Aggregate Portal Sand and Gravel Case Study

Introduction

Sand and Gravel extraction is an energy intensive industry. Although sites and processes can differ, a number of energy saving measures exist that would be applicable across most sites and wharves.

This case study is an introduction to the likely energy saving measures for sand and gravel sites. The information is an amalgamation of a number of surveys undertaken and reports and guidance produced by the Carbon Trust.

Consider an operator that runs one marine wharf and one land based site for the extraction of sand and gravel. Its parent company is looking to reduce energy costs and carbon emissions across its business. Energy spend across both sites is currently around £250,000 including fuels and electricity.

The Site Manager and staff are working together to identify new technologies, processes and behaviours that can be introduced at the site. They are particularly interested in low cost options that require little or no capital investment.

The energy saving measures have been grouped, where possible, to follow the extraction. Some measures /activities can be applied across a number or all of the activities on a site.

1. Energy Management

The site team is uncertain exactly how much energy the site uses and how this changes over time. The team has decided to undertake monitoring of fuel and electricity consumption to identify trends, distinguish potential areas of energy reduction, to benchmark themselves against other sites and companies and to demonstrate success over time.

The team has decided to install a number of sub-meters across the site to provide a more detailed view of the site activities and energy saving opportunities.

The team has started raising awareness, training and motivating staff in energy management - such as through switch off regimes, efficient use of machinery and vehicles - as they have been shown on other sites that this is one of the most important and cost-effective way to save energy.

Some of their favourite awareness ideas are poster campaigns, energy champions for each team, weekly progress reports and Toolbox Talks.

2. Marine Extraction

The company runs a wharf for unloading and processing sand and gravel from ships. There are two company-owned ships and they also process material from other vessels at the wharf. Material is taken from the wharf for processing at its terrestrial site close by.

Ship diesel has been measured as a large energy consumer for the wharf operations. The company has started to measure diesel consumption and work with neighbouring companies to develop the most efficient routes from the extraction sites to different wharves.

Material is off-loaded from the ships using bucket wheels, pumps, grabs and scrapers. The team has identified energy saving opportunities in operation patterns and the addition of controls to motors for this equipment.

3. Water Pumping

The areas the terrestrial site is located in requires water pumping to access the mineral. Large pumps are on continuously to assist with sand and gravel extraction.

Site engineers have initiated a period of pump operation monitoring and assessing water levels to develop solutions to reduce energy from water pumping, as monitoring showed this was a high area of energy consumption at the site.

The engineers found that the pumping operation did not match requirements. Water level rise at the site did not require constant pumping and could be reduced with adequate control. In some areas they were able to manually turn pumps off until needed, in other areas they installed level sensors to improve pump control (such as submersible pumps), whilst in areas where water levels were more constant, pumps were only used at night to maximise off-peak electricity use.

The assessment identified that some pumps were too large for their application, and that the water could be pumped to a lower level and at a lower flow rate.

4. Mobile Plant

Sand and gravel is currently carried by mobile plant to the stockpile on site.

A site team has assessed that there is a suitable haul route to replace the trucks with conveyors and considering all operating costs this option is more cost-effective in the medium term. The team also found that this option had other benefits including a reduction in manpower.

Where it is not feasible to replace mobile plant such as dumper trucks, a group of vehicle drivers looked into ways to reduce on-site energy consumption. They found that driver training led to reduced vehicle idling and fuel savings, they improved the maintenance regimes (such as tyre pressures), and improved haulage routes for more efficient driving.

They also found that through changes to contracts they were able to influence the behaviour of contactors and their choice of vehicles. The team is also looking at the possibility of replacing the diesel fuel bio fuel blends.

5. Conveyors

Where the company uses conveyors on the site they aim to reduce the conveyed distance where feasible. Further actions identified by staff running the conveyors included:

- Improve conveyor operation control with programmable start up and presence sensors.
- Improve motor controls such as variable speed drives (see below).
- Improved plant load management.
- Reduced energy losses through torque adjustment or conversion where possible through the removal of V belts and gearboxes.
- Improved maintenance of the belts and drive system.

6. Motors

Motors are used on the site for a variety of applications such as pumps, conveyors and fans. From energy monitoring it has shown that motors are one of the largest consumers of energy on the site. In some cases the annual cost of energy to run a motor can be up to ten times its purchase cost.

Currently the company does not have an inventory of the size, number and application of the use of motors on the site. As a first step site engineers decided to put together a motor management policy to determine management decisions. As motors are most efficient at high loads, monitoring consumption and installing new motors can reduce costs. New motors are also classified by efficiency with higher efficiency motors (HEMs), which can be purchased at similar costs.

Running the correct motor and controls (also known as drives) can lead to significant energy savings. Motors and improvements to their controls need to be understood within the context of the application, load served and the operation pattern.

Variable speed drives (VSDs) are suited to applications with load conditions at continuously variable demand. VSDs can also be useful for constant conveyors and grinders with a fixed output that varies from job to job. The team found from monitoring that installing a VSD to a 30 kW pump could save around £2,000 a year in energy costs.

Other controls include soft starters that reduce the large energy spike when a motor is switched on – but these do not control motor speed in normal operation. Smart motors can reduce energy consumption as they analyse load conditions for themselves, without needing to feed back information to a central control system.

7. Compressors

Compressed air is used for power and control for a number of applications within processing on a site.

Monitoring has shown that compressed air is the most expensive utility and around 90% of the energy input is wasted as heat. They have implemented a number of measures to reduce the use and improve the efficiency of compressed air at the site.

- They have replaced compressed air in the process where feasible - for example by using suitable electrical actuators or low energy fans.
- Reduced the pressure where high pressures were not required.
- Reduced idling of compressors, which consume 20–70% of their full load power.
- Carried out ultrasonic leak detection surveys and repairs. The found that one small leak costs over £500 a year.

- Where possible reduced air intake temperatures, monitoring found that 10% reduction in air inlet temperature improves efficiency by about 3%.
- Installation of Variable Speed Drives on generators with variable loads and fixed duty motors.
- Where feasible, the installation of variable speed drives on idling compressors saved between 20% and 70% of their full load power.
- Recovering and using waste heat was used to compliment heating the office buildings on site.
- The team is currently considering integrating small distribution networks into a more efficient joined up systems approach.

8. Drying

The company produces specialist sands products for some clients that require additional drying within industrial driers. The team has identified significant savings from the implementation of new intelligent control processes in the driers. Whilst they have also found that agitators which aid the spreading of the sand as it enters the drier is a cost effective way to increase drying time.

In order to reduce the costs of drying site engineers are looking to install covers over the stored material, add simple drainage underneath the stockpile, and where possible leave the stockpile a period to drain before removal and taking from the top. Each measure can save 1-2% of total drying energy and lead to significant savings.

9. Distribution

Drivers are looking into reducing emissions from distribution from the site. They have realised that training of operators, use of articulated trucks, use of lower carbon fuels, optimising delivery routes and in the longer term using rail or water as opposed to road transport are potential opportunities to save energy.

They have calculated a possible reduction of around 10-12% of vehicles fuel consumption with the implementation of these opportunities.

10. Buildings and Lighting

Energy saving measures for on-site buildings and structures can be overlooked as not directly related to the quarrying process. A range of cost effect opportunities are likely to exist to improve heating systems, fabric, controls, lighting, ventilation and cooling systems within a building.

Lighting around the site is up to 10 years old with limited control and it is noticed that lighting is on for most of the time. Timers and occupancy controls would reduce this lighting load and have a small impact of the site's energy consumption.

11. Electricity supply

The electrical engineers are keen to implement savings to lower overall electrical demand. Due to the close proximity of the site transformer to the Plant, along with the fact that many of the newer drives and motors can operate satisfactorily at the European voltage of 380v, then lowering the incoming voltage supply to the optimum voltage for electrical equipment on site will save between 1-3% on the site electricity demand. This involved altering the Site Transformer tap settings to reduce the site voltage from 415v to 380v.

12. Low carbon technologies

The energy team is also looking at low carbon and renewable technologies such as wind turbines, and bio diesel fuels to reduce overall energy consumption.

13. Opportunities in the Case Study

Opportunity	Capital Cost	Carbon reduction	Payback
Energy Management	£5- 10,000	2-10%	Immediate to 4 yrs

and training			
Ship route optimisation	Low capital cost (<£20k)	Varies	Quick win
Water pumping	£<1000	Up to 20% of pumping energy (and 50% of costs if at night)	Quick win
Driver training	£15,000	10% of vehicle fuel emissions	Quick win
Vehicle maintenance	£10,000	1% of site emissions	1-4 yrs
Sub-contractor fuel management	Low capital cost	1-4% of site emissions	Quick win
Bio fuel	<£20,000	1%	1-4 years
Improve quarry road surface	Medium capital cost	<1%	Varies
Use conveyors instead of mobile plant	Medium capital – varies with project	Varies	1-4 yrs
Conveyor improvements – belt and torque adjustment	£12,000	0.5%-1%	1-4yrs
Conveyor controls	£2,000	0.5%	Quick win
Motor controls	Motor controls (VSD, Soft Start)	£20,000	Up to 10% of site electricity
Reduced use and losses from compressed air	£2,500	1-2% of site energy	Quick win
Reduce moisture before drying with covers or simple drainage	£30,000	1-2% of moisture	<1 yr.
Optimise sand drying process	£15,000	2-8%	1-4 yrs
Buildings and lighting	£5,000	<1%	1-4 yrs
Power factor and voltage optimisation	£1,000	1-3% of electricity consumption	Quick win

14. Quick Wins

- Energy management and training
- Driver training and monitoring
- Optimise use of wharves to reduce ship diesel
- Improve vehicle maintenance
- Manage sub-contractor fuel use
- Motor Control - Survey and install variable speed drives on largest suitable motors (crushing and conveyors)
- Reduce water pumping energy– pump size and controls, height, flow rate, operation times
- Reduce moisture content of any material to be dried with covers or simple drainage techniques
- Compressed air - reduce use losses, identify and fix leaks and install variable speed drives

- Buildings and lighting around site – ensure sufficient controls
- Electricity control – power factor correction.