-fold variance between summer and winter. This requires a much greater number of panels to be installed (with associated high relative up-front capital investment) to produce sufficient energy in winter to meet demand. By comparison, wind generation is much more consistent across the year irrespective of season (Figure 3), with a variance of only about 20%[11] between the best and worst days. Wind speeds are estimated to be too high to produce renewable energy (storm conditions) for only around 500 hours per year and too low (calm conditions) for around 1,500 hours per year[12]. Potential production through wind generation could meet demand for about 75% to 95% of the year, meaning that the need for energy storage is more likely to be short term.

However, the infrastructural challenges related to installing and maintaining the wind turbines available on the global market (which have been increasing in physical size) are greater than to install and maintain solar (PV) panels. And more specialist personnel are required for wind turbines than solar panels. This might make a mixed approach attractive over the long run, with early adoption and probable continued dominance of wind energy.

[11] 2020. Ramboll. Falkland Islands government power station energy feasibility study; based on 2017-18 data.
[12] 2023. FIG Power station manager.

4.1.2 Energy Distribution in Stanley

The distribution network of the current power station stretches from Stanley Airport to the base of Mount Kent and includes the Pony's Pass quarry and Falkland Islands Meat Company abattoir. Electricity that is generated by the power station and wind farm is distributed throughout Stanley in one of the three ring circuits. The network and planned future changes to it are designed to minimise the impact of line faults on supply. The distribution network also includes step-up transformers and ninety-six substations that distribute and regulate the electricity generated from the power station around Stanley (see Appendix 2 for details).

In addition to ongoing maintenance and replacement of parts, Stanley's aging distribution network ("the grid") will need significant upgrade and expansion alongside changes to generation and storage to meet growing demand. For example, to accommodate the move of the power station or connection of new wind turbines. Our grid is going to need to be sufficiently flexible to work with new technologies (e.g. renewable generation) and their particular constraints and requirements. For example, after a power failure, substations need to first be magnetised before electricity delivery can restart. Currently larger diesel generator sets accomplish magnetization of the substations, but alternative technologies will be needed to accomplish this as diesel generation is phased out over time.

These upgrades are likely to unlock opportunities for improved grid operation and potentially cost savings. Older transmission networks very often experience various inefficiencies, such as "line loss" between generation and use that can create the need to generate more power than is actually needed, raising fuel and infrastructure costs. Grid upgrades can often eliminate or reduce these inefficiencies. This reduces costs over time, while also affording opportunities to operate the grid more effectively. For instance, storage capacity, improved transmission lines and other tools can help store and use renewable power effectively, while likely improving user experiences. As such, ongoing support for planning and grid improvements are explicitly part of this strategy to support the overall transition and unlock savings where possible.

Changes and formalisation of how private users interact with Stanley's electricity grid are also needed.

There are challenges related to the connection of new users or significant developments. The grid has limited ability to support additional demand in some areas. This has impacts, for example, on where it's currently possible to support and therefore site electric vehicle charge points or support large energy users.

The distribution network is also not able to support the connection of private individuals to feed into or sell back to the grid, e.g. installing solar panels on their house to create electricity while connected to the grid. This is because unpredictable and significant fluctuations in electrical supply or demand can 1) impact the safety of workers, 2) cause damage to infrastructure and personal property, and 3) lead to increased power cuts (for full details see Appendix 2). These challenges are not insurmountable with modern metering and home interconnections, but questions remain on the best use of limited capital to invest and practicalities like who will carry out all the inspections to make sure these are done appropriately to ensure safety of workers, given the challenges of labour shortage.

4.1.3 Energy Storage in Stanley

Battery storage is a widely used form of energy storage for renewable systems and anticipated to be the initial form of energy storage for Stanley. Photo credit: Wikipedia.

Being able to store excess energy generated from renewable sources would allow more of Stanley's electricity to be provided by renewable means, reducing our reliance on fossil fuels. Energy storage enables a consistent supply of energy which can be quickly ramped up or reduced as users' power demand changes and the supply from renewables fluctuates. The amount of storage will need to be increased over time in tandem with renewable generation to provide electricity for periods where wind and sun energy production are low, such as windless nights or periods during the winter when both sunlight and wind are low. It is likely that for prolonged periods of low wind and sun, back-up power will still need to be provided by the diesel power station, but increasing storage means this should happen less frequently.

There are many storage technologies, from batteries to hydrogen to gravity-based storage (see Appendix 3 for details). In the short-term, energy (battery) storage makes the most sense and is what FIG intends to invest in for Stanley. However, it is important to periodically investigate other options as part of the integrated resource planning process, as this is an area where technology is rapidly evolving.

There are several potential sites to be considered for energy storage, including the wind farm and the new power station. Other energy storage sites will also be considered at various points as storage systems increase. For example, Falkland Islands Meat Company (FIMCo), where storage could help to smooth the load by preventing FIMCo from drawing on the grid suddenly during high use times or allowing the stored energy to re-power the grid when it is not drawing power. Similarly, Pony's Pass quarry should be considered as another potential site for energy storage. Upgrades to transmission systems to these relatively remote but high-power demand locations should also be considered, which would make energy storage easier to use overall for the grid as a whole, and could also help reduce the loss of power transmitted to and from these sites, cutting emissions and costs.

4.1.4 Electricity Generation, Distribution and Storage in Camp

In Camp transition to renewable power sources has been successful with a high uptake (Figure 4), largely as a result of past government-driven incentive programmes operated through the FIDC, e.g. the rural energy grant and the thermal grant. Aside from the Fox Bay settlement, which has electricity provided by the government through diesel-based generation, energy in Camp is largely generated, distributed and stored privately using wind turbines, and solar panels, with battery storage and diesel generators for back-up.

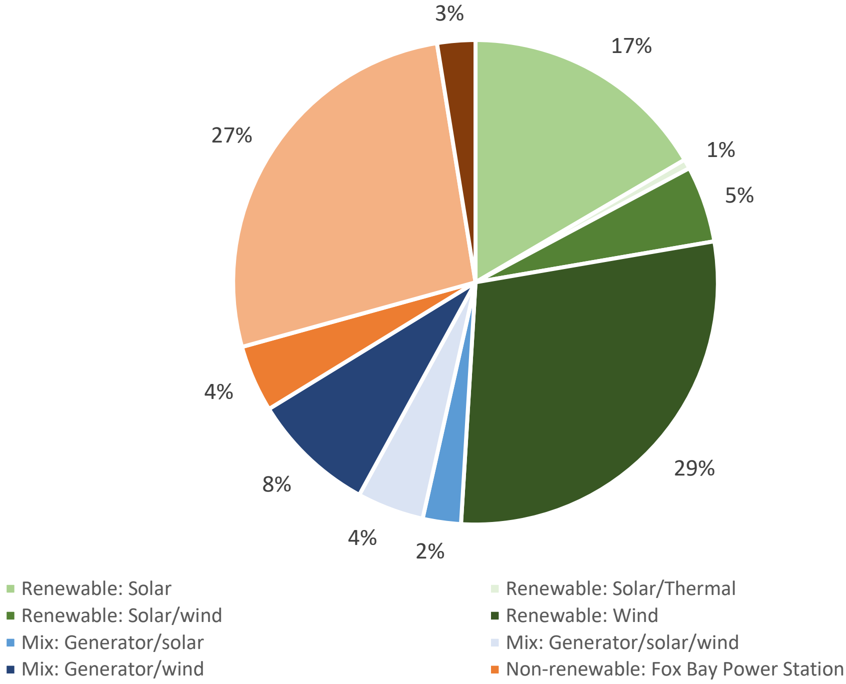


Figure 4: Proportion of energy sources used in Camp based on 2021 Census data. Around 70% of individuals reported relying on renewable energy.

This is quite different to the situation in the early 1990's when electricity in Camp was mainly provided through the use of diesel generators. These were costly to run and only provided power for a few hours a day. The initial drive for renewable transition in Camp was to improve the quality of life in Camp though the provision of affordable 24-hour power, reduced imported fuel reliance, energy savings and electrical system maintenance and safety (ExCo 203-15). The FIG-funded FIDC grants, begun in 1996, were well received with a strong initial uptake by many Camp properties in the early years of the grant scheme (Figure 5).

Renewable energy installations were begun in Camp during the 1990s. They were very successful early adoption of renewable energy to provide secure, 24-hour power. However, many of these installations are now quite aged.

As a consequence, though, many installations are now nearing the end of their lifespan. At 25 to 30 years old, they need significant maintenance or replacement. Although it could be argued that cost savings in fuel over the years should be reinvested into replacement and maintenance of systems, in some cases farms have changed hands with new owners inheriting the cost burden of aging infrastructure. Lower wool prices and other costs have also put pressure on margins in recent years.

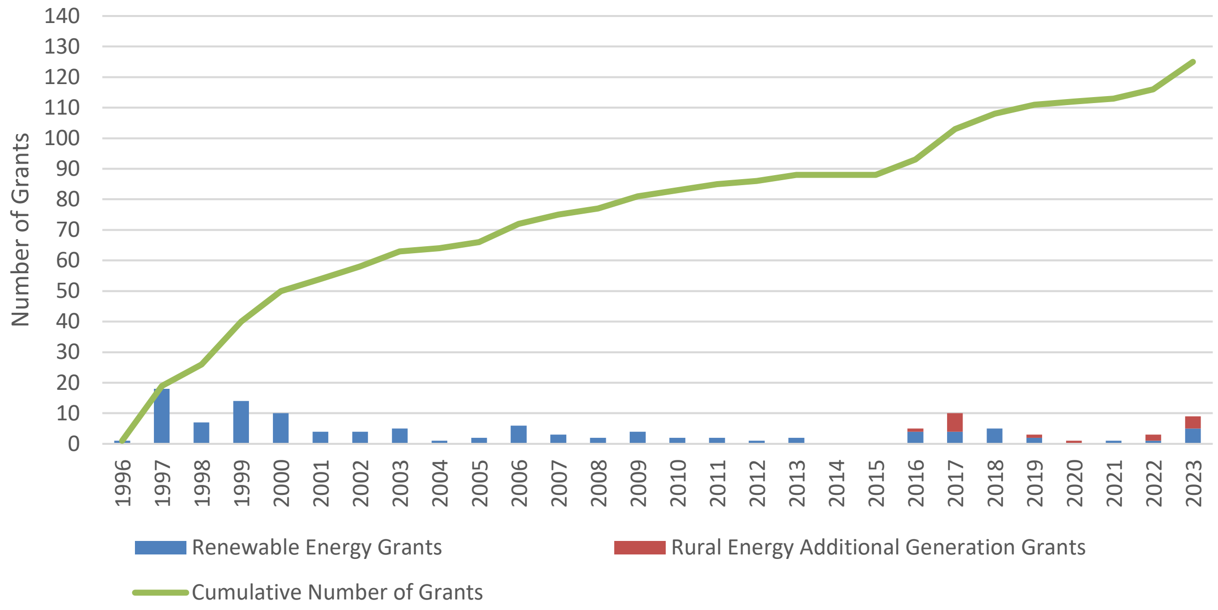


Figure 5: Renewable Energy Grants and the more recent Rural Energy Additional Generation (REAG) Grants have been well taken up in Camp, with a strong initial uptake as many properties converted in the 1990s. REAG grants are for businesses that previously benefited from the RE Grant Scheme and wanted to expand their generation capacity by diversifying into other types of renewables (e.g. adding solar panel arrays to properties that already had wind turbines).

A further challenge will be increasing energy generation and storage demands of business diversification into tourism in Camp and to power renewable heating solutions, such as heat pumps. Without those living and working in Camp reinvesting in renewable energy solutions, there is a risk of increased reliance on diesel generation as a primary rather than back-up source of power. To this end, the Rural Energy Additional Generation Grant scheme and Green Loans[13] are presently available to help fund expansion and replacement of energy systems in Camp. A sensible approach to help finance this transition may be to consider zero or low interest loans to fund replacement and expansion of systems up to a determined threshold, with the repayments reinvested by FIG to fund future replacement and/or expansion once the new systems reach their end of life in 25 to 30 years.

Beyond grant schemes, Falkland Landholdings Corporation (FLH) historically installed wind turbines in their four settlements to supply power to around 40 homes (ExCo 198-15). Some individuals or businesses, have also opted to privately fund renewable power-based systems, such as the recent wind turbine installation at Port Howard. Finally, Fox Bay settlement has public power provision through diesel-based generation. At present, work is underway by FIG to determine options for converting to a renewable power system with energy storage and an updated distribution network.

[13] Green Loans serve as a low-interest, debt-based funding mechanism to help carry out maintenance, upgrade or newly install renewable infrastructure and are available for both businesses and individuals. For a full list of grants and schemes currently available under the FIDC see www.fidc.co.fk.

4.2 HEATING AND COOKING

Currently most heating and cooking in both Camp and Stanley is provided through the combustion of fossil fuels (Figure 6).

There are multiple benefits to reducing reliance on fossil fuels including fewer emissions and pollutants from the burning of fossil fuels, including reduced carbon emissions, and less potential for spills that can pollute water and the environment. One of the chief benefits is an improvement in public health outcomes. Burning fossil fuels releases particulates and other by-products that negatively impact health, including increased risk of cancers and respiratory health issues. Particularly where boilers or cookers are located in homes, where people spend a lot of time, shifting to alternative means of heat provision and cooking can have marked benefits for public health (Appendix 4).

There are different ways to reduce fossil fuel usage, improve heating of homes and improve living conditions and health at the same time. There is a large potential for increasing the thermal efficiency of homes given the existing building standard in the Falkland Islands compared to that of the UK. Checking the level of insulation in homes could be done through engineering studies which use techniques like thermal imaging to check for leaks in the housing structure. This can then inform home improvements for better thermal efficiency. Further, increasing the efficiency of existing heating and cooking technologies means that the same results are achieved using less power. Finally, replacing fossil fuel-based technologies with technologies, such as air source or ground source heat pumps and solar thermal heating[14] that rely on electricity will eliminate indoor air pollution from these sources.

Transitioning home heating and cooking will take time and investment. One of the biggest challenges in the Falkland Islands is that there are a limited number of skilled workers able to carry out insulation measures or install new technologies like heat pumps. Critically, technologies like air-source heat pumps use electricity, so it's also important to make sure that adoption of these technologies doesn't outpace the ability of Stanley's future electrical installations to supply electricity.

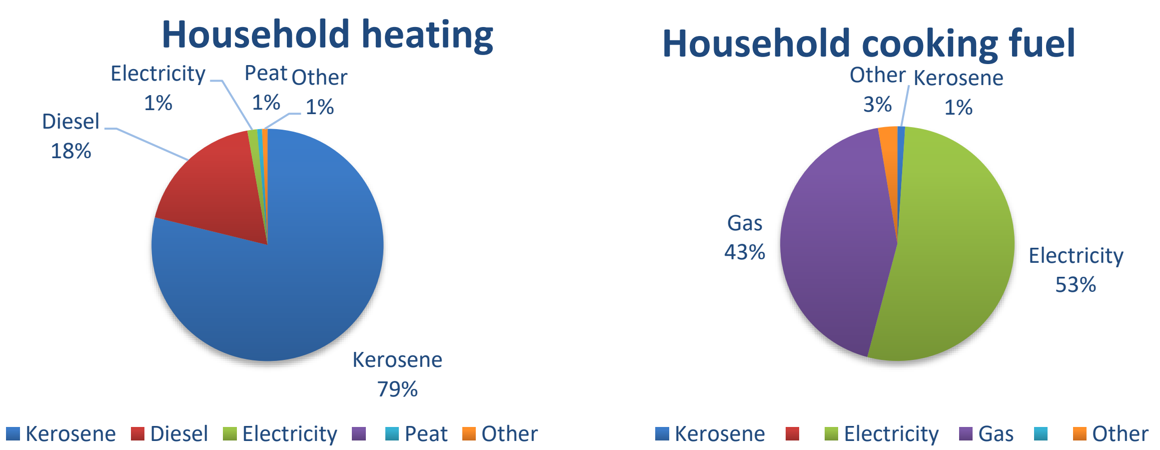


Figure 6. The percentage of households in Stanley by fuel source used for heating (left) and by fuel source used for cooking (right). Source: Census data; 2021.

[14] See Appendix 3 for a breakdown and description of some common renewable technology options

Therefore, the initial focus for Camp and Stanley should be on setting standards for new builds to improve thermal efficiency and to employ cleaner heating and cooking technology as far as possible, which would avoid the need for future more costly and inconvenient retrofitting. At the same time, existing properties can start to gradually be retrofitted to improve thermal efficiency (with lowered energy use and costs) through insulation and draft-proofing before installing less-polluting, energy-efficient technologies. Green loans, grants or other financial schemes could help private individuals to adopt these new technologies so that everyone, irrespective of their financial means, can access improvements in heating their homes and reducing indoor air pollution. This could be achieved for the private sector by aligning FIDC grant schemes with this strategy. FIG investment in improving its own housing stock, will also help to support this. Targeting of public and private finance to focus first on the least energy-efficient buildings or business premises and lower income households should help get the greatest return on investment and ensure those who most need assistance will benefit.

Heat pumps are a sustainable heating option, but work best where buildings have first been properly insulated. Photo credit: Wikipedia.

In Stanley, the electrical demands of homes and businesses with installed heat pumps and other electrical cooking or heating technology should be measured for early adopters as is currently being done with FIG heat pump installations (e.g. flats on Brandon Road). This will allow the future electrical demand for new and retrofitted homes to be better estimated so that we can plan for Stanley's electricity supply to meet future needs.

4.3 VEHICLES

The majority of the more than 1000 vehicles in the Falkland Islands are currently run off of fossil fuels (mainly diesel, some petrol). In 2022, there were only nine electric vehicles in use. Numbers will almost certainly grow in future through transition of technology and consequent availability at a global level. The UK, for example, has an ambition towards zero-emission vehicles, with an interim target of 80% of new cars and 70% of new vans set to be zero emission by 2030[15] . Where powered by renewable sources, zero emission vehicles (e.g. electric cars) offer significant emissions reductions and reduce release of pollutants to the atmosphere.

Electric vehicle use is growing globally. This will place additional demands on 'the grid' that must be planned for. Photo credit: Wikipedia.

Future planning to generate, store and distribute electricity in Stanley will need to consider growing numbers of zero emission (electric) vehicles. For example, the UK's average daily driving distance of 19 km results in a demand of around 1300 kWh per year[16]. Even using conservative estimate of a quarter to a half of this, given the shorter distances in Stanley,

[15] Source: https://www.gov.uk/government/news/government-sets-out-path-to-zero-emission-vehicles-by-2035
[16] Source: https://evbox.com/uk-en/how-much-electricity-does-an-electric-car-use

could lead to a demand of 325 – 650 kWh per car, or an annual consumption of 487.5 MWh to 975MWh for a fleet of around 1,500 vehicles. Electric HGVs and plant would have larger demands.

Promotion of active transport, including e-bikes, within Stanley will help to reduce dependence on fossil fuels or the grid, have side health benefits and reduce traffic congestion around areas like the school. Longer term, public transport options within Stanley could be considered. Photo credit: Wikipedia.

The distribution network cannot currently sustain dedicated public electric vehicle charge points in areas where there is already high demand on the grid. This includes built up parts of town or areas where businesses draw significant power. This is particularly true of the centre of Stanley that currently operates at 3.3kV and experiences a high demand for power.[17] Rapid charging is not currently possible, because it requires a high voltage DC input which the network cannot support. This means that in the short- to medium-term the siting of public fast charge points on the Stanley network will be limited.

Future planning for works on and upgrades to the distribution network will need to identify initial sites for public charge points outside of high demand areas and consider growing future demands for both domestic vehicles as well as HGVs and plant. In Camp, landowners and businesses will need to plan for the likelihood of growing opportunities of electric vehicles and plant in future and consider this as they expand their renewable generation capability or when they replace aging technology, e.g. aging vehicles, aging solar or wind turbines. Electric vehicles offer the option of additional energy storage on days of excess renewable yield.

Alternative transport options within Stanley may be worth exploring to reduce the potential number of electric vehicles that may rely on the grid in future, given the small travel distances. In the short term, a focus on encouragement of increased active transport options, like cycling (including e-bikes) and walking could have benefits for public health, fuel and energy savings. Longer-term consideration of public transport in Stanley, such as an e-bus on regular routes, offer potential savings on carbon emissions and cost of living – reduced fuel and vehicle costs, alongside public health gains.

4.4 OPTIONS FOR PROVISION

Fully public (energy) provision, as for Stanley's electricity supply at present, is only one model to provide power, "green" or alternative heating, storage and other technological solutions related to energy. Private provision or private-public partnerships are alternatives. For example, the private sector has taken advantage of business opportunities around "green" energy technologies like the provision of solar PV installations or domestic wind

[17] Upgrading the East 3.3kV ring of Stanley to 11kV to support greater power demand would require replacement of existing infrastructure, including power lines and substations, with substantial capital costs, diversion of labour from other critical tasks and disruptive works, such as digging up roads and gardens in the centre of Stanley.

turbines in Camp. All options have their advantages and disadvantages (see Appendix 5 for detailed comparison).

Currently, Stanley's electricity provision is fully public. An alternative model might offer possibilities to get renewable energy online faster or be more reliable. However, changing to another model should be critically evaluated, particularly through the lenses of energy security, affordability and the potential impacts of any offshore ownership/stakes in critical public services.

4.5 LABOUR

Capable and skilled personnel are essential to all elements of electricity provision, to meeting the objectives and vision of this strategy and, in simple terms, to keeping the lights on.

The skilled labour needed ranges from engineers and specialists to site workers and electricians. This includes people who can plan and assess options for future upgrades and ensure that these happen seamlessly, those who carry out works in often dangerous and complex situations many metres up a wind turbine, and those who connect new users to the grid, swiftly resolve a power cut or fault in the system and work unsociable hours with little public recognition. As in many jobs in a small remote community like the Falkland Islands, these professionals must not only have the skills to do specialist jobs, but also be able to cope with filling a range of different roles and finding creative solutions to a myriad of challenges on the job.

A fundamental challenge for the continued provision of power and implementation of this strategy is to secure and retain the right personnel and promote training of the next generation of people who can fulfil the needs of maintaining an electricity system that is increasingly renewable, and the new challenges and opportunities that brings.

5. FINANCING OPTIONS

Significant capital investment in Stanley's electricity generation, storage and distribution systems will be needed first and foremost to ensure energy security, to replace infrastructure already past or nearing its end of life, and to meet Stanley's growing power demand and this strategy's objectives. Funds should be targeted towards investing in the move away from imported and polluting fossil fuels toward larger scale renewable energy projects and energy efficiency.

A large part of the transition to renewables relies on the generation of capital to support new clean energy infrastructure. The need for cohesive, staged investment with regular evaluations is required in order to avoid future issues in energy infrastructure. A key element of this approach will be planning and investing early so that energy security is maintained and infrastructure will develop and adapt as and when required, rather than relying on energy infrastructure past the intended lifespan as in the past. Therefore, designing long-term capital projects to generate funding is essential for developing green infrastructure. In addition to standard government funding mechanisms, alternative funding such as green bonds for renewable projects could be considered to help fund large-scale public infrastructure and encouraging inward investment.

Looking beyond Stanley's electricity provision, financial incentives and disincentives should be considered as tools to facilitate a transition of domestic and commercial properties to reduce energy loss, increase efficiency and adopt cleaner technologies for heating and cooking throughout the Islands. Existing incentive schemes and any future schemes should be aligned with this strategy to ensure a cohesive staged transition that meets the Falkland Islands' long-term energy objectives, such as providing affordable, clean energy to all citizens.

The timing and capacity of renewable electricity generation, storage and distribution will need to be aligned with the increasing demands of sustainable home heating and electric vehicles, and the schemes that accelerate these. This will help minimise risk of mismatches between electricity supply and demand, with a staged approach where electricity continues to be available when we need it.

6. THE WAY FORWARDS

An engineering-derived estimate of future projections and needed interventions, 'the base case' (Figure 7) has shaped our understanding of necessary interventions until 2030, with 6.9 MW of wind turbines installed by 2030 (wind Phase 3), as well as 8 MW of battery storage and other essential infrastructure to enable expansion of the wind farm, as well as a new power station by 2030 to ensure energy security.

In order to build the energy future we want we will:

- Improve our infrastructure to meet future electricity demand and to embrace renewable energy;
- Improve the energy efficiency of our buildings;
- Heat our buildings in a healthier and more environmentally friendly way;
- Leverage our energy transition to promote healthier and environmentally friendly transport;
- Value our people and promote skills to support the energy transition; and
- Update governance processes to support our energy transition.

We will achieve this through the actions of the Energy Strategy Implementation Plan, which details the main steps of our energy transition to 2030 and beyond.

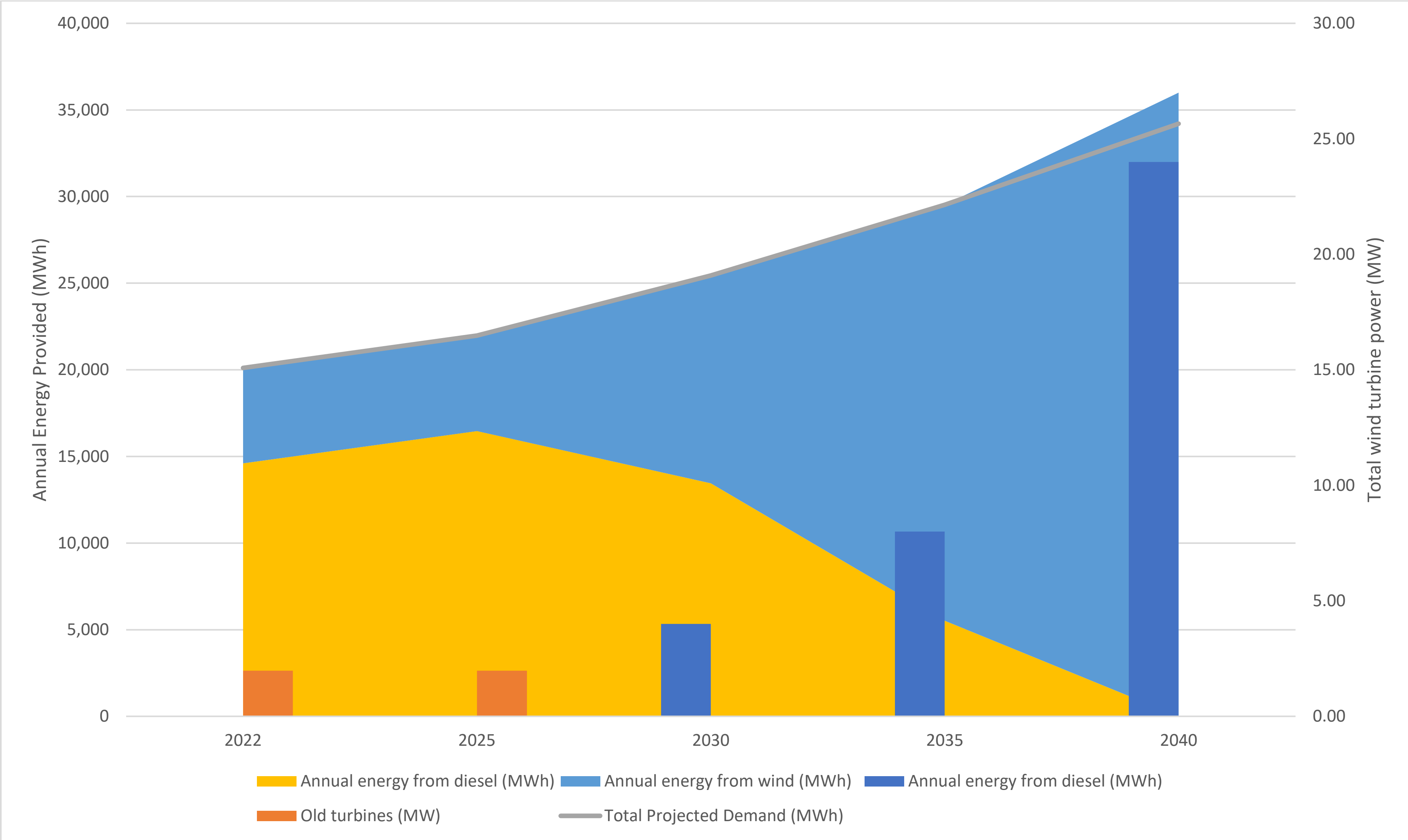


Figure 7: Installation of additional wind turbines (or other renewables) through time should result in full displacement of primary fossil fuel energy production by 2045. Newer, more efficient and less polluting diesel generators will continue to provide back-up power for long periods of time with unsuitable wind speeds. This will require investment in a new power station by 2028, and additional, new wind turbines (renewable sources) installed and running by 2030, 2035 and 2040. Projected demand is difficult to estimate, and so review should be made at strategic intervals of at least every three years, starting at 2027.

The roadmap visualises some of the major steps of the Implementation Plan and includes key periods for review, where we'll be able to check the map against where our community has progressed on this energy journey.

As part of the review process, it will also be possible to assess whether the route ahead still makes sense or needs a bit of course adjustment. This requires a mechanism to check-in regularly and update our future projections and Implementation Plan to make sure we're on track to the energy future we want. Review is critical because it is hard to predict future energy demand with exact precision, particularly in the Falkland Islands where a few developments that are small by international standards could have a massive impact on future energy needs. Technology is also evolving at pace, and options that are currently unfeasible may become feasible in future, whereas others may become obsolete or less attractive. For these reasons it is necessary to regularly re-evaluate and update projected energy demands and how these will be met, so that we continue to do the best for our Islands.

Using the approach of integrated resource planning, review will take place every 3 years, starting in 2027 by an energy review group set up by the Chief Executive. It is anticipated that the group will include relevant technical experts from FIG Public Works, Development and Commercial Services, and Environment.

Review will include examination of whether projected demand and generation has aligned with reality (e.g. real load, real generation of Stanley's electricity) over the intervening years, and projections and best means to meet these over the following five to ten years will be updated. Review should also include examining whether additional technologies for electricity generation, storage and distribution have advanced, making them attractive going forwards, or whether some technologies have proven to be ineffectual. Plans and schemes can then be adjusted accordingly. To aid this, a suite of key performance indicators and metrics will be collected on an ongoing basis. Review in 2027 will ensure planning for Phase 4 (2035) is real demand-adjusted and considers the most up-to-date information.

Summary reporting will be to the Environment Strategy Programme Board and incorporated into the Environmental Strategy progress reports, as appropriate.

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- Batteries on page 13. Photo credit & licence details available from: https://en.wikipedia.org/wiki/Battery_storage_power_station#/media/File:Datacenter_Backup_Batteries.jpg Accessed November 2023.
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APPENDIX 1: GLOBAL CONTEXT

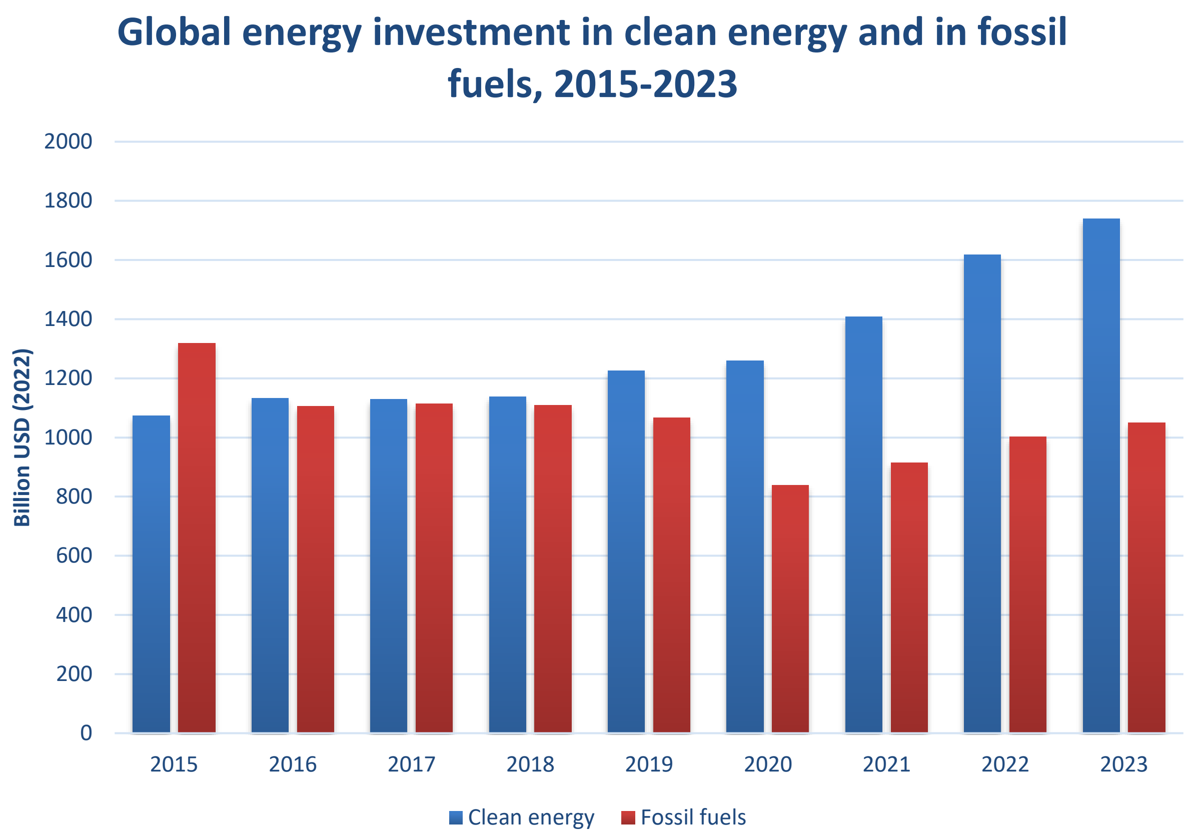

Figure A1.1. Global energy investment into clean energy and fossil fuels, 2015 – 2023. Values for 2023 are estimated. Source: IEA, Global energy investment in clean energy and in fossil fuels, 2015-2023, IEA, Paris https://www.iea.org/data-and-statistics/charts/global-energy-investment-in-clean-energy-and-in-fossil-fuels-2015-2023, IEA. Licence: CC BY 4.0.

As shown in Figure A1.1. global energy investment is moving away from fossil fuels to clean energy. However, there are still major energy-using sectors that rely heavily on fossil fuels, including transport. These sectors continue to contribute to emissions and to be exposed to volatile energy prices. In 2022 the war in Ukraine sent prices of non-renewables soaring and many governments had to step in to avoid an energy crisis. This involved subsidising energy costs for the consumer and reducing dependence on Russian energy sources. Although costs for new solar PV and wind installations have increased globally, reversing a decade-long cost reduction trend, gas, oil and coal prices have risen much faster[18]. Recovery after the covid-19 dip and the subsequent global energy crisis, with high volatility in fossil fuel prices, have driven significant investment in clean energy, with investment rising faster for clean energy than fossil fuels in recent years. 1.7 trillion of the 2.8 trillion US Dollars expected to be invested in energy in 2023 is anticipated to come from clean energy[19] (Figure A1.2).

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[18] IEA (International Energy Agency; 2023). https://www.iea.org/news/clean-energy-investment-is-extending-its-lead-over-fossil-fuels-boosted-by-energy-security-strengths

[19] IEA (2023), World Energy Investment 2023, IEA, Paris https://www.iea.org/reports/world-energy-investment-2023, License: CC BY 4.0. Accessed 11 August 2023.

This trend is expected to continue, with the growth of the world's capacity to generate electricity from renewables set to accelerate. By 2026 global renewable electricity capacity is forecast to rise more than 60% from 2020 levels to over 4 800 GW – equivalent to the current total global power capacity of fossil fuels and nuclear combined. Renewables are set to account for almost 95% of the increase in global power capacity through 2026, with solar PV alone providing more than half. The amount of renewable capacity added over the period of 2021 to 2026 is expected to be 50% higher than from 2015 to 2020. This is driven by stronger support from government policies and more ambitious clean energy goals announced by states[20].

Much of annual clean energy investment is in renewable power (Figure A1.2). Low emissions power is anticipated to make up 90% of total investment in electricity generation in 2023. Investment in electric vehicles has also grown, and since 2021 global sales of heat pumps have undergone double-digit growth. Energy efficiency investment is significant but is expected to level off in 2023 due to increased borrowing costs, tighter household budgets and a slowdown in construction activity[21].

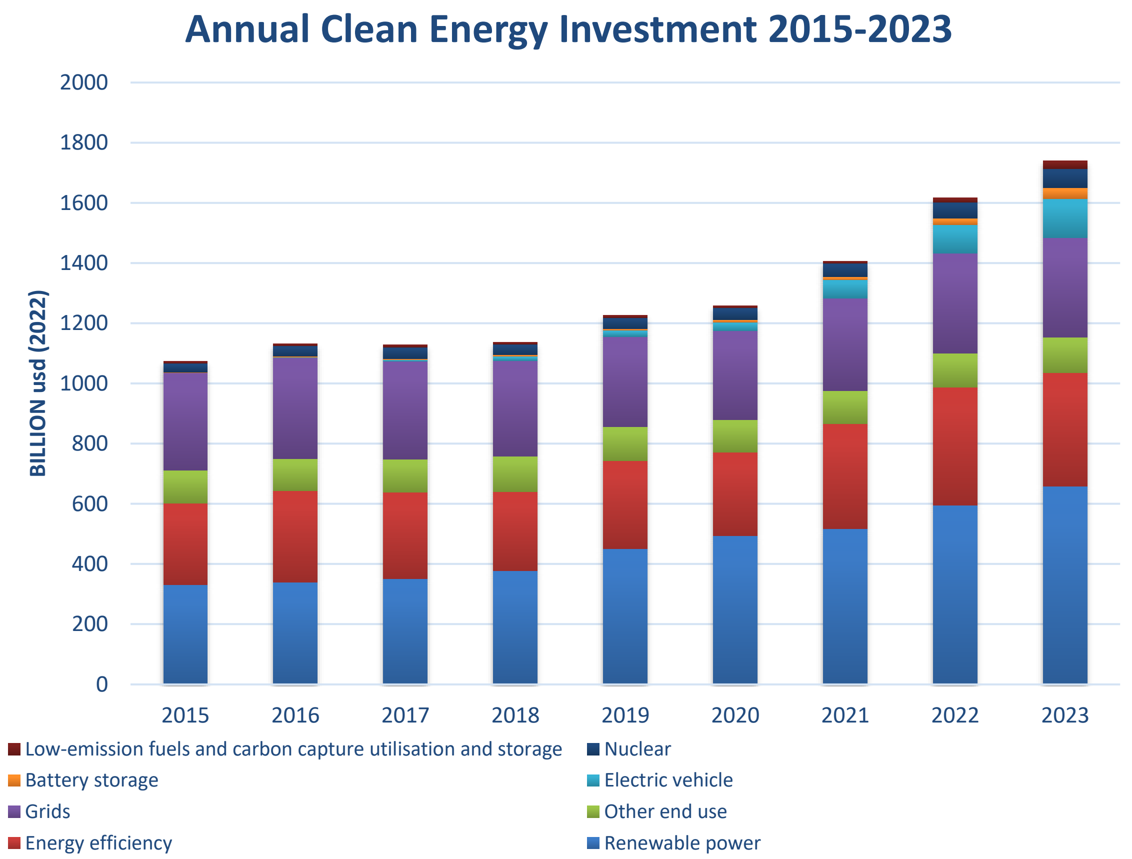


Figure A1.2. The worldwide annual investment in clean energy, 2015-2023. Values for 2023 are estimates. *Low-emission fuels* include modern liquid and gaseous bioenergy, low-emission hydrogen and hydrogen-based fuels which don't emit any carbon dioxide from fossil fuels directly when used and that emit very little during production. *Other end use* denotes renewables for end use and electrification in the buildings, transport and industrial sectors. Source: IEA, Annual clean energy investment, 2015-2023, IEA, Paris https://www.iea.org/data-and-statistics/charts/annual-clean-energy-investment-2015-2023, IEA. Licence: CC BY 4.0.

[20] IEA (2023). https://www.iea.org/news/clean-energy-investment-is-extending-its-lead-over-fossil-fuels-boosted-by-energy-security-strengths

[21] IEA (2023), World Energy Investment 2023, IEA, Paris https://www.iea.org/reports/world-energy-investment-2023, License: CC BY 4.0. Accessed 11 August 2023.

APPENDIX 2: THE FALKLAND ISLANDS CONTEXT

This appendix provides supplementary information on the Falkland Islands energy sector. Please note this information was collected during 2023 for public consultation in early 2024. To understand the progress already made since 2023 in the Falkland Islands energy sector, please see the Energy Strategy Implementation Plan.

Electricity Generation in Stanley

Electricity is generated in Stanley from a mix of wind energy (30%) and diesel generation (70%). Demand is highest in autumn and winter (Figure A1.3), partly from increased heating, and in waking hours (Fig. A1.4).

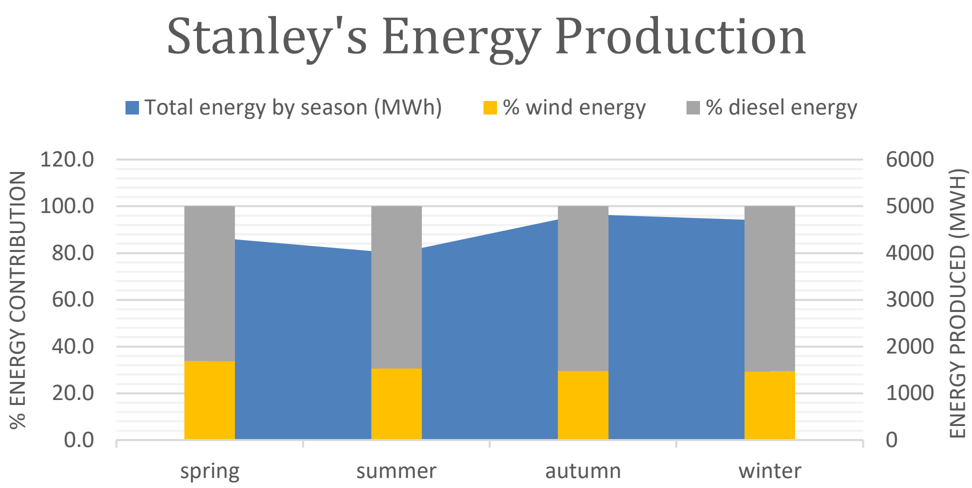


Figure A2.1. Energy delivered to Stanley from wind turbines and diesel generator by season (averaged for the period 2017-2018). The annual average production was 17,864 MWh, and wind contributed on average 31% of this[22].

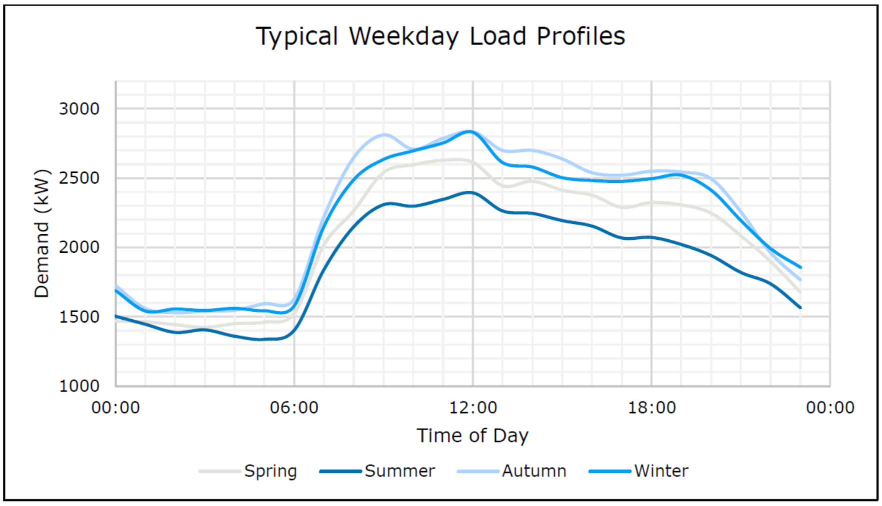


Figure A2.2: Typical weekday load profiles[23]; night time base loads are estimated to be higher in 2023 (¬2MW).

[22] 2020. Ramboll. Falkland Islands government power station energy feasibility study.
[23] 2020. Ramboll. Falkland Islands government power station energy feasibility study.

Stanley Power Station

The power station in its current state has been in operation since 19th May 1973 and now comprises of eight Allen Diesel generators producing between 320kW to 1.5MW of electricity into the Stanley grid network. Three of these engines are now 51 years old, exceeding their life-expectancy by 100%. An interim power station was developed in April 2020 and consists of three 2MW Cummins high speed generators which were designed to support the aging plant until a new power station is constructed. In 2022 it was found that one further generator unit was damaged beyond repair and as a result a new generator has been purchased. There is currently no capacity for storage of electricity at the station.

The existing power station has the capacity to generate a maximum of 6.6 MW, with Stanley requiring in excess of 17GWh of electricity per annum. The installed capacity is approximately twice the current peak load. This high level of redundancy is reflected in the operating hours recorded for the generators which show that each engine has operated only 20% to 35% of the time since commissioned.

Plans are in place to build a new power station (Islands Plan 2022-26), which is anticipated to generate electricity at 11kV. It will include battery storage to allow phased transition to renewables. Long term, this is intended to serve as a back-up power supply for Stanley when wind and solar generation are low for long periods that are beyond the capability of batteries to supply.

Sand Bay Wind Farm

The road to renewable energy for Stanley began to be realised when phase 1 of the Sand Bay wind farm came online in 2007; this represented early adoption of renewables by global standards. The 2007 installation consisted of three 330kW Enercon E-33 wind turbines. The success of this project meant that phase 2 (a further three E-33 turbines and three flywheel storage systems[24]) was commissioned and began contributing power to the grid in February 2010. Phase 3 was originally intended to expand the wind farm with the installation of three more E-33 turbines and battery storage capacity but was halted due to global events. Since the inception of this strategy, Phase 3 was approved by ExCo in November 2023 and procurement of wind turbines commenced in 2024.

The wind turbines generate power when wind speeds are between 2.5m/s and 28 m/s, meaning that for approximately a quarter of the year it is either too calm or too windy to harness energy from the wind. On average, just over 30% of Stanley's power requirement is met by the wind farm. There's significant potential to expand this to generate most of Stanley's power requirements. Though, some challenges, like sufficient storage or other back-up power will be needed for periods with unsuitable windspeeds. If additional generation capacity is installed at Sand Bay, another HV link will need to be installed to increase transmission capacity and redundancy.

One of the challenges the Falkland Islands currently face is that existing infrastructure of the roads and harbours cannot cope with the transport of larger models of wind turbines that are now available on the market. For example, Enercon have discontinued the E-33 model that are already installed at Sand Bay and have since developed more powerful and consequently larger turbines that would be difficult to transport into Mare Harbour by ship and over roads to their final locations. There is

[24] The flywheel storage system converts electrical energy into kinetic (movement) energy for a period of time, allowing it to be converted back to electrical energy when needed. This helps to 'dampen' the lag time between a surge in demand and the supply of electricity from the generators.

potential to expand the Sand Bay installation further, but updates to existing infrastructure would need to happen in order to unload, move and install bigger turbines.

The end of life of the phase 1 turbines is expected in 2027 with the phase 2 turbines following in 2030. Procurement of new wind turbines is currently in progress which would increase the resilience of renewable energy production as the current turbines reach end of life. Without these developments, Stanley risks becoming 100% reliant on diesel for energy generation.

The next steps should be to plan for Phase 4 of wind turbines to expand current generation capacity, i.e. the amount of power we get from wind.

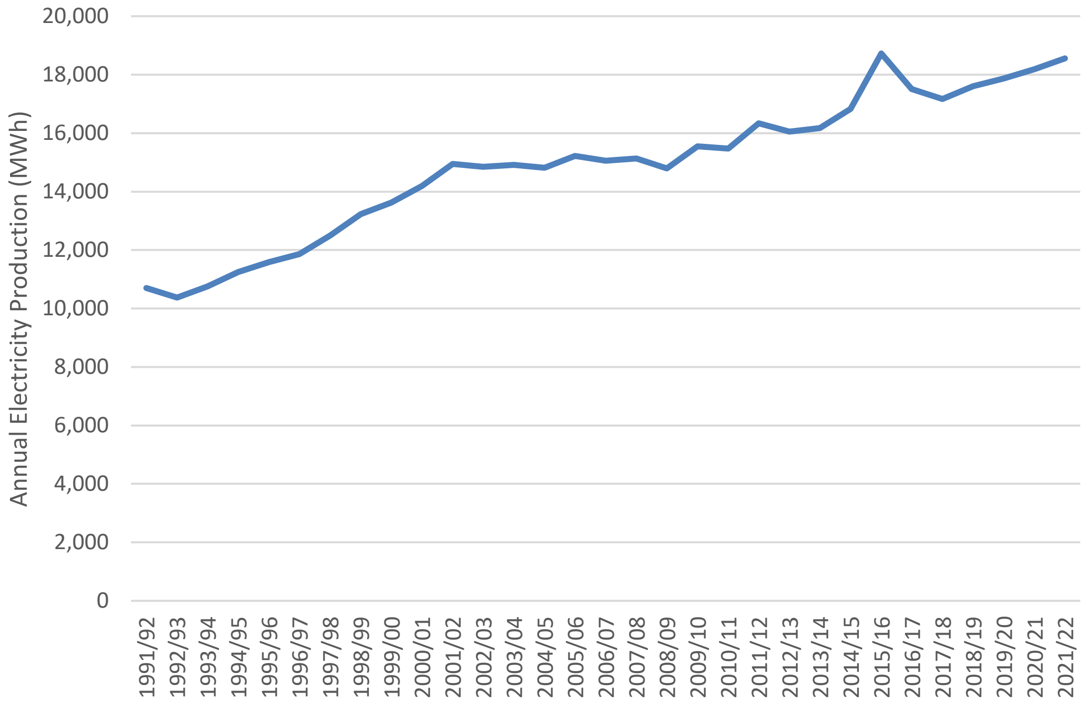


Figure A2.3. Provision of electricity in Stanley has grown in the past 30 years, reflecting our growing community.

Stanley Electricity Distribution Network

The distribution network of the power station stretches from Stanley Airport to the base of Mount Kent and includes the Pony's pass quarry and Falkland Islands Meat Company abattoir. The power station generates power at 3.3 kV and this is then stepped up to 11 kV via four step-up transformers. The new power station is anticipated to produce power at 11 kV so will not require step-up transformers for East and West Stanley. However, two step-down transformers will be required to continue to serve the old, central part of Stanley with 3.3kV[25]. Electricity that is generated is

[25] These step-down transformers are necessary as the infrastructure in the centre of Stanley cannot support the higher voltage expected to be produced by the new power station (11kV). To support a higher voltage the infrastructure would need to be replaced, which would include replacement of all substations and cables and digging up of the centre of Stanley. This would be technically challenging and require high capital investment and labour. For example, a single substation could cost as much as £120,000 (this amount has increased substantially in recent years).

distributed throughout Stanley in one of the three ring circuits that start and end at the power station; one serving East Stanley (East 11kV), one serving central Stanley (East 3.3 kV) and one serving West Stanley (West 11kV).

The East 3.3kV ring, delivers power to the centre of Stanley and has an aging distribution network with overhead lines. The PVC cables are degrading due to UV damage and lines are often damaged as the result of accidents, e.g. vehicles driving into poles. The cost and labour drain of constant replacement warrants a whole-of-life cost benefit analysis and feasibility analysis to determine whether cables should be moved below ground to reduce wear and tear. There are also presently challenges as a result of infill of houses in this area, which are placing a high and increasing degree of burden on the existing infrastructure. Due to limitations in the existing infrastructure it is challenging for this area to support rapid charging units for e-vehicles and continuous infill. It's technically possible to replace existing infrastructure to accommodate the delivery of greater power to the centre of town, but would be extremely costly and disruptive for the centre of town[26].

The design (and upgrade over time) for Stanley's distribution network has been structured to include as much of the network as possible on rings that begin and end in the power station and that include high voltage switching points. The advantage of this structure is that electricity can be re-routed in the event of a line being damaged, e.g. through accidental damage to lines during excavation or other works[27]. If a portion of the line is damaged, a ring main unit can be used to isolate the fault area and electricity can be fed through the other direction of the ring to continue to supply power until the fault is fixed. There remain parts of the distribution grid that are not served through ring architecture; they are on spurs, e.g. FIGAS. These spurs are more vulnerable to disruption from faults, because any fault would have to be fixed before power could continue to be provided to the spur[28].

Across the entire distribution network there are currently ninety-six substations that distribute and regulate the electricity generated from the power station around Stanley. A substation is where the higher distribution voltage is 'transformed' to a lower voltage that is usable in installations, namely 415V for three-phase, or 240V for single-phase supplies. Low voltage cables transmit power from these substations to installations either directly or via overhead lines or underground cables that service a small area.

In addition to maintenance and replacement of parts, the distribution network will require upgrade and expansion to accommodate growing demand and the development of further generating and storage capacity. For example, the move of the power station or connection of new wind turbines or

[26] As explained above, to support greater power delivery, infrastructure would need to support a higher voltage. This would require large-scale infrastructural replacement throughout central Stanley at significant cost and the digging up of roads and gardens.

[27] Accidental damage has occurred quite a few times in the past, where people have not obtained permission or checked with PWD before carrying out excavation works, for example. There is a significant cost of the damage, as well as disruption to electricity supply. Fines have been considered, but not been applied, as it was considered that there is a bigger risk that fines will discourage people from reporting accidental damage and make it very difficult for electrical engineers to find the fault. As it stands, it is difficult to get individuals to report accidental damage.

[28] The spur to SAAS has the potential to be converted to a ring structure in future. One solution to this is through the location of the new power station near Megabid, which will minimise the amount of infrastructure needed to close the loop. This would otherwise require the laying of cable and installation of other infrastructure to close the loop at the current site of the power station.

PV panels. Future developments around Stanley, such as new development related to the port, will require an eventual increase in the number of rings to feed specific loads.

It's essential to consider the constraints and requirements that the distribution network places on generation, e.g. wind turbines, PV panels, and storage technologies and to plan upgrades and solutions in tandem. For example, following a brown-out or black-out where the electricity generation needs to be restarted, substations require to first be magnetised before delivery of electricity can continue. This is currently achieved through larger diesel generator sets; alternative technologies will need to be sought to allow for magnetisation of substations to continue to be supported as diesel generation is phased out over time.

The distribution network is also not currently able to support the connection of private individuals to feed into or sell back to the grid. There are a number of reasons for this, including: 1) the safety of workers, 2) damage to infrastructure and personal property, and 3) unpredictable and significant fluctuations in Stanley's electrical demand that could lead to increased power cuts. First, if electricity can feed back into the grid, it means that even though the public electricity supply is disconnected, someone's private supply could suddenly come online and feed into the grid from the other direction, which could electrocute or injure people working on the lines. Second, it also means that if several solar arrays, for example, were connected on the same street it is expected to raise the voltage on the street which could damage/short out appliances in use in houses in the area[29]. Third, a significant issue would be the sudden increase in load when renewable production drops, e.g. when clouds come over and private generation falls off, which would place sudden and greatly increased demand on the Power Station. This makes the spinning reserve or quantity of energy storage needed unpredictable, and is likely to result in frequent brown-outs.

Currently Stanley's electricity supply is metered, with some properties with meters where readings are physically recorded and others where pre-paid cards are used. Pre-paid card meters are no longer available to purchase and will require replacement with another type in the near future. Smart meters would be a useful alternative, as they could allow multi-level electricity tariffs to shape our load curve and help control power demand. If electricity is cheaper after 6pm, for example, then people may well choose to do washing, cooking, charge their electric vehicles etc. after 6pm at a time when Stanley's electricity load is typically tailing off. This will help level-out peak demand so it is more consistent throughout the day. Many countries have or are transitioning to smart meters. Previously, limitations in the local internet provider's ability to handle data traffic has proved a barrier to smart meters. However, it will be worth re-evaluating this with current or near future projected internet availability and whether there may be alternative ways of overcoming this barrier.

Planned Developments in Energy Infrastructure

Current projects to build a new and updated power station in Stanley and the installation of solar panels at Sand Bay are underway.

[29] It is possible to mitigate this risk through the installation of zero-export meters to prevent feedback to the grid, but this raises challenges and additional human resource pressures and costs to regulate these devices and ensure they are operational. There are current examples in Stanley of these devices not working.

New Power Station

Proposals for the new power station have been approved (as of March 2023) and the Executive Council have given their approval for the development to continue in to the design phase (July 2023) before construction can begin, with an estimated completion now of 2028. The new power station is specifically designed to act as an intermediate solution for Stanley's electricity requirements as the upscaling of renewables are planned and implemented, gradually phasing out diesel generation to a back-up, emergency power role.

The new facility will house five engines, four capable of delivering 2.4 MW, and a fifth 1.6 MW genset to be installed in current power station and later moved to the new power station. The station is being considered to be fitted with battery storage with the capacity to increase storage as required. Two separate chimney stacks each with four flues will be used. Due to the local weather conditions and marine environment, the waste heat boilers will be located indoors. In order to reduce nitrogen oxides (NOx) emissions a selective catalytic reduction (SCR) system may be required. In terms of emissions, the new power station is expected to fall under the definition of a medium combustion plant by EU standards. It is recommended that the new power station follow EU standards, or alternatively the recommendations of the World Bank (IFC). There are proposals to create an air dispersion model and stack height determination calculation for the proposed station which will be used to determine the operational phase impacts from the project at key human health and ecological receptor locations. This will determine whether emissions produced by the new power station are in accordance with international best practice.

As FIG invests further in renewable energy infrastructure, which is proposed, the percentage utilisation or load factor of the diesel power plant is expected to decrease. This means that the new power station's main purpose will be to increasingly act as a backup or standby plant to supplement power when insufficient wind or solar energy generation is available.

The new power station will ensure energy security for the Falklands and reduce fuel usage (and therefore emissions) per unit generated due to increased efficiency built in to the new plant. It is expected that a new diesel generating plant would achieve an efficiency of approximately 42%. As the new power station's function is to principally supplement energy generated from renewables, the cost/benefit analysis requires a more extensive study to determine the overall cost of electricity generation in the Falklands with a view to providing a rational basis for the tariffs to be charged to electricity consumers. Rather than being viewed as a development that is expected to produce a return on investment there are a number of other associated benefits for the new power plant:

- Reduced atmospheric emissions
- Reduced risk of outages due to equipment failure
- Provide electricity in line with increases in demand
- Improve the health and safety of workers at the power plant.

Solar Farm Trial Installation

A solar farm trial is currently in progress; a Photo-Voltaic (PV) 12 kW array is trialled at Sand Bay Windfarm, alongside the existing wind turbines. The PV trial intends to collect data to establish actual energy yield through varying weather conditions and daylight hours at the site. Two separate arrays are being set up in order to evaluate which method is most suitable for the environment. One set of panels on the roof of the Sand Bay Substation building and another on a ground-mounted-frame oriented to capture the most sunlight. It is expected that data collection will last a total of three to four years before any expansion on grid-scale PV generation would be made.

Energy generation in camp

Aside from Fox Bay, energy in camp is generated through privately sourced means in the form of wind turbines, diesel generators and kerosene boilers, as well as solar panels. Renewable energy accounts for the majority of energy generated in Camp.

Previous incentive schemes, such as the rural energy grant and the household insulation grant, have resulted in a high uptake of renewable energy in Camp.

Heating and Cooking

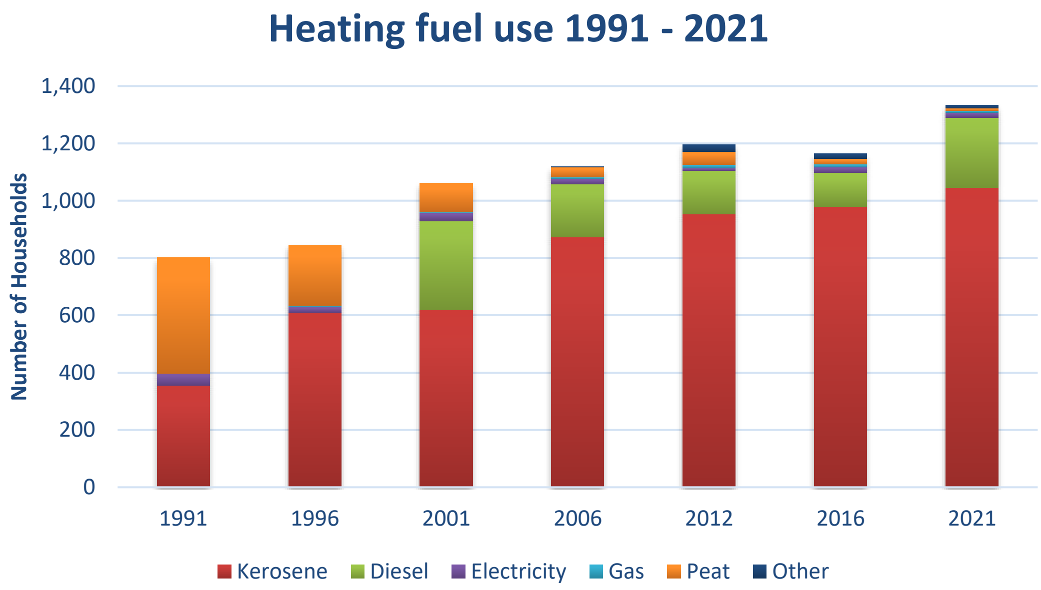


Figure A2.4. The number of households using peat as a heat source has declined through time, being replaced largely by fossil fuel boilers. Source: Census 2021 data.

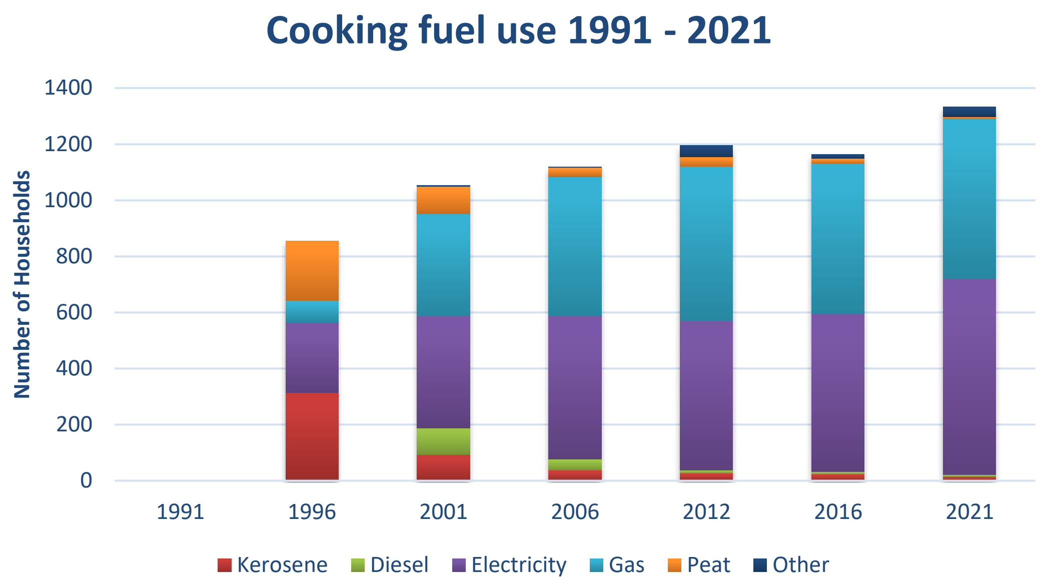


Figure A2.5. The number of households using peat as a cooking fuel source has declined through time, being replaced largely by gas and electricity. Source: Census 2021 data.

APPENDIX 3: TECHNOLOGY OPTIONS

Options for Stanley's Electricity Generation

The Falkland Islands Government has already begun investment in renewable technologies in construction of the Sand Bay Wind Farm. To further our commitment to increased use of renewables as well as reducing our reliance on diesel fuel sources, expansion of the existing renewable technologies will be required. In the Falklands, wind energy is considered to be the most consistent on a seasonal basis with around 20% variability throughout the year. In comparison, the amount of solar radiation available varies significantly, with sunlight levels in winter reaching only 12.5% of the summer level. This seasonal fluctuation in light levels means that an oversized amount of PV panels would need to be installed to meet demand during winter (when demand is highest and light is lowest) compared to the amount needed to supply electricity for the other 6 months of the year. This means high capital investment in a large number of solar panels as well as battery storage to supply electricity whenever light is low (including at night). It does offer lower operational costs, though, and less specialised maintenance (Table A3.1; Figure A3.1, A3.2).

Table A3.1. Comparison of solar photovoltaic panels and wind turbines.

Parameter	Photovoltaic per 10,000m^2	Wind Turbines per 500kw
Seasonal variation in output	12.5- 100%	82- 100%
Annual output MWh	1360.3	1536.63
Capital cost	Relatively higher	Relatively lower
Cost/MWh	85% more expensive than wind (estimated in 2020)	85% cheaper than solar (estimated in 2020)
Impact of the location	Location has minimal impact provided cells have an unobstructed view of the sun	Site needs to be in an exposed location with unobstructed aspect looking west
Design life	25 years	25 years
Maintenance requirements	Regular cleaning of glass, preventative measures for nesting birds and wildlife, replacement of inverters approx. every 10 years	Regular inspections, 6-month maintenance program
Unscheduled maintenance/ breakdown protocol	Very infrequent as no moving parts. Equipment quite basic so no need for specialist access.	Costs often covered by company warrants. Requirement of crane to replace high level/heavy components
Installation considerations	Terrain in the Falklands likely to be challenging for frameworks to support PV's. Windage of structure/PV will also require considerations. Requirement for strategically positioned substations depending on scale of arrays.	Turbines are typically spaced approx. 7x their rotor diameters apart so would require a large area. Existing infrastructure is limited- need to hire/purchase a suitable crane/lorry for transportation. Shipping constraints may also be challenging
Environmental considerations	Very little noise Visually a low-level impact but may cover large area	Visual impact substantial
Other considerations	Support structures/ fixings to consider the wind loading	Impact on bird life

If long term, large scale storage options become more viable in future, this could present an interesting opportunity to store excess energy from summer. It may also be worth exploring the possibility to export/sell excess energy production in summer months to help offset the high costs, but this relies on there being a way to sell off excess energy through shore to ship power (cold ironing) or through portable means (e.g. developments in hydrogen or other technologies that make it attractive to produce at small-scale).

Other renewable sources of power exist and these are summarised as part of the emerging energy technologies, in Figure A3.3.

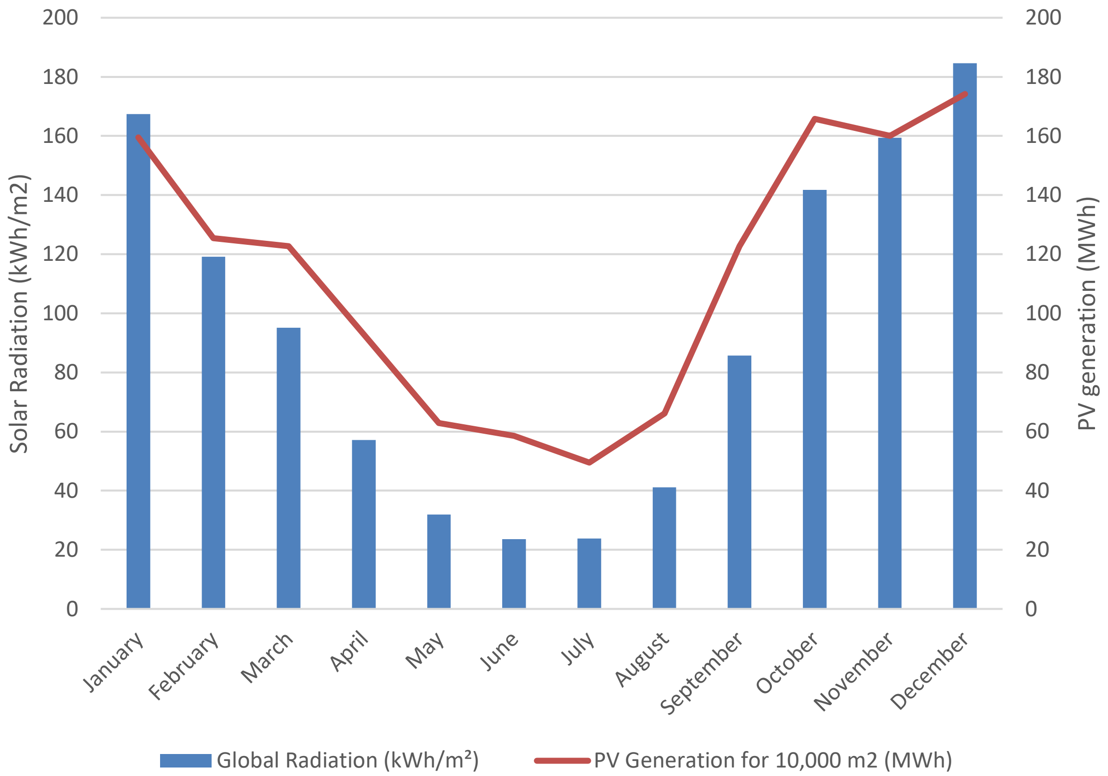


Figure A3.1. Solar radiation by month for Mount Pleasant Complex (for reference year 2000 – 2009) shows the low amount of solar energy available for photovoltaic (PV) cells during the 6 darker months of the year. This means a much larger area of 'solar panels' (PV cells) would be needed to supply sufficient electricity to Stanley throughout the year [30].

[30] 2020. Ramboll. Falkland Islands government power station energy feasibility study.

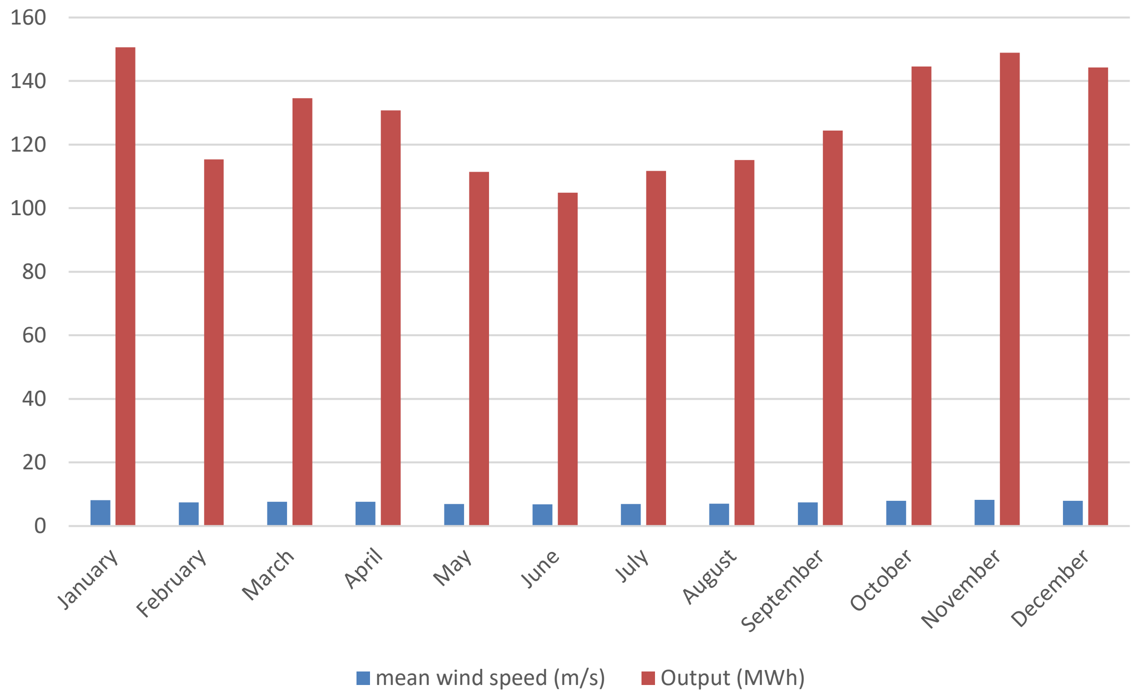


Figure A3.2: Energy generated from wind is fairly consistent throughout the year as is shown by the output for this 500 kW wind turbine in the Falkland Islands [31].

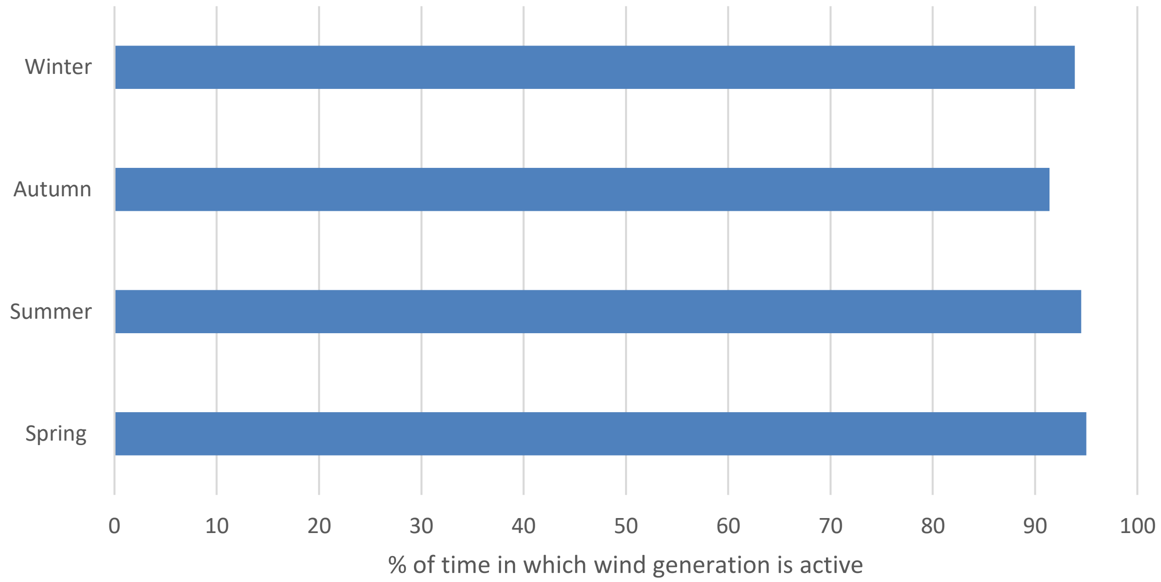


Figure A3.3: From Stanley power station seasonal data for 2017/18, it's possible to see that wind generation is active for most of the time throughout the seasons[14].

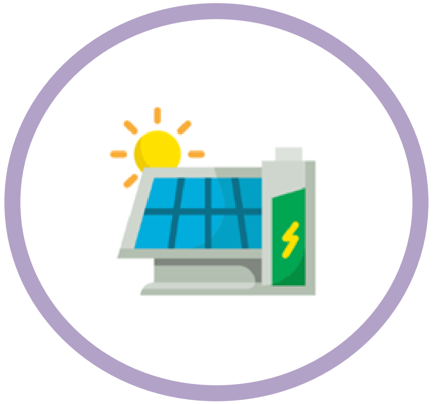
[31] 2020. Ramboll. Falkland Islands government power station energy feasibility study.

WIND TURBINES

Details: Converts kinetic energy of wind into electrical energy. Technical capacity to deliver the majority of Stanley's energy needs.

Strengths: Familiar technology and a high-wind environment. Battery storage available.

Weaknesses: Currently limitations as to when the energy can be harvested from the wind (between 2.5m/s and 28 m/s). Only smaller turbines suitable for installation in the Falklands due to limitations in transport and infrastructure.



SOLAR PANELS (Photovoltaics)

Details: converts sunlight into electricity by using photovoltaic (PV) cells. PV cells are made of materials that generate electrons when exposed to light. The electrons flow through a circuit and produce direct current (DC) electricity, which can be used to power various devices or be stored in batteries.

Strengths: No moving parts, limited maintenance/wear and tear. Easy to transport and install.

Weaknesses: Variable amounts of radiation available. Panels require regular cleaning.

WASTE TO ENERGY

Details: Gases produced from incinerators are used to drive turbines and generate electricity.

Strengths: Efficient ways to use non-recyclables, financially sound and creates jobs.

Weaknesses: requires sufficient amounts of waste and would only work for a small number of buildings.

Currently being considered in plans for the new Waste Management Facility and Power Station for surrounding buildings.

Figure A3.4. Emerging technologies currently considered feasible for electricity generation in Stanley. Note that waste to energy is more likely to be directly used for heating rather than converting the heat to electricity.

TIDAL

Details: Ocean tides/currents move turbines to create electricity

Strengths: Reliable and consistent

Weaknesses: Large environmental impact;
High biofouling and corrosion risks;
High installation and maintenance costs

WAVE

Details: Harnessing energy from the wind via waves for generation of electricity

Strengths: Reliable;
Many potential locations for installation

Weaknesses: High biofouling risk and corrosion risk;
Large moving parts and tech still in early stages of development

GEOTHERMAL

Details: Harnesses the natural heat from the earth for either heating or electricity generation

Strengths: Proven technology; Reliable and reactive

Weaknesses: Steep geothermal gradient, so boreholes required likely more than 1 km depth;
Expensive to build and maintain

VERY SMALL NUCLEAR

Details: Nuclear fission reactors smaller than conventional nuclear reactors

Strengths: Modular, best suited to smaller grids, very efficient

Weaknesses: Requires community acceptance and stringent health and safety protocols

SMART GRIDS AND DISTRIBUTED GENERATION

Details: electrical generation and storage performed by a variety of small, grid-connected or distribution system-connected devices referred to as distributed energy resources

Strengths: allows real time communication between grid and consumers so consumption based on individual preferences e.g. price

Weaknesses: needs stable and reliable internet connection; installation is expensive

Figure A3.5. In addition to solar and wind energy, there are other emerging technologies for generation. These are not currently considered suitable or technically feasible for the Falkland Islands.

Options for Stanley's Energy Storage

The ability to store excess energy generated from renewable sources would allow a greater proportion of the electricity used in Stanley to be provided by renewable means, reducing our reliance on fossil fuels. It would also help to mitigate the intermittent nature of the weather.

Energy storage allows a consistent supply of stored energy which can be ramped up or reduced quickly, giving the power supplier a capacity to react to changes in power demand, and prevent fluctuations in the power supply to consumers. This eliminates the impact of the variability in wind or solar and allow the power station to replace generation capacity if a generator drops out of the system for some reason. It also builds a mechanism for including other renewable energy generation sources in the future through the storage system.

Battery storage is the most feasible for the Falkland Islands in the short-term. Green hydrogen has some potential, but requires substantial investment in infrastructure. Green hydrogen may be worth investigating further to understand it's full potential as a long term storage option (i.e. to store energy over long periods), particularly as technology continues to advance in future.

Table A3.2. A comparison of storage technologies. Batteries offer the best initial investment for early adoption. Green hydrogen may be worth exploring as a long-term storage option, especially as technology advances, as will pumped hydro if any upgrades are planned for Stanley's water supply. Some of these storage technologies are emerging technologies and it will be worth monitoring their development for promising options for the Falkland Islands.

Type	Details	Strengths	Weaknesses
Chemical batteries	(Li-A) (Pb-A) Modularised battery units	Adaptable, variety of uses Amount of energy released vs amount of energy stored above 90% Technology now exists to achieve 100% renewable Variety of cost Fast reaction time	Disposal / waste implications Short life (10-15yrs)
Green Hydrogen	Produced using electrolysis of water with electricity generated by renewable energy	Can be stored for a long time, is very efficient and is abundantly available	Large energy demand for production, Efficiency of 35% High infrastructure costs Storage and transportation, Waste issues/ requirements
Compressed Air Energy Storage (CAES)	Uses electricity to compress air that is stored in underground caverns until released and passed through a turbine	Reactive power, Able to mitigate fluctuations in demand	Heat energy generated as a by-product
Flow cells	Vanadium flow batteries are most well developed	Design life of 25 years or more Minimal degradation of energy storage during product lifetime Relative low fire risk Ability to charge and discharge at the same time	Amount of energy released vs amount of energy stored is 75%

Type	Details	Strengths	Weaknesses
Hot sand	Stores additional energy as heat in sand	Sand abundant resource in Falklands	Not commercially available yet, costly to install
Pumped Hydro	Another reservoir at a higher elevation that generates power via a turbine as water moves down from one reservoir to another	High efficiency Long term environmentally friendly	Requires power to pump water back into the upper reservoir (recharge) Specific locations and geography are required Large initial financial outlay

Options for Home Heating

By far, the best way to save energy is to effectively insulate a building. This includes building envelope insulation, limiting draughts, and efficient windows and doors. The Falkland Islands has a standard for building insulation. However, this has not changed for some time and now falls substantially behind the UK. Before installing new heating technology in homes, it is critical to ensure that insulation and draught-proofing have been carried out. Checking the level of insulation in homes can be done relatively simply through engineering studies which can use techniques such as thermal imaging to check for leaks in the housing envelope.

Heat Pumps

Ground and air source heat pumps differ in performance, energy efficiency and costs and are somewhat suited to different climates. For instance, air source heat pumps are suitable for buildings located near the beach or windy areas and properties that do not have large gardens. Whereas, ground source heat pumps are more suitable for colder climates due to soil temperature remaining above 5°C year-round. Here we can look at a comparison between the two.

Table A3.3. A comparison of heat pumps, based on values from the UK.[32]

Factors	Ground Source	Air Source
Installation Cost	£18,000- £30,000	£10,000- £18,000
Performance (CoP)	3.5 – 4.5	2.5 – 3.5
Energy Consumption	3.5 -4.5 kWh (hourly)	4 kWh (hourly)
Approximate Running Cost (Yearly)	£1500 –£2000	£1200 –£1800
Carbon Emission	Low	Very Low
Maintenance Charges	£500	£500
Shelf Life	20 – 30 Years	15 – 20 Years
Heat Source	Soil	Air
Proficiency	100%	99.99%
Noise	No	Up To 60 dB

[32] Source: 2023. https://www.theecoexperts.co.uk/heat-pumps/air-source-heat-pumps-vs-ground-source-heat-pumps.

Costs

The additional cost for the ground source heat pump installation comes from the external work required on the land of the property where the heat pump is installed. Despite the greater upfront cost of installing a ground source heat pump, this type of pump is more efficient when it comes to heating your home. Improved efficiencies result in higher fuel savings and lower energy bills. It is estimated that over the course of an average year heat pumps save the user around 20-40% on their annual heating and cooling bills, depending on the cost of electricity.

Efficiency

How effective a heat pump is at heating a specific asset (in this case a building) has two factors which directly impact it. Firstly, the CoP (coefficient of performance) of the heat pump in the given situation (i.e. air source vs ground source and temperature differential required). Secondly, the parameters of the building in question (energy efficiency, type of heating system, size of building). Heat pumps are an effective use of electricity to heat a building with a typically high CoP, but if the building is draughty or poorly insulated those benefits can be quickly lost. Therefore, it is important that the building itself is as efficient and well-insulated as possible to maximise the heating potential of heat pumps.

On average a three-bedroom house in the UK typically uses 15,000 kWh of heat per year from traditional heating. However, because ground-source heat pumps are around three times more efficient than traditional heating methods, they can create the same amount of warmth using only 5,000 kWh of electricity annually. Air source heat pumps are slightly less efficient than ground source, but still offer an efficiency advantage. Of course, actual electricity consumption depends on the unit specifications, outdoor temperatures, user's settings and a property's insulation and should be taken account of in improvement schemes.

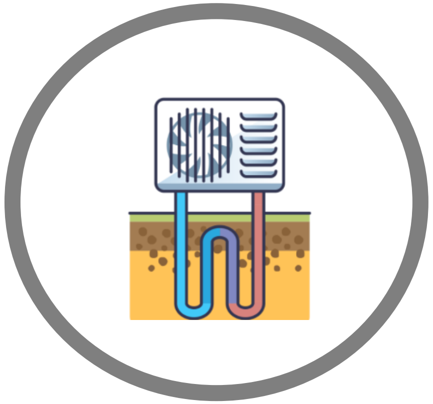
There are several installations of heat pumps in domestic applications in the Falkland Islands, with FIG adopting the technology in new build government accommodation in recent years.

AIR SOURCE HEATPUMPS

Details: Standalone unit which captures and transfers heat from outside air to both water and air indoors

Strengths: Very efficient in terms of the heat produced relative to the amount of electricity used

Weaknesses: lower heat supply compared to traditional boilers; sufficient space is needed for installation and may require operational costs



GROUND SOURCE HEAT PUMPS

Details: Heat is transferred from the ground via circulating water in underwater pipes and pumped to a heat exchanger in the house

Strengths: Temperatures are more stable in the ground, so these use less electricity than air source heat pumps; long lifespan; and require minimal maintenance

Weaknesses: Expensive and more suitable for new properties under construction; requires substantial space surrounding property

SOLAR HOT WATER HEATING (Solar Thermal)

Details: Absorbs radiated energy from the sun which heats fluid which is transferred to a coil within a specially designed hot water cylinder and stored until use; currently being installed in new builds in Stanley

Strengths: Low maintenance and simple technology compared to PV panels; can be integrated into existing structures easily

Weaknesses: Start-up costs are expensive and system is limited by sunlight levels

Figure A3.6. Renewable technologies for home heating.

Energy Use in Industrial/Commercial/ Public Premises

The commercial, industrial and public sectors have a variety of facilities and equipment that consume energy. Given that many of the commercial/public buildings were not originally built with energy efficiency as a key priority, the potential for energy saving is very high. In the Falklands, over 50% of energy consumption is from these sectors[33]; the majority of the energy is used to provide services like lighting, ventilation, cooling and hot water. In addition to reducing emissions and the private and public sector showing their commitment to better environmental outcomes, by reducing energy use, there are also cost savings to be made.

In terms of heating of buildings, much the same options exist as for domestic properties, such as heat pumps. However, other energy use and efficiency options as well as alternative renewable technologies within the commercial sector may be unique to different businesses. Organisations can do a simple assessment of their energy use, plan and implement reductions (e.g. see Box 1 for advice).

Box 1: A quick guide to improving energy efficiency in commercial/public buildings

- Planning and creating a strategy for energy saving
- Setting goals specific to the organisation/company i.e. reducing the spending on electricity by 25%
- LED bulbs and lighting controls e.g. motion sensors or timer controlled
- Installation of thermostats
- Install solar thermal arrays on to roofs for hot water supply
- Install energy efficient boilers
- Conduct thermal imaging study to assess insulation gaps then:
    - Improve insulation e.g. cladding, draught management, triple glazing, cavity wall insulation
    - Produce annual energy audit to track and monitor energy consumption

[33] Based on PWD electricity use data in Stanley in summer 2022/23.

APPENDIX 4: ENVIRONMENTAL AND HEALTH CONSIDERATIONS

The handling, transportation and burning of fossil fuels are a pollution risk, with associated health and environmental impacts, and are a source of carbon emissions for the Falkland Islands.

Reducing the use of fossil fuels in power generation, home heating and cooking is expected to have benefits for public health. By replacing and moving the power station away from the centre of Stanley, where it is currently close to residential areas, the school and hospital, air quality is expected to improve in these areas. Fitting technologies that don't rely on combustion for heating, like heat pumps, should also improve air quality in homes. Transitioning to renewable power is essential to further reduce emissions (air pollution). This includes reducing reliance on diesel for energy production through reducing use of the power station and using clean energy to power homes.

Human Health

As the power station is old, much of the equipment is outdated and is no longer manufactured. This means that repairing broken parts in difficult and the equipment no longer meets safety standards in the UK. Furthermore, the burning of diesel emits a number of harmful chemicals into the surrounding environment which negatively impact human health. The prevalence of diesel-powered engines makes it near-impossible to avoid exposure to diesel exhaust and its by-products, including here in the Falkland Islands. Furthermore, the current power station is situated next to the school, leisure centre and hospital, emitting pollutants close to people that are most vulnerable to the deleterious effects of air pollution.

The health effects of breathing in diesel fumes are well-documented. Chemicals such as arsenic, nickel and benzene are produced from the burning of diesel. These microscopic particles are small enough to penetrate deep into the lungs and contribute to a range of health problems including cell mutations that can lead to cancer. Long-term exposure to diesel fumes poses the highest cancer risk of any toxic air contaminant. Studies show that workers who are regularly exposed to diesel fumes are more likely to develop lung cancer than those who are not exposed to diesel emissions. As an example, in California one study estimated that approximately 70% of the cancer risk that the average inhabitant faces are associated with breathing in diesel exhaust particles[34].

Exposure to diesel exhaust fumes can also have immediate health effects such as irritation of the airway and eyes, headaches, light-headedness and nausea. The fumes can also exacerbate pre-existing medical conditions such as asthma and hay fever. This often disproportionately affects the most vulnerable in the population, including children, the elderly and the infirm. Children's lungs are especially affected as their respiratory systems are still developing; exposure to diesel exhaust can cause childhood illnesses and can reduce lung function[35].

Although the new power station should somewhat mitigate the ill-effects of diesel exhaust in Stanley due to more energy efficient equipment, the installation of air quality monitors, regular stack testing and a plant that is located out of Stanley, it will still ultimately remain as a major pollution source. For

[34] Accessed 2023. https://oehha.ca.gov/air/health-effects-diesel-exhaust

[35] Manisalidis, I., Stavropoulou, E., Stavropoulos, A. and Bezirtzoglou, E., 2020. Environmental and health impacts of air pollution: a review. Frontiers in public health, 8, p.14.

this reason, the transition to unpolluting renewable energy sources must remain as the primary objective as diesel is phased out from use.

Gas and kerosene, two popular fuels for heating and cooking in Stanley, are also pollution sources. Indoor air quality is impacted by both indoor and outdoor sources as particles can enter through doors and windows, as well as gaps in buildings. Gas and kerosene produce high levels of PM2.5 (particulate matter) and NO_2 (nitrogen dioxide) with studies showing that a large fraction of particulates enter indoors and can affect health. This is alarming as many people spend the majority of time indoors. Therefore, improving indoor air quality is of substantial importance in our efforts to improve public health.

Environmental Considerations

Fossil fuel derived pollutants can increase levels of nutrients and carbon dioxide. Once in nature, many pollutants remain and tend to accumulate. These can disrupt healthy ecosystems and are the cause of acid rain, harmful algal blooms, soil contamination as well as a number of other negative impacts.

Air pollution can damage crops by reducing growth and survivability of seedlings, as well as impacting the quality of soil. Acid rain caused by sulphur dioxides (SO_2) and nitrogen oxides (NOX) emissions in the atmosphere can cause damage to waterways by increasing acidity. This results in more aluminium absorption from soil, making the environment toxic for organisms. Pollutants can slow growth rates, cause disease and make plants and animals more vulnerable to fluctuations in temperature. In some cases, these pollutants can inhibit an organism’s ability to reproduce. It also reduces the ability of ecosystems to provide services such as carbon sequestration and decontamination.

Climate Change

Whilst reducing greenhouse gas emissions to mitigate climate change will impact energy decisions, climate change will also undoubtedly impact the day to day running of energy generation infrastructure. Increased frequency of storms including wind and flash flooding may severely impact the generation and distribution of electricity around Stanley. UV radiation compromises the structural integrity of many materials, and so increased weathering of external infrastructure may result in a reduced life expectancy of many component parts of the energy generation and distribution network. It’s therefore important to consider building in resilience to climate change in design and implementation of energy infrastructure and operation.

APPENDIX 5: ELECTRICITY PROVISIONING CONSIDERATIONS

Provisioning for energy is a complex process that requires careful planning, investment and regulation to ensure that the Falkland Islands energy needs are met in a safe, reliable and sustainable manner. Different methods of energy provisioning exist around the world, from fully public to fully private provision. Numerous factors can influence which model of energy provisioning should be adopted to best suit local needs. In order to understand how different models might impact the Falklands, the advantages and disadvantages of each are presented in Tables A4.1 to A4.3 below.

Table A5.1. Fully private electricity provision, i.e. a privatised energy sector.[36]

Pros	Cons
Private firms have pressure from shareholders to perform efficiently in order to maximise return on investments	No dividends are distributed to the government and are internalised by shareholders
Long term view not impacted by current state of government	Short-term goals to increase profits may impact investing in long-term projects
Lack of political interference: more focus on business and economics than political pressures	Public interest in the form of energy security should not be profit driven and focus should be on the most affordable option for consumers
Profit incentive to cut costs and increase efficiency, although this doesn't always hold true in the Falklands due to the effect of monopolies and oligopolies inherent in such a small community	Public interest in the form of energy security should not be profit driven and focus should be on the most affordable option for consumers
Increased competition as a result of de-regulation which can increase efficiency	Natural monopoly can set higher prices and exploit consumers which cannot be regulated
Selling state owned assets to private sector can raise significant capital	Lack of responsibility due to fragmentation of industries

[36] Sources: Accessed 2023. https://finmin.lrv.lt/en/competence-areas/public-and-private-partnership-ppp/ppp-advantages-and-disadvantages?__cf_chl_tk=pW4ITUp271RhNV3I_k9vCjVejkyBRRhH9R8c6ikKI.I-1699541996-0-gaNycGzNDXs ; Accessed 2023. https://www.local.gov.uk/publications/public-private-partnerships-driving-growth-building-resilience

Table A5.2. Fully public energy provision, i.e. a nationalised energy sector[37].

Pros	Cons
Delivery of a consistent supply of energy to the population with public interest rather than profit	Lack of efficiency as profit incentive is absent which can drive up costs than if the energy sector was subject to market forces
Capital mobilisation: profits generated from the corporation can be mobilised and used for improving infrastructure	Potential for industry to be under-funded as a result of government investing in to other aspects of the economy
Eliminates the risk of monopoly exploitation as the government defines	A lack of competition can stop firms from entering the energy industry which in turn can decrease the competitiveness of the market
Increased sustainability by regulating renewable energy that may otherwise not be fed in to the grid	Reduced efficiency and productivity as government bureaucracy may slow down decision-making and implementation
Long-term goals may be more achievable as there is no stakeholder pressure for a return on investment	Potential to run at a loss or deficit which could result in funds from key areas being diverted to support nationalised energy industry
Increased transparency; if energy price rise, FIG has a greater ability to intervene and protect vulnerable community members	Deter inward investment which may prevent technology transfer

Table A5.3. Public-private partnerships (PPPs) for energy provision[38].

Pros	Cons
Access to financing: PPPs would allow for the FIG and an external partner to pool resources and expertise to increase generate increased capital than if sectors were stand-alone	More expensive due to the additional costs of the private sector including profit margins and management fees
Increased innovation and efficiency which can result in cost savings and increased productivity	Can be more expensive as are more complex models that require significant negotiation and management which can result in project delays and increase overall costs
Risks are shared between both sectors enabling both parties to leverage strengths and reduce weaknesses	Risk of private sector dominance in decision-making and control over the project in order to prioritise their agenda
Improved project management with the private sector bringing more rigorous project management, which in tun can improve service delivery	

[37] Accessed 2023. https://www.learn-economics.co.uk/Nationalisation.html

[38] Nduhura, A., Lukamba, M.T., Molokwane, T. and Nuwagaba, I., 2022. Non-compete provision: implications for stakeholders of public private partnerships in the energy sector of a developing country. International Journal of Public Policy, 16(5-6), pp.311-332.

APPENDIX 6: CHALLENGES AND OPPORTUNITIES

Energy challenges and opportunities for the Falkland Islands include:

- **Future demand needs, while almost a certainty to increase, are subject to vary in how fast and exactly when they increase.**
    - Increase is not likely to be linear or smooth:
        - Developments that would be considered small on a global scale, can have a huge impact on overall demand. For example, the new waste management facility could add an extra 600 kW demand when operational.
        - Changes to business operations occur at high speed in response to market and other changes, can result in very rapid changes in demand. e.g. if SAAS needs to create a significant expansion in number of freezer containers in operation at any given time; a planning application in August 2023 had a 2.1MW demand, which is the same as the entire night time load of Stanley when SAAS and the abattoir are in operation.
    - It's hard to predict the rate at which the public and business will shift to electric vehicles (or other electric plant) and heat-source air pumps, which rely on electricity.
- **Single points of failure need to be avoided to ensure energy security.**
    - Improved climate change resilience recommends no single source of energy generation for a system. As most renewable generation is weather dependent, it seems sensible to adopt a hybrid approach to allow for redundancy.
    - Single points of failure could include the failure in the generation, distribution and storage system, e.g. a cable to or from critical infrastructure. A preliminary analysis has been undertaken, but is not included in this public document for security reasons.
    - This often means additional expenditure to ensure sufficient redundancies for energy security.
    - Future decisions on redundancy should be based on a risk-impact analysis, with critical services taking priority.
    - There may be some single points of failure that cannot be mitigated, and these need to be acknowledged and planned for response in case of failure.
- **Wind turbines are getting larger and we are market-takers, so we will be required to buy from available technology.**
    - Infrastructural issues may pose a challenge for getting very large windmills onto the Islands, for example port facilities and cranes to unload large parts and heavy weights for transport by road
    - With larger wind turbines, a fault with a single turbine will have a greater impact. For example, if one of five small wind turbines break you would only lose 1/5 of the power (20%); if one of two large wind turbines break you would lose half your power (50%). This drives the need for greater redundancy in the system (i.e. the need to have more wind turbines than just to meet the maximum projected demand), in case of maintenance or damage.
- **Solar panels have low production ability during the winter** (as little as 12.5% of summer levels), **necessitating larger number of solar panels (redundancy in summer) at high capital cost**.
    - If excess energy generated in summer could be supplied (sold) to additional users in the Islands (e.g. shore to ship power), stored into energy forms that are either transportable (for sale or use elsewhere) or to store large quantities over long periods, then this could be an opportunity

to help offset the cost of the large capital investment in solar (high level of panels required for winter). At present these options are limited, but may be worth re-evaluating in future as technology and opportunities change.

- **Whole of life costs and feed-on impacts on long-term delivery of goals need to be considered in investments to help avoid investments that focus on short-term savings, over long-term effectiveness and cost**, especially given labour shortage in the Falklands.
    - Whole of life costing to evaluate alternatives
    - Whole of life costs can include, installation, operation, maintenance, replacement, decommissioning and waste management
    - Dependencies and side benefits/costs should also be considered,
        - e.g. investment in a crane to allow for unloading of wind turbines from port may carry a high cost and add to the cost of wind turbines, but could have side benefits for allowing other use / movement of heavy goods on and off the Islands
        - e.g. short-term cost reductions, such as not including static VAR compensators into the design of the new power station, could impose longer term limitations on expansion of proportion of renewables.
- **Consider economic, environmental and social costs and benefits when evaluating alternatives, as far as possible,** e.g. health benefits of reducing emissions, realistic cost estimates for electricity from different sources
- **Connection challenges on current distribution network**
    - The network cannot support private sources (e.g. renewables) feeding back into the grid
    - Connection costs for new users need a method of cost determination to ensure equitable distribution of costs for new users
    - Connection for new users' needs to consider avoiding issues on excess demand created by infill on the existing grid
- **Upgrade to renewable technologies requires upgrades to multiple elements of the grid, not just generation, for example:**
    - Static VAR compensators will be required to allow for reactive power demands to be met. Currently the reactive power element of demand can only be met by conventional diesel generation. Renewable technologies (particularly wind and solar) do not generate reactive power, only real power. A Static VAR compensator is a device which injects reactive power onto the grid as required. There are other devices which carry out a similar function, but all provide that reactive power element that is required.
    - Technology to allow magnetisation of substations following a brown-out or black out to allow power to continue to be fed to the grid.
    - If generation is centralised at Sand Bay, a second HV link to Stanley will be required to increase transmission capacity and provide needed redundancy.
- **Acquiring and keeping skilled and experienced professionals to work in the public energy sector**
    - Few people on the Islands are pursuing relevant fields in the energy sector for further study.
    - The current public energy sector workers often leave their roles due to better pay and conditions in the private sector. Recruitment to replace them is extremely difficult due to the relatively low salaries offered.
    - In future additional skills will be needed to adapt to the growth of renewable technologies and more modern infrastructure, so that there are skilled people to install, run and maintain it.