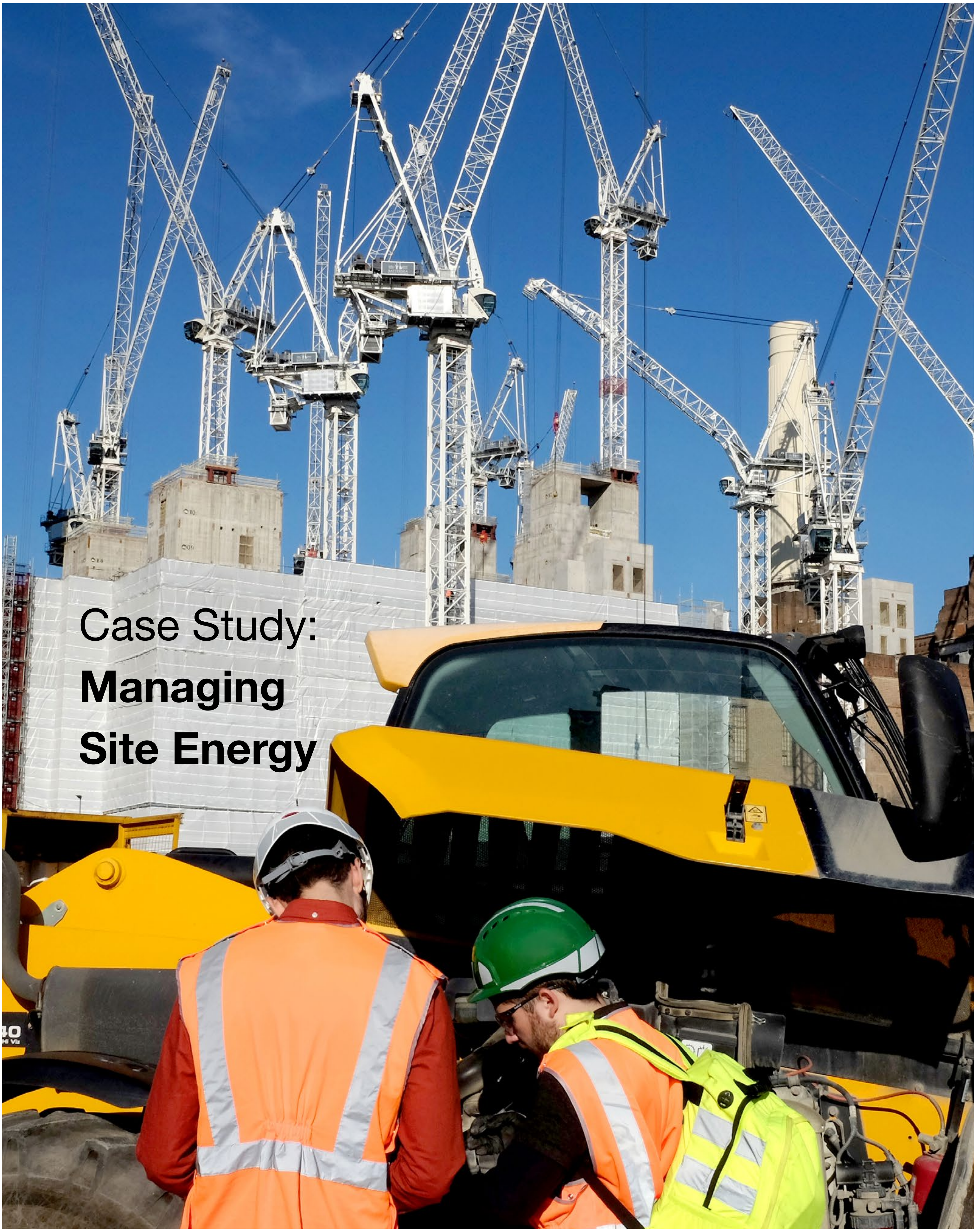


Case Study: **Managing Site Energy**

RSP Regulatory Services Partnership

MERTON LONDON BOROUGH

LONDON BOROUGH OF RICHMOND UPON THAMES

THE BRIGHTER BOROUGH Wandsworth

Speedy GreenPowerHire

Erith

Outline

Energy demand and power solutions are vital considerations to the UK carbon agenda. Not only do we need to move rapidly towards renewable energy, but we also need to better manage the supplies which we have. Generators remain reliant on fossil fuels, LPG and HVO, and will continue to be so for the near future.

The need for a cultural change is especially clear within the Construction & Demolition Industries, where there is a self-driven desire to accelerate the decarbonisation process. In London, a regulatory framework is in place against which appropriate traction has been established. Key projects such as the London Construction Low Emission Zone are assisting in the push for cleaner engines and the uptake of alternative technologies. The non-road mobile machinery [NRMM] fleet in London is likely to be the cleanest in the world.

Traditionally, sites would fulfill their power demand through the deployment of 'over-specified' generators, in order to cater for the site power demands. Specifying a considerable headroom of power availability has been an accepted practice over many decades. As the power demand increases, it has been a simple matter of specifying larger and/or additional machines.

Generators are the single biggest contributor to CO_2, PM and NO_x emissions on site. In London they represent 11% of the fleet by number, but are responsible for 61% of the particulate, 43 % of NO_x and 36% of overall CO_2 emissions from NRMM. (Figures based on inspections of the deployed construction fleet)

The reason for this disproportionate contribution is that they are large, powerful pieces of equipment that can run for very long periods of time, often with complexities arising from low exhaust gas velocity and temperature.

The ideal solution would be to electrify sites before any work commences, thus removing any need for generator deployment. This is often however, logistically difficult or requires significant enablement groundwork.

In order for sites to properly and more fully address the issue of Air Quality & Carbon, a new focus on power management needs to take place. Technology is moving very quickly, and we are seeing new power supply solutions and practices on exemplar sites. The introduction of battery packs, and of battery packs tethered to generators, minimises the size of the generator required and better manages the load versus the demand.

Ideal solutions for sites would follow the following hierarchy:

- Connection to an adequate power supply (ideally from a renewable source)
- Connection to an inadequate power supply with demand managed through the addition of battery storage.
- Pure battery storage / normally charged off-site and brought on.
- Low emission diesel generators tethered to battery to manage supply.
- Low emission generators only.

Note: The rapid development and subsequent availability of hydrogen-fuelled generators is likely to enter into this hierarchy soon.

In order to achieve the best outcome for construction sites, the consumption of power should be a key consideration at the planning stage, alongside the established environmental and construction logistics plans. This will benefit air quality, reduce carbon emissions and reduce fuel consumption, as well as drive innovation and competition in the generator industry. In the process, some of the strain on the UK power network shall be relieved.

In this case study we review a ‘real-world’ case of a generator tethered to batteries to allow the generator to be used less, and to operate in the most efficient loading zone.

The motivation for this approach for the construction project was to explore innovation, reduce toxic pollutants and minimise carbon impacts. Additionally, this method can reduce fueling costs and the need for road-based delivery of fuel.

Our thanks to Erith Group and Speedy Hire for their collaboration and sharing of source data.

Site Intro

At Cotswold Road in the London Borough of Sutton, the derelict former Sutton Hospital buildings are being cleared to make way for state-of-the-art modern facilities which will form part of the new world-leading campus for cancer research and treatment. The regeneration of the site is expected to create 13,000 jobs in construction, health, science and education and bring significant investment into Sutton.

The soft strip, tree removal, asbestos removal, and demolition work is being carried out by Erith Group, who are using a Battery Energy Storage System supplied by Speedy Hire.

From 21st August to 2nd October 2024 Merton Council NRMM Officers were permitted access to the site and to the online telematics data, in order to estimate independently the degree of fuel and CO_2 emissions savings during this approach.

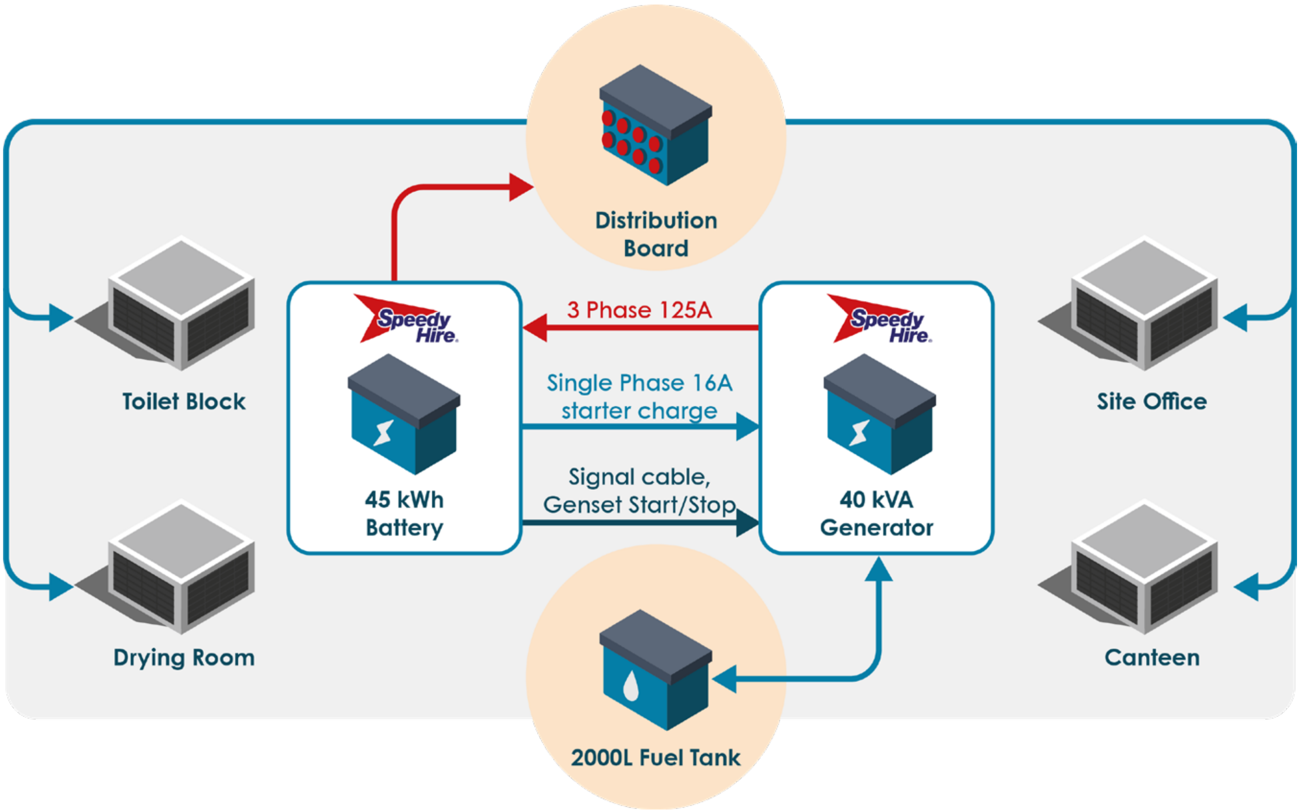
The Application

The power requirements on site were for 4 welfare cabins: one office, one canteen, one drying room and one toilet block. These contained all the appliances you would typically expect, including laptops, space heaters, water heaters, lighting, kettle, microwave, air conditioning, fridge, radio chargers etc.

The site operated a 40kVA generator alongside a 45kWh battery. The generator was to run for around 4 hours per day, taking the site load and additionally charging the battery. The battery would for periods reach a sufficient level of charge to take over from the generator, enabling the generator to shut down. This increases the efficiency of the generator (due to the increased load), and reduces the overall generator run time.

The battery monitors its own state of charge and ensures that it is at 100% charge at the end of the working day, so that the battery power will last through the night. The battery is also phased so as not to allow the generator run at unsociable hours to mitigate against noise disturbance.

Battery demand schematic:



Calculating the impact (Methodology)

Generator fuel consumption is typically only advertised at a 75% loading. However, generators do not ordinarily run at such a high load in construction industry 'real-world' deployments. As part of this case study therefore, we needed to create a tool that estimates fuel consumption at any given generator load, most particularly at low loads (<25%).

There are reference tables available online that estimate the fuel consumption of different sizes of generator at various load. We did not make use of any reference tables that suggested a completely linear relationship between load and fuel consumption. This would suggest that at zero load, there is zero fuel burned. In reality we know that as load increases, the kWh per litre burned also increases.

This source data is summarised in Appendix 1, but the tool is designed to be a prototype, with scope to incorporate more source data, as and when it becomes available to us.

Extrapolating trendlines from the fuel consumption at 25%, 50%, 75%, and 100%, the tool can estimate the difference in fuel consumption at any two loading points. For example, if the advertised fuel consumption is based on a 75% load, but we need to know the fuel consumption at 14% load, the tool will compare the average fuel consumption of all generators in the source data at 75% and at 14% on the trendline. It will give the difference as a factor (for 75% to 14% this factor is 0.304716283). We then multiply the advertised fuel consumption by this factor.

To complete this case study we were given full access to the site and battery telematics, the key pieces of information being the generator run time, kWh consumed by site appliances, and kWh produced by the generator. From this we were able to calculate the average load on the generator, and what the average load would have been if the generator was running on it's own without battery support.

This modelled approach has been fairly accurate in the real-world cases we have tested it on. In this particular case, actual fuel usage with the BESS support was 8% lower than the value estimated by the tool.

Findings

We estimate that by using the Battery Storage System, the following benefits were obtained:

Reducing generator run time by 859 hours (85%)

Reducing fuel consumption by 895 litres (57%)

Reducing CO_2 emissions by 2.35 Tonnes

This is in comparison to a scenario where the generator was instead run 24 hours per day to fulfill the site power demand.

In addition, we also estimated the fuel use in a scenario where the generator had been running for 10 hours per day, and then switched off at night. In reality, this could compromise the site's duty of care to employees, starting the day without hot water, and possibly with wet personal protective equipment. However, it is interesting to note that the battery and 40kVA generator working together and providing power around the clock, would still use 170 litres less diesel than a generator powering the site for just 10 hours per day on its own.

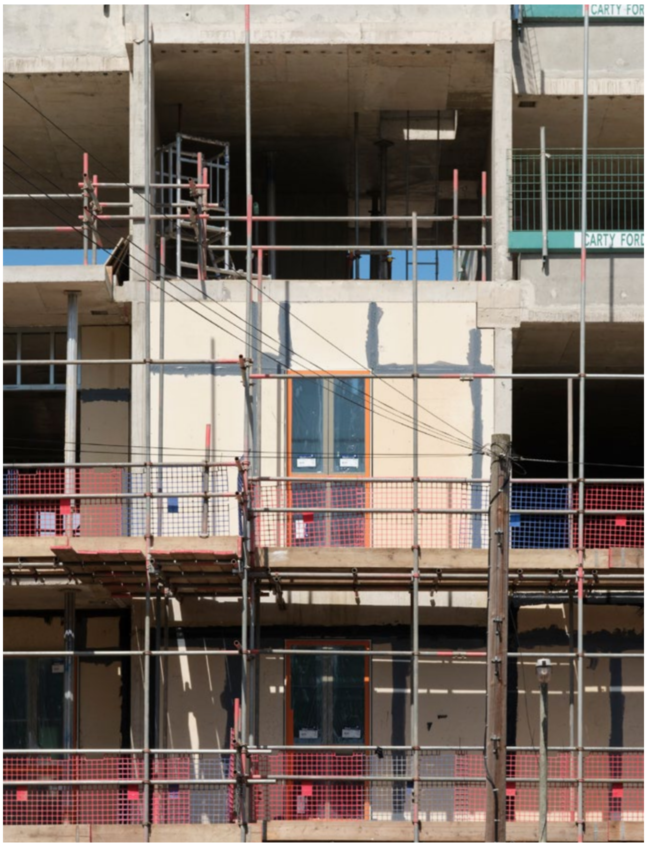
Lessons Learned

There are several valuable lessons learned to take away from this case study. Battery storage on construction sites is an emerging technology and it works differently from simply deploying a generator. If it is not looked after or set up correctly it can actually worsen emissions and increase fuel consumption.

Telematics

Telematics is an extremely helpful tool for monitoring and managing site power. Where there is a visualised record that something has been left running, or if the rate of charge is insufficient, or where generator or battery specification is inappropriate, it can alert operators. There are many useful parameters to be monitored and considered. When both the site and supplier have access to that data, problems can be diagnosed and resolved quickly, and the battery parameters and site operations can be optimised to save the maximum amount of fuel thus reducing the environmental impact.

For example, at the beginning of this case study the charge rate on the battery was quite low. This meant that the generator was running for longer than it needed to, and the battery was less able to recover from days of high power consumption. By doubling the charge rate we were able to shave 2 hours per day off of the generator run time. This was only identified through access to telematics, and we estimate that an additional 123 litres of diesel could have been saved with early identification of adjustments like this.



Timed Sockets

Whenever using a battery system there must be a greatly increased focus on power efficiency. Engineered solutions to conserve power, such as timed sockets, could have significant potential for further reducing fuel consumption and making it easier for sites to transition to an operating culture using battery storage systems.

In our study for example, leaving the drying room heaters on all night added 45 minutes onto the generator run time in the day. The battery has used more power so takes longer to charge back up. If the heaters were to come on at say 2am instead, this could reduce the generator run time even further, and could still ensure clothes were dry by morning. This approach would not be possible using a generator alone, it would have to be left running all night.

If a site is only using a simple generator, when staff switch the generator off at the end of the day everything on site automatically loses power. With a battery system in use, that doesn't happen, there's a need to manually walk around site switching everything off. If an appliance that is not needed has been left running, it will continue to drain power all night/weekend, and fuel will need to be burned to make up that lost power. There is also a risk of losing power to essential applications, such as aviation lights and security features. With timed sockets, these inconveniences and emissions are avoided, so that the site does not have to change it's working practices.

Manual/Auto

The battery has no control over the generator unless the generator is in Auto. So, it is fine for sites to start the generator manually if they need to, but they must remember to switch it back from Manual to Auto as soon as possible, otherwise the generator will just keep running.

Stage V Generator

The latest EU Emission Stage V generators are generally 98% cleaner for PM (soot) and 80% cleaner for toxic NO_x emissions than their Stage IIIA counterparts. However, these newer machines do not cope well with prolonged periods of low-load. If this site were not using the battery storage system, the average load on the generator would be around 4%. It is likely that a Stage V generator could have encountered reliability and maintenance issues.

However, use of a battery storage system as in our example, brought the average load on the generator up to a much healthier 41%. Exhaust gas temperature and velocity is appropriate at this loading for the operation of the exhaust gas aftertreatments. This particular generator is below 37kW which means the London Low Emission Zone does not require it to be Stage V. However, Stage V generators at this size are commercially available, and if used in this case would have saved an additional 1.1kg of PM (soot) and 7.7kg of toxic NO_x emissions, reducing soot emissions to less than 1 gram per day.

Recommendations

Consideration of power management on construction sites is a logical progression in the technological advancement of cleaner equipment, there should be a driver for the industry and a framework for the construction industry to implement change. The Planning agenda is a suitable context in which to embed appropriate power management as part of the planning conditions and environmental management documentation to deliver the best outcomes in construction for carbon, toxic pollution and fuel efficiency.

With the appropriate guidance, documentation and conditions, the introduction of a Power Management condition could be delivered by any authority in the country without the requirement of onerous and lengthy process of legislative change.

In order to embed this into the planning agenda the following steps would be required:

A desire and will from the local authorities to support its application.

- Guidance for Planners.
- Standard Planning conditions
- Guidance for developers (Handbook for Power Management Plans)
- Guidance to construction industry
- Simple calculators for site power management.

This approach would support the transition to cleaner generators, create a reduction in fossil fuel/HVO use and drive innovation and competition in the generator fleet, as well as support the national grid.

Appendix

Fuel Consumption (Litres per hour)

Generator size(kW)	Load on generator			
	25%	50%	75%	100%
20	2.3	3.4	4.9	6.1
30	4.9	6.8	9.1	11.0
40	6.1	8.7	12.1	15.1
60	6.8	11.0	14.4	18.2
75	9.1	12.9	17.4	23.1
100	9.8	15.5	22.0	28.0
125	11.7	18.9	26.9	34.4
135	12.5	20.4	28.8	37.1
150	13.6	22.3	31.8	41.3
175	15.5	25.7	36.7	48.1
200	17.8	29.1	41.6	54.5
230	20.1	33.3	47.3	62.8
250	21.6	36.0	51.5	68.1
300	25.7	42.8	60.9	81.4
350	29.9	49.6	70.8	95.0
400	33.7	56.4	80.6	108.3
500	41.6	70.0	99.9	135.1
20	1.8	3.1	4.5	6
24	2.2	3.7	5.4	7.2
32	2.9	5	7.2	9.6
40	3.6	6.2	9	12
60	5.4	9.4	13.5	18
80	7.2	12.5	18	24
120	10.8	18.8	27	36
160	14.4	25	36	48
200	18	31.2	45	60
280	25.2	43.7	63	84
400	36	62.4	90	120