Wider applications of integrated data and outputs from CLEAR Info

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1 Introduction

The CLEAR Info project aims to improve how businesses implement environmental legislation by using integrated data on the environmental performance of parent companies.

The project trialled a system for integrating and analysing the data the Environment Agency (EA) of England collects as an environmental regulator, providing information to drive improvements in parent company performance. The project will help enable European regulators to share data across regulatory boundaries and build an understanding of corporate performance. The overarching idea behind CLEAR Info stems from the issue that without any clear view of company-level environmental compliance or impacts, it is very challenging to produce a comprehensive overview of a given company's environmental performance. Thus, investors cannot make informed choices and an individual company may find it difficult to have a clear overview of its own overall environmental compliance level. This is especially true if it operates on multiple sites or if it owns several subsidiary companies. The project aims to demonstrate how clear information on the environmental performance of parent companies can promote effective implementation of European Commission (EC) environmental legislation (Williams et al., 2013).

In addition to the focus on parent companies, the project has also demonstrated how integrated data can be used by regulators (Action 5.1) investors (Action 3.3), and other data users (Actions 3.6 and 5.2). However, the project anticipates that improvements made to the way regulators (such as the EA) manage environmental data will have wider applications in the society. For instance, the EA captures and analyses a huge amount of data in its capacity as a regulator to the nuclear, oil, chemicals and waste disposal industries in England. The EA also appraises and helps with preventative measures in other areas including water, air quality, flooding and coastal management. These monitoring activities are supported by thousands of disparate data sets (Young, 2013).

The aim of this report (Action 5.3) is to consider other ways in which the data, approach and outputs of CLEAR Info could be used by other groups/sectors in society. This aim is in line with the new 'Digital Agenda for Europe' (European Commission, 2014). This European Union (EU) strategy on Big Data supports and aims to accelerate a transition towards a data-driven economy in Europe. The hope is that this will stimulate research and innovation on data and lead to more business opportunities and increased availability of knowledge, in particular for small and medium sized enterprises (SMEs), across Europe (European Commission, 2014). In this regard, this report addresses the following questions:

- What other groups could use the data and/or outputs?
- What would they use these for?
- What evidence is there of the potential for these groups to generate, analyse and use environmental data?
- What are the challenges for this approach and proposed solutions?

The datasets considered in this report will not only be limited to those held by the EA. The report will focus on the outputs from Actions 3.3, 3.6, 5.1 and 5.2. Overall, the benefits, opportunities and viability of using CLEAR Info outputs to promote more effective implementation of European Union legislation for other business groups will be considered. There will be a particular focus on SMEs due to their importance to the European Union economy.

The wider application of the outputs from the following CLEAR Info Actions will be considered.

2 Datasets and Outputs

2.1 Action 2.1

A technical working group comprising data architects, developers and project team members were tasked with creating an integrated data set that could be used to generate parent company reports. In the first stage, all data sets were profiled in detail to gain a comprehensive understanding of the various aspects covered by the data and to identify any caveats to be aware of when aggregating the data. The group built a proof of concept structure, which demonstrated that disparate source data could be matched to a company hierarchy, and an initial integrated data set was made available for producing reports. After several iterations of improvements, a final data integration tool was built and populated with the CLEAR Info integrated data. The integrated data set consisted of EA regulated site data sets, linked to company name and company ownership hierarchy.

2.2 Action 3.6

This action explored how UK environmental datasets can be linked to other datasets across the EU regulatory environment. It identified barriers to linking and proposed solutions to integrating UK datasets with other global data. The action developed an environmental scoring methodology to apply an environmental performance to a company's and site's operations based on a various factors.

2.3 Action 5.1

This action explored whether the publication of data under the INSPIRE data standards would provide a consistent format for publishing environmental regulatory data across Europe, allowing regulators to link up data for multinational companies.

2.4 Action 5.2

This action held a 'hackathon'. The event brought together a cross-section of data users who were tasked with finding innovative solutions to a range of environment related problems by using data integration. Through this exercise, the action was able to identify the benefits and the practical challenges of integrating data.

Building on the work with different data users, this report explores the opportunities for using or expanding the CLEAR Info integrated data for SMEs and other groups.

3 Wider applications of outputs and data

3.1 Small and Medium-sized Enterprises

Small and medium sized enterprises (SMEs) are businesses employing less than 250 members of staff, having a turnover of less than €50 million and/or an annual balance sheet not exceeding €43 million (Wilson, Williams and Kemp, 2011). They are the economic backbone of the EU. These 20.7 million companies represent more than 98% of all European businesses and provide 67% of total employment with a workforce of nearly 90 million people. SMEs contributions are also essential for pursuing the goals of 'Europe 2020', the strategy for smart, sustainable and inclusive growth. The European Commission promotes the growth of SMEs through the Small Business Act for Europe as they are considered important for Europe's sustainability and growth strategies. This framework includes an initiative to raise SMEs' awareness of environmental and energy-related issues and to assist them in implementing legislation, assessing their environmental and energy performance and upgrading their skills and qualifications (Calogirou, Stig, Peter and Stella, 2010; TNS, 2013).

It is reported that approximately 70% of environmental impacts in the EU can be linked to the activities of SMEs (Calogirou et al., 2010). SMEs face difficulties complying with environmental legislation as they are expected to conform to a large assortment of environmental legislation. There is little to differentiate their workload from that of larger, more resource-rich companies. These have resulted in SMEs demonstrating low levels of awareness and understanding of environmental issues as well as low levels of compliance (Wilson, Williams and Kemp, 2011). Hence, the effective implementation of environmental legislation is crucial to minimising the negative impact(s) that can occur from environmental legislation (Wilson, Williams and Kemp, 2012). In the UK, it has been shown that the impact of environmental regulation on SMEs is overstated and impact increased in tandem with effort to comply and enforcement action (Wilson, Williams and Kemp, 2012). Similarly, other studies have reported that most SMEs have little knowledge of or interest in environmental issues and generally have difficulties when it comes to integrating environmental aspects into their activities. One way for SMEs to shift from a reactive to a proactive environmental behaviour is to adopt environmental innovations (Calogirou et al., 2010; Halila, 2007). Clear Info outputs exemplify such environmental innovations. In the following sections, this report will evaluate the wider applications of integrated data with a particular focus on SMEs. The report addresses potential benefits and opportunities that integrated data offer as well as

some of the challenges that would be faced if SMEs were to adopt integrated data as part of their core business.

Benefits and Opportunities for SMEs

In spite of their dominant position, most SMEs have little interest in environmental issues and generally lack tools and methods for integrating environmental work within their activities or handling problems related to the environment (Halila, 2007). As shown in this project, integrated data can help alleviate this situation. Environmental performance dashboards based on integrated data from a wide range of regulatory regimes, are one tool and method that could help SMEs assimilate environmental work as part of their core business. However, the content of such dashboards would depend on the environmental regulations that an SME has to comply with, i.e. the EA may not hold data on them. Similarly, SMEs deal with issues such as profitability, competitiveness and staffing, resulting in environmental issues being neglected. Because of the sheer number of SMEs, there needs to be an effective system of regulation which controls activities and targets those businesses that pose a high risk to the environment (Wilson, Williams and Kemp, 2011). Using integrated data can help make the environmental regulation system more effective since it can provide a quick, easy-to-understand snapshot of environmental performance of businesses. In the UK, for the regulation of SMEs, this would require further research since CLEAR Info focused on a company level linking mechanism. Since not all SMEs have to register with Company House, a different approach to collating the data would need to be identified.

Integrated data can help SMEs get better understanding of the significant amounts of legislation they need to comply with. It can also help them obtain a quick overview of their performance across operations. In addition, it can help them identify interrelations between various activities and their environmental performance. These issues are important given that the reasons for the low levels of compliance and understanding among SMEs include the fact that there is a significant amount of environmental legislation for them to comply with. In the UK, there are up to 80,000 pages of European legislation and several EU Directives covering the environment. SMEs are expected to meet all applicable legislation, which can impose a significant cumulative burden (Wilson, Williams and Kemp, 2012). It is significant that since 1997, more environmental legislation has passed through the UK parliament than any other area of law except that covering justice and tax (Wilson, Williams and Kemp, 2011). Similarly, previous studies have shown that SMEs thought the guidance provided with new environmental legislation was poor (Wilson, Williams and Kemp, 2012). Integrated environmental data can help clarify such new legislation.

For regulators, it has been identified that in the UK, a more sophisticated SME screening process is required in order to help identify those organisations which can pose a risk to the environment, in particular those SMEs not currently part of an inspection regime. Risk assessments need to use compliance auditing as part of this screening process, offering a link between compliance and environmental protection (Wilson, Williams and Kemp, 2011). An integrated data system could enhance such a screening process.

Integrated data can help inform compliance performance indicators. It has been shown that SMEs non-compliance is only really recognised and acknowledged if identified by a regulator and only regarded as serious if prosecuted (Wilson, Williams and Kemp, 2012). Hence,

SMEs need to improve their compliance control systems. They need guidance and support in order to measure their compliance. Such guidance can best manifest itself in the development of environmental compliance performance indicators (CPIs) (Wilson, Williams and Kemp, 2011).

Not all SMEs are aware of the environmental impacts of their operations. Additionally, they do not consider the efforts required to comply to be comparable with the pollution threat of their activities. (Wilson, Williams and Kemp, 2012). Integrated data can help educate SMEs about their environmental footprint in a simplified manner. For instance, as discussed in the next section, integrated data can be used to create a map of the environmental performance of the whole supply chain of an organisation. This can help address the environmental impacts of an SME that do not fall under its direct control, for instance, impacts attributable to its suppliers. Integrated data can also help educate SMEs to see across the board, how their actions can improve and hence comply with 'more' legislation since SMEs tend to think that more legislation would not result in better protection for the environment (Wilson, Williams and Kemp, 2012). However, it should be noted that SMEs prefer prescriptive requirements. Comparison can be made with the non-prescriptive requirements of environmental management systems which have not been widely implemented by smaller SMEs (Wilson, Williams and Kemp, 2012).

A high level of environmental protection needs to be cost-effective and socially justifiable. This is best achieved through a balanced combination of legally based permit provisions and judicious self-regulation by the operators. This is exemplified by the regulatory framework provided by the IPPC Directive. Hence, integrated environmental permitting can be considered as an instrument for a systems approach (Silvo et al., 2002). Integrated data has the potential to contribute to the self-regulation aspect of such a systems approach.

A recent EU study on the resource efficiency of SMEs across Europe provides some useful insights to the current approach to environmental issues in SMEs and the potential for improvement that an integrated data approach to environmental compliance can take advantage of. These are summarised below:

- 93% of SMEs are taking at least one action to be more resource efficient. The most common actions being to minimise waste, save energy (both 67%) and save materials (59%). At least half are also recycling by reusing material or waste within the company, or by saving water (both 51%). It should be noted that SMEs could achieve further waste reduction by switching to online-based transactions. For instance, in the UK, the EU Life+ project edoc (electronic duty of care) enables the free reporting of waste produced or handled by organisations. By doing away with the need for waste transfer notes, the system saves organisations resources whilst enabling them to fulfil their duty of care for waste (edoc, 2014).
- SMEs with 50-249 employees are the most likely to be taking each kind of action, particularly saving energy (80% vs. 65%-69%).
- Eight out of ten SMEs are planning additional resource efficiency actions in the next two years, particularly saving energy (58%) and minimising waste (56%).
- The majority of SMEs in the EU act to become more resource efficient in order to reduce costs (63%), although 28% say the environment is one of the top priorities for their

company. The larger the SME, the more likely they are to say their actions are as a result of consumer or provider demand.

- More than half of SMEs (55%) encounter difficulties when trying to set up resource efficiency actions, particularly complex legal or administrative procedures (26%).
- Medium-sized enterprises, as well as SMEs active in manufacturing and industry sectors, are the most likely to have encountered difficulties with the complexity of legal or administrative procedures.
- 42% of SMEs taking resource efficiency actions say their production costs have decreased in the past two years as a result – this is an increase of seven percentage points compared to 2012 (TNS, 2013).

The above points indicate that there are opportunities for integrated data/CLEAR Info outputs to assist SMEs achieve resource efficiency. Integrated data can help SMEs better understand the overall impact of their activities, hence identify areas to maximise resource efficiency. This would, however, be constrained by the availability of data.

It has been shown many SMEs, because they are reluctant (or unable) to deploy scarce resources to environmental issues, rely upon the knowledge of others to inform and direct their strategic decision-making on regulated activities. This requires that they trust the sources from which the information is provided. These include trade associations, chambers of commerce, non-governmental support agencies, suppliers, customers and informal business contacts. Developing trusted networks could therefore be a particularly effective way of managing the implementation of state regulation for many SMEs (Lynch-Wood and Williamson, 2014). It is important to take this into account if promoting the uptake of CLEAR Info outputs (discussed in section 2) among SMEs. However, it should be noted that a trusted network is not a 'one size fits all' unit. It is likely to be quite specific in terms of its constituency and mode of operation, and would require ground level facilitation rather than top down direction (Lynch-Wood and Williamson, 2014).

It has been proposed that by clustering/participating in networks, SMEs improve their corporate social responsibility (CSR). Such clusters help them address the limitations faced when they try to implement CSR individually. The networks help motivate the uptake of CSR among SMEs when the network (cluster) is characterised by close geographical proximity and operates in the same sector. This can also lead to innovation through cooperation and competition (Høivik and Shankar, 2011). A cluster approach allows the achievement of sustainable objectives and the adoption of CSR-related tools by SMEs. This is made possible by setting up specific cluster tools: local multi-stakeholder working groups, communication tools to disseminate expertise and best practices, operational models, guidelines to support organizations toward CSR, and audits at the local level (Battaglia, Bianchi, Frey and Iraldo, 2010). Promoting use of integrated data via such networks has potential to increase its uptake among SMEs. Networks can help to build relationships between SMEs and government, and play a key role in building the kind of cooperative relationship and trust needed for collective action to solve environmental problems (Revell, Stokes and Chen, 2010). One such network is the Low Carbon Oxford initiative in the UK. The network brings together private, public and charitable organisations to cooperate on Oxford's transformation to a sustainable and inclusive low carbon economy. They set annual

joint targets for carbon emission reduction and reporting. By doing this, they encourage SMEs to consider their environmental impacts (Low Carbon Oxford, 2014).

It is claimed that SMEs miss the opportunities to use innovative environmental management tools that can favour and facilitate their capability to guarantee legal compliance. Such tools include Environmental Management Systems (EMS) (Daddi, Testa and Iraldo, 2010). In Europe, although up to 24% of SMEs actively engage in actions to reduce their environmental impact only 0.4% use a certified EMS (Calogirou et al., 2010). It is argued that EMSs are the key to better manage compliance. However, some SMEs are not able to use them due to lack of human, technical and economic resources. Using a 'cluster approach' to environmental management can be an effective solution to this problem. By way of this approach, it has been shown that many SMEs have been supported in applying an EMS and, as a consequence, to comply with legislation (Daddi, Testa and Iraldo, 2010). It is important to note that SMEs can easily apply non-certified environmental management systems. This can be very simple and low-cost systems for reducing environmental impact. The systems could be simple guidelines on how to improve their environmental performance (Calogirou et al., 2010). There is an opportunity to use integrated data to complement or be part of such EMS. Integrated data would make it easier to identify and visualise problem areas in the compliance and environmental performance. This could in turn be fed into the EMS.

3.2 Other Groups

Supply chain

Integrated data can help organisations align their buying decisions to their green, ethical, and other business requirements. The supply chain connects all businesses to the same network, but companies looking to commit to ethical and sustainable practices do not have control over the behaviour of their suppliers. However, it is difficult to gather information about the practices of the whole supply chain. To overcome this problem, in the USA, an innovative data visualisation tool called 'ProductBio' has been developed. It is a database of suppliers that helps businesses find partners that match their ethical and green policies. The online platform simplifies the complex process of procurement by using big data to analyse approximately 1 million product supply chains and grading them with green credentials (Springwise, 2014). The ideas proposed in action 3.6 could be used to develop a similar tool for similar purposes. ProductBio assembles the data into a graphical dashboard that illustrates the environmental performance of each product category. The tool enables firms to assess the performance of their business partners, how their supply chain compares to the industry standards as well as get recommendations for alternative suppliers with good environmental certification. By signing up to ProductBio, businesses are able to show customers how they are making more sustainable decisions (Springwise, 2014).

Integrated data can help businesses understand and act on their environmental impacts outside their direct control. A Carbon Trust study (Hsu, 2014) found that only 20% of the carbon footprint of the pharmaceutical company GlaxoSmithKline were within its own boundaries. The rest comes from indirect emissions, with 40% of that coming from the use of its products, such as propellant inhalers. Similarly, they found out that 92% of the carbon footprint of the British Telecommunications (BT) company were due to emissions outside its

direct control. Around two-thirds of those emissions were from BT's supply chain, which involves 17,000 global suppliers providing products and services worth £9.4 billion. By linking up various data, the company was able to effectively highlight carbon hotspots where it could focus its efforts to create opportunities for carbon and cost reduction (Hsu, 2014). This is an example of how CLEAR Info (such as air emissions) and other data can be joined up to assist organisations get a clearer picture of their environmental performance. Such use of data can also incentivise smaller suppliers to be more responsible in their own operations. The data can be supplemented by an organisation's own data collection. For instance, the electronics company Hitachi provides an online platform for suppliers to submit how they meet sustainability criteria (Hsu, 2014).

Higher education

Carbon emissions at UK universities has been rising in recent years prompting concern that institutions will fail to meet strict targets for reductions by 2020. Overall, carbon emissions at 139 universities rose by 3.9% between 2005 and 2010, even though capital funding for English institutions is now linked to reductions (Williams, 2014).

Every year, UK universities are ranked in so-called league tables organised by various organisations including The Times newspaper. The main aim of the rankings is to apprise potential undergraduate applicants about UK universities based on a range of criteria. These include student satisfaction, staff/student ratio, academic services and facilities expenditure per student and research quality. All of the league tables also rank universities on their strength in individual subjects. Since universities are generally considered as centres of research and teaching excellence, the idea of league tables could be extended further to include their environmental performance in the rankings. Student satisfaction and related academic data could be joined up with EA data on air quality to produce more holistic league tables for universities.

Consumers and Citizen Advocacy groups

Citizen Science/Crowd Sourcing is an opportunity to gather more current or accurate data held by regulators in Europe. It also provides an opportunity to citizens to engage in environmental awareness. It can be used to analyse data or create ideas on how to work with it (Young, 2013). For instance, the project eBird documents the presence or absence of bird species, and their density, through a data checklist. Using a simple web-interface, it engages tens of thousands of participants to submit their observations or view results via interactive queries into the eBird database. eBird encourages users to participate by providing online tools that maintain their personal bird records and enable them to visualize data with interactive maps, graphs, and bar charts (eBird, 2014). Similarly, the EA held a 'hackathon' in conjunction with the UK Ordnance Survey and the University of Bristol. About 100 professional developers and students, split into teams, were given data from all three organisations with a task to integrate them, find ways of engaging the public in environmental awareness and taking proactive measures to improve particular aspects of the environment (Young, 2013). One of the winning teams designed a web application called 'Polish off a Penguin'. The application allows the public to see how many penguins would be able to hypothetically survive the ecological conditions in a certain locality. It uses data on water pollution, air quality, hazardous waste and the conditions for a penguin's favourite food

and cross analyses it against scientific information about their survival necessities. It then formulates a figure about how many penguins would perish on any given street in England (Young, 2013). Another competition that the EA organised aimed to encourage people to engage in leisure activities and holidays around environmental points of interest. Using the Natural England's and the Agency's data, the winning application allowed people to check all of the animal species and other ecological treasures that they might find in any given touring destination. The application also showed links to local restaurants, hotels and other attractions, boosting the economies in those locations (Young, 2013).

In the Netherlands, a smartphone application called iSPEX expands the functionality of the phone into a scientific instrument to measure dust in the atmosphere, simply by appending a small device to it. Users can then continually add to the data pool collected by air quality regulators (Young, 2013). These measurements by thousands of citizen scientists are delivering accurate data on dust particles in the atmosphere that add valuable information to professional measurements. In 2013, collected data was combined into unique maps of dust particles above the Netherlands. The results matched and occasionally exceed those of field-based measurement networks and satellite instruments (iSPEX, 2014).

It has been suggested that using a smartphone application to take photos, the light intensity on the photographs could be measured to enable the calculation of a direct correlation with air quality. This would provide constant field monitoring across a region/country. Engaging with the public in this manner can help improve the environment without too much diversion from what people normally do (Young, 2013).

In China, the Mangrove Conservation Network, a non-profit organisation in the coastal city of Xiamen, allows people to upload information on damaged mangroves (e.g. from pollution) from their phones. These are then posted on 'Baidu Map' (China's equivalent of Google Maps). The idea is that when more people are made aware of the pollution, public opinion would add pressure on local authorities to effect changes (Chen, 2013). For Citizen Advocacy Groups, integrated data can be an opportunity to push for or influence certain environmental policies.

As pollution concerns rise in China, online 'pollution maps' are boosting environmental awareness among the populace. Increasingly non-governmental organizations in China are using such maps to hold polluters to account. 'Danger Maps', a website started in 2012 allows people to find potentially polluting sites such as toxic-waste treatment facilities, oil refineries and power plants. Since 2013, about 6,000 pollution sources had been plotted on the maps based on government data and user input on 'Baidu Map'. Boosting environmental awareness among the population helps them understand how important information and data can be for sustainable social activism (Chen, 2013). Although pollution controls are much tighter in Europe compared to China, using similar data (e.g. INSPIRE geospatial data, EA air quality data, transport data, etc.) and linking these to health data (e.g. respiratory health), citizens in Europe could be engaged in environmental issues such as the importance of air quality and how this relates to their behaviour (e.g. driving).

Data visualization of integrated data opens up new opportunities for business leaders to identify new questions to pose in the decision-making process, that they may not have considered before. For instance, Scotland's Environment Web (SEWeb) is using such

analytics to teach residents about Scotland's environment so that they can help improve it. Users can analyse and view multiple layers of data about the environment, filtering the data to suit their areas of interest (e.g. air, water, and terrestrial).The data visualization tools save the time and effort needed to trawl through detailed reports to find the relevant information. This allows users to absorb information faster and more completely (Spotfire, 2014b).

Data and analytics can help energy companies, government agencies, environmental organizations explore the impact that fracking is having on the environment. They can extrapolate various datasets such as ground water, land use and the chemicals that are involved in fracking, to analyse and measure changes in the quantities that are present in groundwater supplies, streams and other waterways. Such readings can alert interested parties if the presence of hydrochloric acid, tetramethylammonium chloride or other toxic chemicals is reported at higher-than-accepted levels (Spotfire, 2014a). Such analysis promotes transparency and implementation of the Water Framework Directive.

Manufacturers

The FP7 project ZeroWIN investigated and demonstrated how existing environmental sustainability approaches and tools can be improved and combined to best effect in an industrial network where traditionally disparate industries can exchange waste (by-products) for use as resources/raw materials. This both helps to prevent waste and offers financial dividends to industries. The networks are based on enabling regional collaboration of enterprises (Curran and Williams, 2012; Hickey et al., 2014). Crucial to the success of such networks is the availability of regular and reliable volumes of the wastes to be used as raw materials. The waste types could range from waste water, waste heat, electronics, wood, plastics, construction wastes, glass and paper (Ongondo, Williams, Dietrich and Carroll, 2013; Tischer, den Boer, Williams and Curran, 2014; Dietrich et al., 2014; Hickey et al., 2014). This requires data and information about the generation and sources of such waste. Integrating data on the location of industries, the types and volumes of waste they produce and the permits they hold could help visualise and help build such industrial networks based on waste (resource) generation. This would promote the implementation of various EU Directives including Waste Framework, Landfill Directive and WEEE (Waste Electrical and Electronic Equipment) Directives.

Farmers

Combined with crop data, climate data customarily used for weather forecasts can help deliver real time advice to farmers during droughts as demonstrated by a United Nations project on the use of big data (UN, 2014).

Charities

Charities involved in reuse of WEEE are habitually constrained by lack of sufficient quality products for reuse (Ongondo et al., 2013). Paradoxically, in the UK, almost a quarter (23%) of WEEE taken to Household Waste Recycling Centres could be reused or repaired, with a potential value of £220 million. Recent tests carried out by the UK Waste and Resources Action Programme (WRAP) showed that after cleaning, 12% of all WEEE was fit for resale, while a further 11% was suitable for resale once minor repairs were carried out (WRAP,

2011). The WEEE Directive encourages the reuse of whole appliances and cooperation between authorities involved in the collection, reuse and recycling of WEEE in order to promote this goal (Ongondo et al., 2013; Ongondo and Williams, 2012; European Union, 2012). Integrating data about the types, volumes, seasonal variations and locations (Designated Collection Facilities (DCF), local authority sites, etc.) of WEEE arisings in relation to the spatial proximity, storage and WEEE handling capacity of each reuse organisation can be of use to charities involved in reuse of end-of-use electronics. These would require linking up WEEE data found in the EA Waste Data Flow data with other geo-spatial data of the location of reuse organisations (research currently being undertaken at the Centre for Environmental Sciences, University of Southampton). Such knowledge would strengthen the case for reuse organisations to be allowed better access to potentially reusable WEEE found at DCFs. This supports the implementation of WEEE legislation.

Local Authorities

Previously, to crack down on restaurants that were illegally dumping cooking oil into and clogging up sewers in their neighbourhoods in New York, the city authorities would send the health department inspectors to restaurants on blocks with backed-up sewers and hope by chance to catch restaurant staff in the act. Recently, the city has been using big data to tackle the problem. The city's Office of Policy and Strategic Planning employs a 'geek squad' of civic-minded data analysts whose job is to integrate data from various sources to find solutions to issues facing the city. In the case of the dumped oil, the team used data from an agency that certifies that all local restaurants have a carting service to haul away their grease. Comparing restaurants that did not have a carter with geo-spatial data on the sewers, the team was able to hand inspectors a list of statistically likely suspects. The result was a 95% success rate in tracking down the dumpers (Feuer, 2013).

The UK Land use statistics (Generalised Land Use Database) dataset shows what proportion of land is taken up by homes, water, roads, railway lines and green space. It can be broken down by regions, local authority areas or smaller zones. The data can be applied to help with regional resource planning. For instance, a local authority could overlap it with location of flood areas data from the EA. This would amplify which residential areas are in danger of flooding. This could help shape development policies and emergency responses (Marrs, 2014). Policy officials working on housing development or the environment could also use the data to show them the mix of housing and green space in a specific area, and the extent to which domestic housing has been built on green spaces rather than brownfield land. Such information could be useful in determining, for example, the regulatory environment or tax system for house-builders (Marrs, 2014).

3.3 Challenges

This section discusses the viability of the wider application of integrated environmental data.

Previous studies have highlighted the need for more information in order for SMEs to comply with legislation. Small businesses suffer from uncertainty about government requirements. Nevertheless, supplying business with better information is about more than simply easing compliance (Zorpas, 2010). The following recommendations have been proposed to make it easier for SMEs to comply with EU environmental legislation (Calogirou et al., 2010):

- Exchanges of information between administrations. Creation of a common database to enable administrative units to exchange information.
- Simplification of the administrative requirements for reporting on environmental issues and avoiding duplication of requested information is necessary. Solutions include creation of electronic registration systems at national level where possible. This would enable monitoring information to be submitted electronically with a unified format and regular frequency.
- Creation of one-stop shops for the provision of information and tools for the fulfilment of administrative requirements.
    - SMEs demand one-stop-shop facilities to gather information (legislation in force, new requirements, criteria for applying for subsidies, contact details of advisors or providers, available tools, fiscal treatment, etc.), on how to fulfil administrative requirements and, in short, save time and avoid duplication of work.
    - These one-stop-shops could also provide training services to SMEs concerning environmental legislation and its requirements. A suggestion would be to create a network of affiliated one-stop shops at national level to which SMEs could contribute a small yearly subscription fee.
- Standardised EMS reporting is expected to improve the cost and the time needed to comply with reporting requirements.
    - Enterprises suggest that the use of standards and more standardised ways of EMS reporting might be an appropriate solution. This is currently being implemented within EMAS through the development of sectoral key indicators. The approach remains voluntary, but the reporting will be standardised.

In the case of the UK Environment Agency, some of these recommendations are already part of normal practice. Generally though, for an effective uptake and implementation of integrated environmental data amongst SMEs, these proposals (or their variants) need to be part of the package. It should be noted though that whilst online support may be adequate for larger SMEs, 'micro' and 'small' businesses need direct support (Wilson, Williams and Kemp, 2012).

On the issue of networking among SMEs, it has been suggested that government and policymakers should take a much more proactive approach to encouraging environmental practices among SMEs. In the UK environmental management among SMEs is often encouraged on a voluntary basis. However, such initiatives should be complemented with regulatory and licensing systems to safeguard SMEs engagement with environmental management (Brammer, Hoejmose and Marchant, 2012). In the UK, a study showed that SMEs did not feel that the implementation of environmental legislation was effective. Although extensive support was provided by the regulators SMEs preferred to use other sources (Wilson, Williams and Kemp, 2012).

For many SMEs, traditional command-style regulatory rules signify the beginning and end of their responsibilities. Alongside this, SMEs are generally unlikely to adopt self-regulatory environmental approaches, or to respond to voluntary instruments. Hence, care must be exercised when designing programmes for such purposes. Voluntary approaches still have a place in a regulatory toolkit. However, different types of regulation affect firms in different ways, and different types of firms will engage with different types of regulation in different

ways and for different reasons (Lynch-Wood and Williamson, 2014). Hence, although there is a common definition for SMEs, they cannot be considered a homogeneous group. Different strategies are needed for different sized SMEs (Lynch-Wood and Williamson, 2014; Wilson, Williams and Kemp, 2012). However, it has also been reported that the simultaneous influence of firm size and organisational capabilities on innovative-preventive environmental practices suggests that size is a relevant but not a deterministic condition for developing the most proactive environmental strategies. Therefore, it should not be assumed that SMEs cannot develop proactive environmental strategies owing to scarcity of resources (Aragón-Correa, Hurtado-Torres, Sharma and García-Morales, 2008).

Understanding compliance levels can help measure the link between legislation and environmental protection. The effectiveness of environmental legislation can only be understood if SMEs are subject to regular regulatory contact. Inspections and audits need to remain a key part of regulators' enforcement strategies. Frequency should be dictated by how well environmental risk is managed rather than by environmental hazard. (Wilson, Williams and Kemp, 2012). Although this recommendation can also be seen as an opportunity, the challenge here is how to use integrated environmental data as a complementary part of the inspections and audits strategy.

Where use of integrated environmental data complements site regulatory inspections, it is important that there is a consistency in enforcement. A previous UK study found that inspection was inconsistent between SMEs. Where regular visits were made they were uncoordinated with little reference to previous visits (Wilson, Williams and Kemp, 2012).

Studies show that despite a concerted attempt by UK policy-makers to portray 'eco-efficiency' measures as cost reducing, most owner-managers of small firms view environmental measures as expensive to undertake. As a result, owner-managers tend to be highly resistant to voluntarily improving their environmental performance. Given that SMEs are such a vast sector of the economy, this perceived discord between profits and environmental protection is clearly a major barrier to the 'greening' of industry (Revell and Blackburn, 2007).

The following would need to be taken into account when planning use of integrated data among SMEs:

- SMEs are more familiar with national environmental legislation than the legislation imposed by the EU.
- SMEs bear administrative burdens deriving from monitoring and reporting obligations.
- Environmental tools and solutions investment are mostly a priority in high environmental impact SMEs.
- Certified EMSs are more attractive solutions for medium-sized and large enterprises as well as companies with a high impact on the environment (Calogirou et al., 2010). To make EMS more accessible to all SMEs, pragmatic approaches such as providing sector specific support should be considered.

It is widely believed that voluntary regulations and standards (including certifications such as ISO 14001), self-management (e.g. EMS) and industry-driven approaches are ineffective interventions for promoting environmental improvement among all SMEs because very few

SMEs adopt them. Policy-maker motivations for voluntary regulations is that SMEs are expected to investigate and identify business benefits (such as cost reductions) which can be achieved from environmental improvement (Parker, Redmond and Simpson, 2009). This poses a challenge where integrated data is proposed as a complement to EMS. However, there is an opportunity to promote use of integrated data as a means to potentially identify cost reductions that can accrue from environmental improvement. It should be noted as well that compliance and profit driven SMEs see market driven forces as more compelling than weak regulations. A well-coordinated and diverse strategy intervention approach is likely to be more successful in engaging SMEs. It has been recommended that such an approach should be developed into a practical toolkit for supporting agencies (Parker, Redmond and Simpson, 2009).

There are at least two methods to promote the use of integrated environmental data by SMEs; self-directed learning (e.g. DIY guides and toolkits); and facilitated education (i.e., workshops, conferences, etc.) (Parker, Redmond and Simpson, 2009). The decision about which method to use (or to what extent to combine both methods) would be a big challenge given the cost implications. Government guidance positively affects SMEs environmental performance. Some studies reported that SMEs preferred educational information and advice as the most important for encouraging environmental improvement. They perceived that education would encourage their environmental improvement (Parker, Redmond and Simpson, 2009).

Studies have shown that many SME owner-managers are still unsure whether environmental protection results in increased profits. The majority still perceive cost as a potential barrier to environmental good practice. This may be because SMEs tend to only perceive clear financial benefits from efficiency measures such as recycling and energy efficiency, and remain concerned that other environmental measures will be expensive (Revell, Stokes and Chen, 2010). The issue about cost as a potential barrier to environmental good practice is an important consideration for implementing an integrated environmental data approach within SMEs. On the one hand, if the SMEs would be required to generate such data themselves (i.e. self-reporting business intelligence), the issue of purchasing the necessary software arises. On the other hand, if regulators such as the Environment Agency were to produce such data on behalf of SMEs, the cost burden would shift from business to government which in itself might not be feasible given budget constraints.

Some challenges have also been identified in respect to the other groups.

Citizen science. Consumers might be wary of participating if their involvement might lead to their personal data being accessible to unauthorised persons. In such cases, it is important to ensure consumer confidentiality.

Public Sector. To effectively make use of big data needs someone who knows how to process it. However, for the public sector, that sort of capability in data processing is not particularly high (Marrs, 2014).

It has been suggested that there is a need to redefine the way that authorities understand and engage with the process of sharing and working with public data sets. Suggestions include phased releases of datasets, with certified levels of quality at each step; initiatives to

stimulate more private sector involvement in data sharing; and a focus on building the skills across the board to work with data in the modern age (Young, 2013). For instance in the UK, too many public sector boards have limited their engagement in the big data initiative to simply uploading specific datasets into the central (data.gov.uk) repository, leaving them there for others to perchance discover. Improving data quality will be a fundamental step in unlocking the value that data holds for the public sector and beyond (Young, 2013).

Actions 5.1 and 5.2 of the CLEAR Info project demonstrated that interoperability of data is still a big challenge to data integration. Although in some cases it might be possible to transform one type of data to common interoperable standards, this can be a resource consuming activity.

Other challenges identified by Action 5.1 for integrating data are:

- In many EU member states, data is generated by local authorities. Differences in the collection, storage and permitting methods make it hard to aggregate at a national and international level. For instance, the format it is held in could be databases, data in free text fields, geographic data in maps, paper records, spreadsheets, etc. It would require a lot of effort to transform each data set into a compatible format.
- Differences in definitions such as “breach of permit” data in the UK could vary in each member state making it difficult to aggregate and compare pan-European data in a meaningful way.
- Specific to CLEAR Info, there were difficulties in matching available data sets to company names. The CLEAR Info project matched Environment Agency data to “Companies House” registrations with varying degrees of success in each data set, depending on how the site or permit owner was identified. The challenge was greater for international companies since the system for recording companies is different in each country.
- The level of detail in most data sets is very complex. In the age of big data and visualisations, users would want simplified information, and some context about what it is and how it has been measured, to get a high level overview. They lack the time to interrogate it and are only after the relevant information. Hence, data needs to be provided with some interpretation and high level collations.
- Changes in company or site ownership need to be kept up to date. Such changes can make it difficult to look at trends over time in the data, because previous year’s data may not relate to exactly the same sites and subsidiary businesses. Processes for notifying the authorities of the change of ownership vary between member states.
- Availability of regulatory data can be a barrier. Data may be gathered at local level and held in different formats. At the national level, datasets may not be available for others to use. In the UK, it is possible to request permit data through “Freedom of Information” requests. However, this is a resource intensive process lasting up to three months without guarantee of success.
- Language barrier issues in respect of some data were identified. Some datasets were not available in English, making it difficult to assess their usefulness even at a high level.
- Draft datasets produced to align to the INSPIRE standards were incompatible in some cases. For instance, INSPIRE standards drilled down data back to site level, rather than conveying the company ownership.

- Although Action 5.1 explored how the INSPIRE model could be extended, the permit and monitoring data were all unconnected. Plausible solutions pointed to the need for agreed pan-European data standards that serve the purpose of the user.

4 Summary

A number of opportunities exist to co-opt integrated environmental data into the activities of SMEs and other groups in order to help with compliance of EU legislation. For SMEs, at a baseline level, integrated data can help them make sense of the multitude of environmental legislation they have to comply with. However, this in itself is no guarantee of compliance. Efforts need to be made to help SMEs understand how the use of integrated data can improve their core business performance. At a practical level, integrated data can help SMEs become more resource efficient amongst other benefits. This report has also illustrated various innovative uses of big data across the globe including the great potential in citizen science.

Although there are several opportunities to use integrated data amongst SMEs and other groups, there are equally many challenges that would need to be overcome including how SMEs perceive regulation and regulators as well as the relationship (if any) between environmental performance and profitability. Given the important role of SMEs in Europe and the clear benefits of using integrated environmental data, further practical research beyond the life of the CLEAR Info project is needed to address the issues raised in this report.

5 References

Aragón-Correa, J.A., Hurtado-Torres, N., Sharma, S. and García-Morales, V.J., 2008. Environmental strategy and performance in small firms: A resource-based perspective. *Journal of Environmental Management*, 86(1), pp.88–103.

Battaglia, M., Bianchi, L., Frey, M. and Iraldo, F., 2010. An innovative model to promote CSR among SMEs operating in industrial clusters: evidence from an EU project. *Corporate Social Responsibility and Environmental Management*, 17(3), pp.133–141.

Brammer, S., Hoejmose, S. and Marchant, K., 2012. Environmental Management in SMEs in the UK: Practices, Pressures and Perceived Benefits. *Business Strategy and the Environment*, 21(7), pp.423–434.

Calogirou, C., Stig, S.Y., Peter, L.B. and Stella, A., 2010. *SMEs and the environment in the European Union*. [online] Denmark: European Commission, DG Enterprise and Industry, p.211. Available at: <http://ec.europa.eu/enterprise/policies/sme/business-environment/files/main_report_en.pdf> [Accessed 31 Jul. 2014].

Chen, L.Y., 2013. *Danger Maps Backed by Alibaba Pinpoint Chinese Pollution*. [online] Bloomberg. Available at: <http://www.bloomberg.com/news/2013-06-12/danger-maps-backed-by-alibaba-pinpoint-chinese-pollution.html> [Accessed 30 Nov. 2014].

Curran, T. and Williams, I.D., 2012. A zero waste vision for industrial networks in Europe. *Journal of Hazardous Materials*, 207–208(0), pp.3–7.

Daddi, T., Testa, F. and Iraldo, F., 2010. A cluster-based approach as an effective way to implement the Environmental Compliance Assistance Programme: evidence from some good practices. *Local Environment*, 15(1), pp.73–82.

Dietrich, J., Becker, F., Nittka, T., Wabbels, M., Modoran, D., Aionesei, C., Kast, G., Williams, I., Curran, T., den Boer, E., Kopacek, B., Schadlbauer, S. and Musterle, J., 2014. Extending product lifetimes: a reuse network for ICT hardware. *Proceedings of the ICE - Waste and Resource Management*, 167(3), pp.123–135.

eBird, 2014. *Global tools for birders, critical data for science*. [online] Available at: <http://ebird.org/content/ebird/about/> [Accessed 24 Nov. 2014].

edoc, 2014. *edoc — The new way to transfer waste*. [online] Available at: <http://edoconline.co.uk/> [Accessed 9 Dec. 2014].

European Commission, 2014. *Towards a thriving data-driven economy | Digital Agenda for Europe*. [online] Available at: <http://ec.europa.eu/digital-agenda/en/towards-thriving-data-driven-economy> [Accessed 27 Nov. 2014].

European Union, 2012. Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE). *Official Journal of the European Communities*, 55(197), pp.38–71.

Feuer, A., 2013. Mayor Bloomberg's Geek Squad. *The New York Times*. [online] 23 Mar. Available at: <http://www.nytimes.com/2013/03/24/nyregion/mayor-bloombergs-geek-squad.html> [Accessed 1 Dec. 2014].

Halila, F., 2007. Networks as a means of supporting the adoption of organizational innovations in SMEs: the case of Environmental Management Systems (EMSs) based on ISO 14001. *Corporate Social Responsibility and Environmental Management*, 14(3), pp.167–181.

Hickey, S., Fitzpatrick, C., Maher, P., Ospina, J., Schischke, K., Beigl, P., Vidorreta, I., Yang, M., Williams, I. and den Boer, E., 2014. A case study of the D4R laptop. *Proceedings of the ICE - Waste and Resource Management*, 167(3), pp.101–108.

Høivik, H. von W. and Shankar, D., 2011. How Can SMEs in a Cluster Respond to Global Demands for Corporate Responsibility? *Journal of Business Ethics*, 101(2), pp.175–195.

Hsu, J., 2014. *Why Big Data will have a big impact on sustainability. Carbon Trust*. [online] Available at: <http://www.carbontrust.com/news/2014/02/why-big-data-will-have-a-big-impact-on-sustainability> [Accessed 30 Nov. 2014].

Low Carbon Oxford, 2014. *A network of organisations with a shared vision of Oxford as a low carbon city.* [online] Available at: <http://lowcarbonoxford.org/> [Accessed 17 Dec. 2014].

Lynch-Wood, G. and Williamson, D., 2014. Understanding SME responses to environmental regulation. *Journal of Environmental Planning and Management*, 57(8), pp.1220–1239.

Marrs, C., 2014. *Big Data: Land use statistics. PublicTechnology.net*. [online] Available at: <https://www.publictechnology.net/articles/features/big-data-land-use-statistics> [Accessed 30 Nov. 2014].

Ongondo, F.O. and Williams, I.D., 2012. A critical review of the UK household WEEE collection network. *Proceedings of the ICE - Waste and Resource Management*, 165(1), pp.13–23.

Ongondo, F.O., Williams, I.D., Dietrich, J. and Carroll, C., 2013. ICT reuse in socio-economic enterprises. *Waste Management*, 33(12), pp.2600–2606.

Parker, C., Redmond, J. and Simpson, M., 2009. Review of interventions to encourage SMEs to make environmental improvements. *Environment and planning C : Government & policy*, 27(2), pp.279–301.

Revell, A. and Blackburn, R., 2007. The business case for sustainability? An examination of small firms in the UK's construction and restaurant sectors. *Business Strategy and the Environment*, 16(6), pp.404–420.

Revell, A., Stokes, D. and Chen, H., 2010. Small businesses and the environment: turning over a new leaf? *Business Strategy and the Environment*, 19(5), pp.273–288.

Silvo, K., Melanen, M., Honkasalo, A., Ruonala, S. and Lindström, M., 2002. Integrated pollution prevention and control - the Finnish approach. *Resources, Conservation and Recycling*, 35(1–2), pp.45–60.

Spotfire, 2014a. Data Analytics To Evaluate the Environmental Impact of 'Fracking'. *TIBCO Spotfire's Trends and Outliers*. Available at: <http://spotfire.tibco.com/blog/?p=22398> [Accessed 30 Nov. 2014].

Spotfire, 2014b. Life Is Data: Using Analytics to Save the Environment. *TIBCO Spotfire's Trends and Outliers*. Available at: <http://spotfire.tibco.com/blog/?p=26407> [Accessed 30 Nov. 2014].

Springwise, 2014. *Platform gives businesses green supply chain recommendations*. [online] Springwise.com. Available at: <http://www.springwise.com/platform-businesses-green-supply-chain-recommendations/> [Accessed 30 Nov. 2014].

Tischer, A., den Boer, E., Williams, I. and Curran, T., 2014. Industrial network design by improving construction logistics. *Proceedings of the ICE - Waste and Resource Management*, 167(2), pp.82–94.

TNS, 2013. *SMEs, resource efficiency and green markets*. [Flash Eurobarometer] Brussels: European Commission, DG Comm, p.293. Available at: <http://ec.europa.eu/enterprise/policies/sme/business-environment/files/main_report_en.pdf> [Accessed 31 Jul. 2014].

UN, 2014. *Big Data Climate Challenge Winners show the UN how data can drive climate action. United Nations Global Pulse*. [online] Available at: <http://www.unglobalpulse.org/big-data-climate-challenge-winners-show-UN-how-data-can-drive-climate-action> [Accessed 30 Nov. 2014].

Williams, I.D., Marsden, C., Laidlaw, S., Stokes, K., Macgregor, A. and Passant, F., 2013. Using company level environmental reporting and information to promote effective implementation of environmental legislation. In: C. Raffaello, H. Pinjing, K. Peter, M. Yasushi, R. Debra and S. Rainer, eds., *Sardinia 2013 Symposium*. Proceedings of the Fourteenth International Waste Management and Landfill Symposium. S. Margherita di Pula, Cagliari, Sardinia, Italy, September 30 - October 4, Paper 118.

Williams, R., 2014. *Emissions rise at UK universities puts 2020 targets in doubt*. [online] the Guardian. Available at: <http://www.theguardian.com/education/2011/jun/07/uk-universities-emissions-rise> [Accessed 1 Dec. 2014].

Wilson, C., Williams, I.D. and Kemp, S., 2011. Compliance with Producer Responsibility Legislation: Experiences from UK Small and Medium-sized Enterprises. *Business Strategy and the Environment*, 20(5), pp.310–330.

Wilson, C.D.H., Williams, I.D. and Kemp, S., 2012. An Evaluation of the Impact and Effectiveness of Environmental Legislation in Small and Medium-Sized Enterprises: Experiences from the UK. *Business Strategy and the Environment*, 21(3), pp.141–156.

WRAP, 2011. *Realising the Reuse Value of Household WEEE*. [online] Banbury, UK: WRAP (Waste and Resources Action Programme), p.25. Available at: <http://www.wrap.org.uk/content/value-re-using-household-waste-electrical-and-electronic-equipment> [Accessed 15 Sep. 2013].

Young, M., 2013. *The Environment Agency - The open data environment. Big Data Insight Group*. [online] Available at: <http://www.thebigdatainsightgroup.com/site/article/interview-stefan-carlyle-environment-agency-open-data-environment-0> [Accessed 30 Nov. 2014].

Zorpas, A., 2010. Environmental management systems as sustainable tools in the way of life for the SMEs and VSMEs. *Bioresource Technology*, 101(6), pp.1544–1557.