Cleanweb UK: How British Companies are using the Web for Economic Growth & Environmental Impact

Working Paper: A Market Scoping Study

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Abstract

The Cleanweb sector sits at the intersection between cleantech, web technology, the Internet of Things and Collaborative Consumption. It combines technology innovation, new business models and commercial sustainability objectives with reducing our impact on the environment. These technology businesses are transforming the way their customers activate environmental change. The UK is particularly well-placed in Europe to take a lead in shaping this market if the right support is provided for the companies in this sector. This scoping study is the first attempt to map out the UK Cleanweb sector so that an understanding of the sector's emerging trends and business support requirements can be formed and appropriate action taken. The report makes recommendations for how this sector can be supported for economic growth and for environmental benefit.

Keywords

Cleanweb, cleantech, startups, SMEs, environmental, sustainable development, web technology, IT, ICT, innovation, business models, collaborative consumption, internet of things, energy, cities, food, transport

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Jack is an organiser of Cleanweb UK, the world's largest Cleanweb community, bringing together 750 entrepreneurs, developers, designers, energy professionals, and environmentalists. He has been interviewed about Cleanweb by the New York Times and is nominated for Best Paper award at the 2014 ICT for Sustainability conference in Stockholm, for his work *Web for Sustainability: Tackling Environmental Complexity with Scale*.

Jack also coordinates the Open Knowledge Foundation's Open Sustainability group, the international community on the use of open data for the environment. Jack holds a BA and MSc in Physics from the University of Cambridge, and has received a number of awards for web innovation, including the World Bank's Apps for Climate competition, the Linked Up Prize for Open Data in Education, and the BP Helios Award.

Executive Summary

The *Cleanweb* is the web-enabled evolution of Cleantech. It is known by other names including *Web for Sustainability* and *Tech for Good*. Many agree that *Cleanweb* is a useful shorthand to convey the distinctive characteristic of this sector which uses Information & Communications Technology (ICT) to deliver web services to business customers and consumers with energy or resource efficiency benefits. It sits at the intersection of Cleantech, web technology, the Internet of Things and the Sharing Economy.

Cleanweb companies have rapidly scalable business models which can make a global contribution to protecting the environment. A Cleanweb business may not be "clean" first, but the service they deliver has a measurable environmental benefit. The use of ICT means that they can be less capital intensive, faster to scale and more accessible to customers. An attractive opportunity for investors and for sustainable development.

Cleanweb examples from the USA, particularly Nest Labs, have demonstrated how rapidly these businesses can grow and create economic value and jobs. It took just 4 years from starting up to sealing a $3.2B sale to Google in the case of the Nest intelligent thermostat, which provides an energy saving hub for the connected home. This is green technology growth at web speed.

In the UK there is significant activity in the Cleanweb market and a real opportunity to stimulate economic growth which doesn't damage the environment. Whilst there has not yet been the runaway financial success of a Nest equivalent we have seen rapid growth from AlertMe, CityMapper, Masabi and Open Energi. The most visible UK Cleanweb companies tend to be working in the areas of smart energy management and sustainable transport, particularly in cities, whilst significant opportunity is seen in sustainable agriculture and food. Cleanweb food companies may now follow the recent and successful IPO of Just Eat which now has a market value of £1.5B. These market segments of energy, transport and food are also the areas which have significant overlap with the Internet of Things (IoT) and the Sharing Economy. The Cleanweb sits at the intersection of IoT, Sharing Economy and Cleantech.

To identify a Cleanweb company you should look for these characteristics: (i) The ability to support a change in the behaviour of a person or the operation of a thing; (ii) A scalable business model which is revenue generating; (iii) Use of ICT for connecting people or things; (iv) An application of technology that can rapidly address a significant market opportunity; and (v) The ability to increase the productive use of natural resources (i.e. energy, water, materials, etc) or address another global environmental challenge (i.e. climate change, air pollution, ocean acidification, etc.).

It is estimated that there are thousands of Cleanweb companies around the world. The Cleanweb Initiative has been establishing national hubs in many locations around the world to create a grassroots movement for change. This groundswell of activity is producing new technologies and new businesses. In the UK, at a national level this is not directed to achieve economic nor environmental policy goals and this is a missed opportunity. Capital light and highly disruptive businesses, which the Cleanweb sector can provide, are highly desirable to investors so there is an opportunity to support this UK market to grow the economy, create jobs and attract inward investment.

The UK policy environment for starting a new business is favourable at present with over half a million new companies being created each year. However, Cleanweb startups presently

have limited opportunities to receive targeted support that understands how to shape their particular commercial propositions in a way which can serve a business need and deliver environmental benefits. Cleanweb SMEs tend to fall between two stools, business support focused purely on web businesses and the other is Cleantech. There are only a few incubation programmes which have managed to combine these two worlds to produce fast growing Cleanweb businesses. Continued support and expansion of these existing programmes is essential to identify these Cleanweb innovators. Whilst a dedicated Cleanweb incubation programme could accelerator this innovation and the growth of the sector.

Finding follow-on funding is even harder for these companies as there is no targeted investment for the transition of these companies from startup to SME, that critical inflexion point at which they move from being a startup to becoming a *Scaler* business. More commercialisation support is required for Cleanweb businesses with a commercial understanding of their needs in terms of investment and funding; skills development and talent recruitment relevant to their sector; and expert optimisation analysis to increase impact in commercial and environmental terms.

The UK has an opportunity to capitalise on the potential for economic growth in the Cleanweb sector. There is an opportunity for the UK to be the European leader in this field. The danger is that this promise could fade without the right support for this technology and these businesses. Cleanweb SMEs are already looking to the USA and continental Europe for investment and business support. Rather than these businesses moving overseas the UK could attract more of these types of business to set up shop in the UK.

Political support for the Cleanweb sector could also lead to faster growth of this promising sector in the UK. Policy mechanisms that send clear messages to businesses and consumers about the environmental impacts and the need for better environmental performance would support the growth of Cleanweb business. In particular the energy, transport and food sectors. Measures to support the use of ICT for addressing climate change and environmental policy goals and the need for more resilient cities would be equally valuable in the support of growth. Incentives for responsible investors to place money into businesses which have an environmental impact, particularly at an early venture stage, could also see much needed growth finance flow into these businesses.

The grant funding provided by InnovateUK and the European Commission is becoming more accessible to SMEs and is being targeted on Cleanweb areas of interest such as energy, transport, food and cities. More emphasis is still required on the benefit of ICT as a key technology in solving environmental challenges in a commercially viable manner. The UK has a rich seam of academic research and industrial research, development and innovation in the Cleantech and high tech/ICT sectors. The application of this technology expertise for clean goals is an important opportunity for economic growth at a regional and a national level. This is exportable UK intellectual property.

Cleanweb companies can address different sector challenges, but underneath these commercial propositions there is significant overlap in the use of ICT. It is here where there exists opportunities for greater collaboration and knowledge exchange to accelerate growth.

To catalyse the UK Cleanweb sector it needs more direction. The Cleanweb UK network is a useful grass roots movement providing a valued forum for the exchange of ideas about the Cleanweb. This should be built on to stimulate growth and competition. More needs to be done to create links with Universities, funders, investors, suppliers & customers. A focal point is required for collective actions to champion the needs of the UK Cleanweb sector and facilitate specialist support for the sector. To do this successfully there needs to be a collection and dissemination of data relevant to the growth of the sector, which this report has started to do. This is the first of nine recommendations to accelerate the growth of the

UK Cleanweb sector which are given in section 7 for Cleanweb UK, the business community and Government.

1 Introduction

Information and Communications Technology (ICT) is being used to accelerate action to reduce our environmental impact. The application of ICT is being used by cleantech companies to break through cost barriers to make these businesses less capital intensive and easier to scale. There are innovative new *Cleanweb* businesses which are transforming markets, characterised by companies like Google's Nest Labs and Avis' Zipcar.

The Cleanweb sector sits at the intersection between cleantech, web technology, the Internet of Things and Collaborative Consumption. It combines technology innovation, new business models and commercial sustainability objectives with reducing our impact on the environment. These technology businesses are transforming the way their customers activate environmental change. The UK is particularly well-placed in Europe to take a lead in shaping this market if the right support is provided for the companies in this sector.

UK Cleanweb companies are very actively building innovative web technologies to solve global environmental challenges. Over six thousand Cleanweb start-ups are thought to exist around the world, although there are no accurate estimates of the total number in the UK 250 have been identified in this study.

A clear map of this market sector is required for the UK to succeed in supporting this technological and business innovation. Much of this Cleanweb innovation is fragmented, taking place in SMEs, and there has been no clear view of the trends in this market nor direction for how this innovation will reach scale to maximise the public benefit.

This scoping study's objective is to explain how companies are using this technology to deliver change and the areas of society where this benefits. This market scoping study will start to build the evidence base on which public support for the Cleanweb sector can be provided so that targeted funding and private investment can be made available to bring the best ideas to scale quickly creating jobs and economic value.

This study set out to answer the following questions:

1) Which Cleanweb companies exist in the UK that use web technologies to manage and analyse data that can be used commercially to deliver public environmental benefits?
2) What are the emerging trends in the Cleanweb sector?
3) Which UK organisations are providing support for innovation in this sector?
4) What support is required to accelerate the public benefits from Cleanweb innovation & can existing initiatives be leveraged to have a rapid impact?

2 Summary of Cleanweb Market

Cleanweb History

The term *Cleanweb* was coined by US entrepreneur, Sunil Paul. Paul presented his vision of the Cleanweb on 21st April 2011 to Gigaom's *Green:Net* conference in San Francisco (Ingram, 2011). In his mind the Cleanweb is the idea that "IT is going to be the next big driver of cleantech innovation."

Paul's argument for Cleanweb was that the introduction of the internet, and increasingly cheaper IT, would fundamentally change the economics of what we have known as Cleantech. He used renewable energy supply, efficient travel, accommodation supply and energy efficient lighting as examples of its application.

Paul used the cost of solar photovoltaic (PV) electricity service delivery as his first example. The cost of PV hardware had already seen significant improvement whilst the cost of capital and the cost of sales had not seen the same reduction of costs. It is these activities where IT could provide a cost breakthrough, which is what SolarCity had recently achieved with its *Solar Lease* product. This used the internet to acquire a large number of small clients which could be aggregated to form a large fund in a business model which used financial engineering. It is this use of IT with traditional cleantech and a web business model which sets Cleanweb companies apart as a new innovation.

The second area where Paul said the Cleanweb could apply IT to achieve environmental goals was travel and particularly ride sharing accessed through your mobile phone. This embodied the idea that the sharing economy could be utilised to reduce the need for new products through shared services and therefore reduce the overall demand for the use of limited resources. Later in 2011, Paul would become a Cleanweb CEO of ride sharing company SideCar, a competitor to the present market leader, Uber.

Paul used the table below to show that the Cleanweb shared characteristics with both Cleantech and the Web world. This shows that Cleanweb is more than traditional Cleantech, emphasising the benefits for investment of greater capital efficiency and faster scaling.

Cleantech	Cleanweb	Web
Materials, Chemistry, Biology	Internet, Social, Mobile, Local	Internet Social, Mobile, Local
Policy shapes market	Policy and Market interact	Policy influence by Market
Physical	Internet of Things	Entirely "virtual"
Better infrastructure	Use services to accelerate infrastructure and become more efficient	Better services

Figure 1. Sunil Paul slide to show Cleanweb at intersection of Cleantech & Web

The use of web technology gave Cleanweb a more human face than cleantech has traditionally achieved. This ability to engage consumers through social technology as well as businesses is seen as a transformative force for the Cleanweb.

In 2014 a definition of Cleanweb was developed for discussion with the wider Cleanweb community:

> Cleanweb is connected IT that address resource and sustainability challenges.

In the decade prior to Sunil Paul's presentation, several US companies had already started to be formed to innovate in this area. To better understand what Cleanweb companies look like the following examples illustrate the best application of the Cleanweb to date:

- Zipcar, a car sharing service was formed in January 2000 which allowed customers to rent cars by the hour in cities.
- Silver Spring Network was founded in July 2002 providing smart grid management software to market.
- More Associates was founded in the UK 2003 and later created Onzo, a domestic smart meter, and Carbon Culture, which applies gamification techniques to behaviour change for organisations who want to reduce their greenhouse gas (GHG) emissions.
- Recyclebank was formed in 2004 allowing consumers to get benefits to encourage recycling.
- The Climate Corporation was founded in 2006 to provide granular weather forecast information to farmers.
- SolarCity was founded in July 2006 to provide new financing & installation for domestic solar PV installations.
- Opower was founded in 2007 to encourage domestic energy efficiency savings.
- AirBnB was founded in August 2008 to allow sharing of spare rooms/homes as an alternative to hotels.
- Uber followed in March 2009 to enable car ride sharing.
- Nest Labs was founded in 2010 to develop and launch an intelligent domestic thermostat. A smart fire alarm followed.

Definition of Cleanweb

Cleanweb is a new term and still relatively unknown. People who have heard of cleantech often make the connection between the use of web technology to address environmental or resource challenges. An example of a technology or a company is usually required to form a stronger picture and that is why this study begins with a number of Cleanweb examples.

In describing Cleanweb companies, Oriol Pascual and the author have drafted these five characteristics of a Cleanweb company (Pascual, 2014). A Cleanweb company has:

- The ability to support a change in the behaviour of a person or the operation of a thing
- A scalable business model which is revenue generating
- Information and communications technology (ICT) for connecting people or things
- An application of technology that can rapidly address a significant market opportunity

- The ability to increase the productive use of natural resources (i.e. energy, water, materials, etc) or address another global environmental challenge (i.e. climate change, air pollution, ocean acidification, etc.).

Pascual has also identified that the Cleanweb market operates at the intersection between three other emerging markets – Cleantech, Internet of Things & Collaborative Consumption (Pascual, 2014).

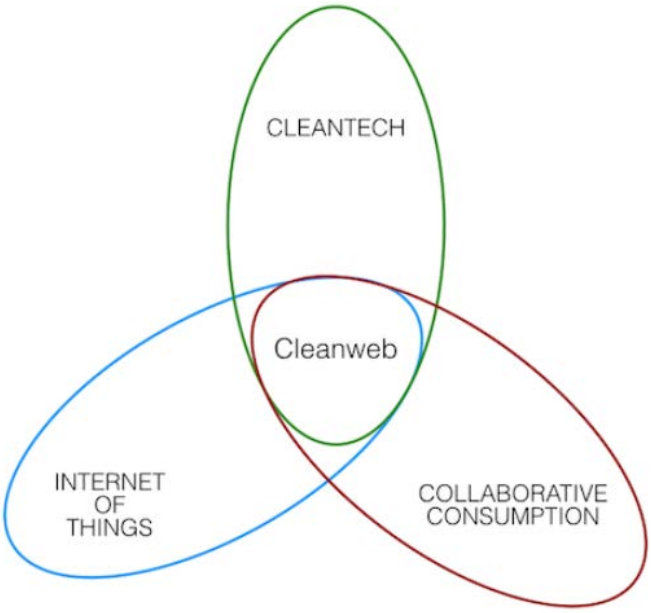


Figure 2. Cleanweb at the intersection (Copyright Oriol Pascual)

In early 2014 a group of individuals[1] involved with The Cleanweb Initiative attempted to write a definition of the Cleanweb. There was an extended discussion about the key elements of what constituted as Cleanweb.

For reference, the definition of *cleantech* formed in 2007 is *any product, service, or process that delivers value using limited or zero non-renewable resources and/or creates significantly less waste than conventional offerings*. (Pernick & Wilder, 2007)

This Cleanweb definition was produced over several iterations: *Cleanweb is connected Information Technology (IT) solutions that address resource and sustainability challenges.*

'Connected IT solutions' was used instead of 'web technologies' or 'digital technologies' to emphasise the connected nature of the Cleanweb, which the other terms imply. The terms 'resource' and 'sustainability' were both included to recognise a slight difference in emphasis between the American and European contributors to the discussion. The use of the term 'sustainability' is to recognise that not all environmental problems can be addressed through resource efficiency and alternative resource use.

For this report a survey was undertaken to gather feedback from the UK Cleanweb community. In the course of one month from May-June 2014, 70 people completed the detailed survey. The results are described in detail in the following sectors. In this survey the Cleanweb definition was tested to see whether it helped in understanding what the Cleanweb is as a concept. Figure 3 shows that a significant majority did find this definition useful. Some

[1] Blake Burris & Chris George from The Cleanweb Initiative, Jack Townsend & Sonny Masero from Cleanweb UK, Nicholas Eisenberger & Sameer Rashid from Pure Energy Partners, Oriol Pascual, James Smith, Jason Neylon, Michael Conti and Cristian Fleming.

suggestions were made on how different terminology could be used, how it could possibly be improved and how it could be changed to become more emotive – more of a *purpose statement* to capture the imagination rather than a definition.

There is a desire for a more emotive and engaging statement rather than a purely descriptive definition. There are three main elements which are appear to stand out in capturing the imagination: *smart* - the use of IT, digital and/or web technology; *sustainable* - the need to address a natural resource, environmental and/or sustainability problem; and *social* - the connectivity between people and/or things.

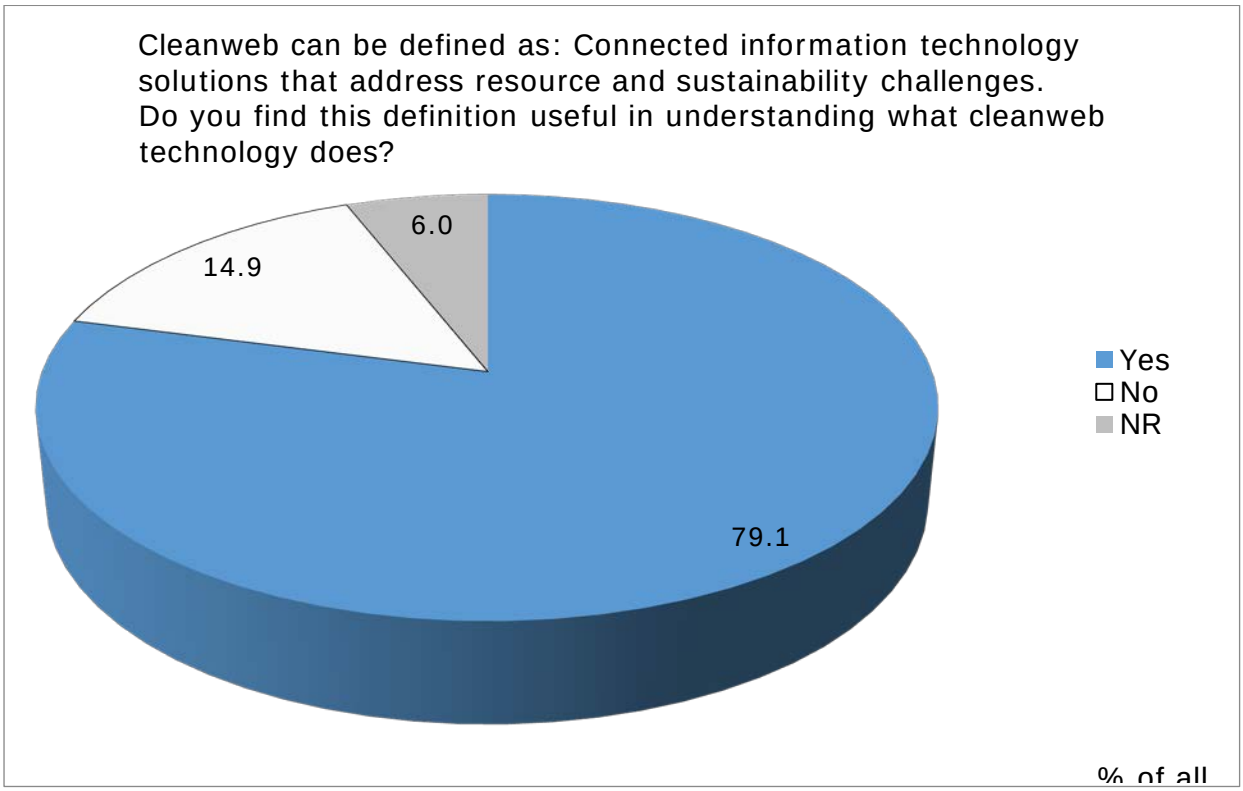


Figure 3. Do you find this definition of 'Cleanweb' useful? (Respondents: 64)

Awareness of Cleanweb Companies

Public awareness of Cleanweb technologies and companies is relatively low. There are a few notable exceptions. From a survey of Cleanweb UK members the best known Cleanweb companies are the larger US based companies as shown in Figure 4. It is Zipcar's acquisition by Avis and Nest Labs acquisition by Google, one year apart, which stand out as consumer brands despite their very different growth paths, use of technology and business models. These companies are described in more detail below as case studies.

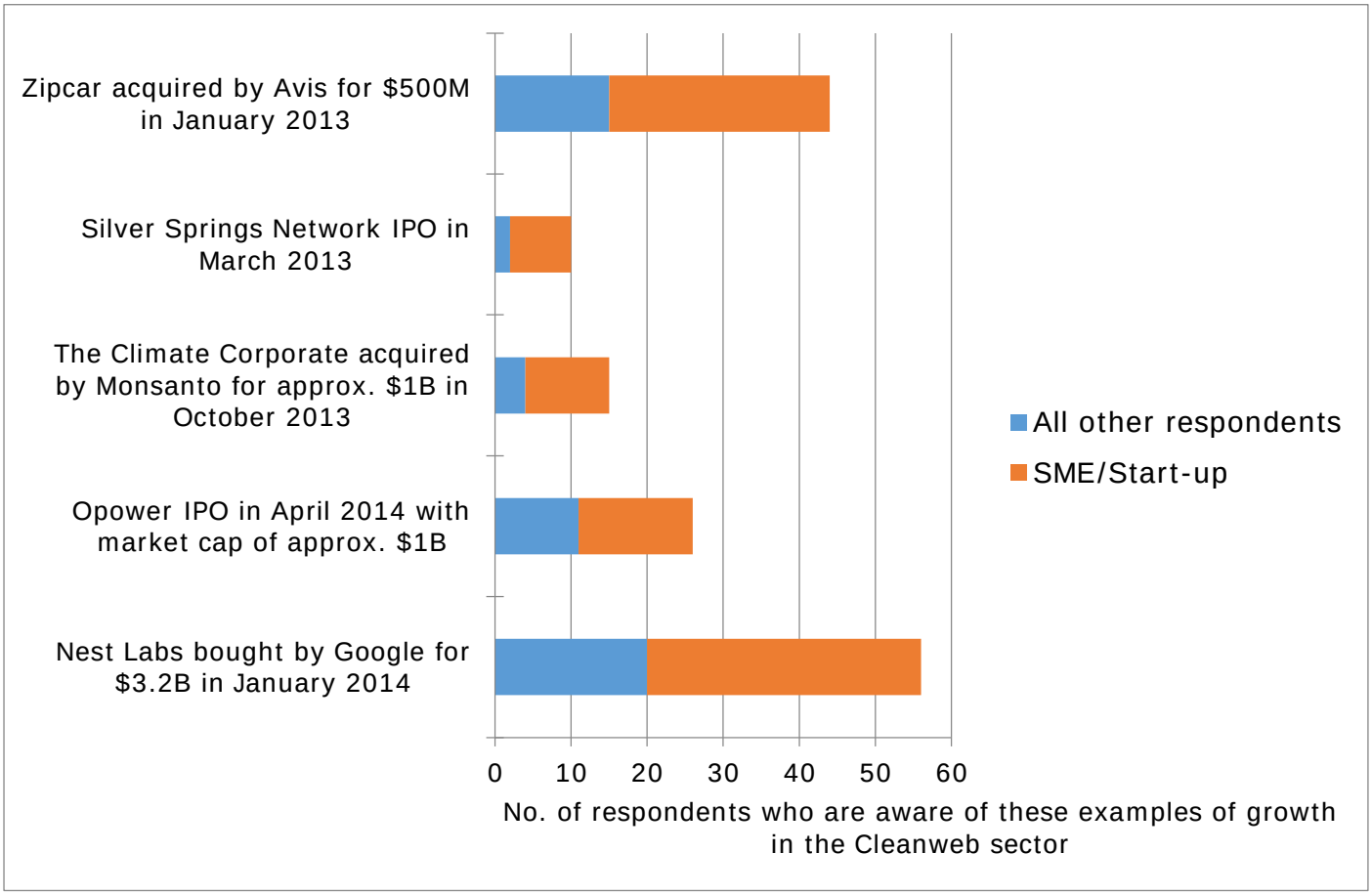


Figure 4. Examples of how fast the Cleanweb sector is growing (Respondents: 64)

Nest Labs Case Study

Nest Labs was founded in 2010 by Tom Fadell (CEO) and Matt Rogers (Vice President, Engineering) in California, USA. Prior to founding Nest, Fadell was Advisor to the CEO of Apple, Inc. and before that he was Senior Vice President of Apple's iPod Division. Fadell is a Computer Engineer by training and had previously founded a youth culture marketing agency called *Fuse* after leaving a CTO role with Philips Electronics. Rogers was also part of the Apple iPod team responsible for software development and worked as a computer engineer on the iPhones and first iPad.

Nest Labs has developed two products. A Wi-Fi connected domestic *Learning Thermostat* that learns the temperature preferences of the customer and the hours when home heating needs to be provided. The thermostat can act autonomously, using the customer's preferences and a presence sensor, to provide data variables to an algorithm that can optimise the heating requirement for the home and ideally reduce energy consumption. Forbes reported that Nest has sold around 1 million thermostats and sales of 40,000-50,000 per month when they were acquired (Rogowsky, 2014). The *Nest Protect* smoke and carbon monoxide detector tests itself and has a voice rather than an alarm to warn of any danger. Fadell and Rogers' vision for Nest is to "reimagine every unloved product in the home" (Komisar, 2014).

To fund this rapid four year growth of Nest Labs, the first round of investment for Nest Labs in September 2010 was provided by Shasta Ventures and Kleiner Perkins Caufield & Byers (KPCB) (CrunchBase, n.d.). Additional follow-on funding was provided by two further investment rounds involving these original investors plus Google Ventures, Generation Investment Management, Intertrust, Lightspeed Venture Partners and Venrock. Their final round of investment in January 2013 was for $30M, which helped to fund the acquisition of MyEnergy in May 2013. MyEnergy provides a similar online service as Opower to encourage

consumers to reduce energy consumption. This was prior to the acquisition of Nest by Google in January 2014 for $3.2BN when Nest had estimated revenues of $200-300 million (Rogowsky, 2014). Following this acquisition, Nest acquired Dropcam for a cash price of $555M in June 2014. Dropcam provides a Wi-Fi camera to consumers with a Cloud storage service for the continuous video recording.

The future of Nest Labs in more "open". In June 2014, Nest announced that it would open its platform to developers to allow other devices and services to interact with the Nest products (Barr & Winkler, 2014). Mercedes Benz has become a *Works with Nest* partner so that a Nest customer's car can notify the thermostat when the customer is on their way home and to turn the heating on. A partnership with Whirlpool will notify a washing machine or dryer that the customer is leaving the home and to control the appliance accordingly. Jawbone's *UP24* fitness band will let the thermostat know when a customer has woken up and to set the thermostat accordingly. The *Google Now* service will allow a customer to control their thermostat remotely. This is the start of the so-called *conscious home*, with the Nest thermostat providing a hub for a web of connected devices.

Zipcar Case Study

Zipcar was founded by MIT business school graduate, Robin Chase, and Harvard geochemist, Antje Danielson (Dunhaime-Ross, 2014). The car-sharing business idea, allowing a customer to rent a car by the hour, was formed whilst talking in their childrens' playground in Cambridge, Massachusetts, USA. Shortly after they first discussed the idea they incorporated the company in January 2000. Whilst this concept of a car club is now commonplace in many major cities, the idea for the technology behind Zipcar was inspired by Switzerland's Mobility co-operative, which allowed members to access cars without swapping keys. This business model and use of technology has now been replicated around the world. It is one of the earliest and most successful examples of the sharing economy and a conceptual path can be drawn from this innovation to multi-billion dollar, ride sharing company Uber.

Chase and Danielson started by raising $75,000 (Eha, 2013). Their first Zipcar, a green VW beetle, was on the road in May 2000 and they quickly grew to 600 members by September. One year after the company is formed, in January 2001, Danielson leaves Zipcar. Almost two years later, in December 2002, Zipcar raised $4.7M to fund the company's expansion (Crunchbase, n.d.). Shortly after, in February 2003, Chase was replaced by Scott Griffith as CEO with the mission to "go turn this political movement into a big company" (Gara, 2013). In 2006, Zipcar raised another $25M and expanded into Europe and, in 2010, the company received a further £21M of funding and strengthened its position in the UK by acquiring Steetcar for $50M. The investors involved in these later funding rounds included Benchmark, Globespan Capital Partners, Greylock Partners, Meritech Capital Partners and Pinnacle Ventures.

Zipcar's IPO followed in April 2011 raising $174M and was valued initially at $1B before the stock price tumbled from $28 to $8.24 during the course of 2012. When the company was acquired by Avis Budget Group for $491M it is estimated that there were 11,000 cars and 767,000 subscribers to the service. Griffith left Zipcar on the day after the acquisition was announced (Gara, 2013).

Since leaving Zipcar, Chase has gone on to found French peer-to-peer car-sharing service, Buzzcar, in 2011. She is also Chairman of Portuguese technology company Veniam Works. Chase's vision for Veniam Works looks at the confluence of the smart grid and cars enabled by Veniam technology to form a mesh network (Weinberger, 2009). Using the principle of "cooperative gain" Veniam is attempting to integrate multiple communication networks through cars as network nodes. This vision for an efficient, mobile mesh network is to underpin the *Internet of Things* allowing multiple machines to communicate with each through this novel network rather than being channelled through only fixed broadband connections. Mesh networks are being experimented with in Barcelona, Athens and Vienna.

Griffith is now a venture capitalist focused on investment in 'the connected car'. Danielson returned to academia after leaving Zipcar and is Director of the Institute of the Environment at Tufts University and a Board Member at the Earthos Institute.

Environmental Impact of Cleanweb

One of the real distinctions of a Cleanweb company is that it provides a positive environmental impact, as well as being faster to market and easier to scale. Within the Cleanweb community there is a debate about whether a Cleanweb business should have a specific environmental purpose or whether the environmental benefit can be a corollary impact of the core business.

For instance, the Nest thermostat is sold on the basis that the customer will *use energy more efficiently* and consequently *save money* as well as having a more *comfy home*. Other, similar devices, emphasise the money savings or a comfy home as the first benefit. Zipcar, on the other hand, focusses on the *cost benefit of not owning a car*, but having an *easily accessible* one only when you need it to *rent for short periods* of time. The environmental vision of the Zipcar founders got diluted by investors during the company's growth. In the UK, Loco2 has an explicit mission to reduce carbon dioxide (CO_2) emissions by providing an easy-to-book train travel service that makes it more attractive to get a train across Europe than to fly. Demand Logic's intent is to help building managers better understand how their building is operating so that they can optimise the energy usage. Demand Logic's customer buy their service because they want to save money and they want to reduce energy and CO_2 emissions.

Some people will argue that the environmental impact of the business will grow as the business enjoys financial success as the company will gain scale to create a bigger impact. Google was a popular Cleanweb example amongst the survey respondents because they have the potential to take Cleanweb solutions to scale. *"Google is one - they can drive change at scale."* Whilst others are highly critical of SMEs that are acquired by large corporations. In some cases, even saying these companies are no longer Cleanweb companies. *"The Climate Corporation stopped being Cleanweb the moment it was acquired by Monsanto..."* was one survey respondent's comment.

The final test for many people appears to be whether the environmental impact can be measured, and is measured.

AirBnB, the home-sharing service, is a prime example. On 31 July 2014 they published an environmental impact study of home sharing compared to using a hotel (AirBnB, 2014). Differentiating between their USA and European markets to show, unsurprisingly, significant benefits. Opower has similarly calculated the amount of energy they have saved through the service they provide to their consumers via their utility customers. From over 24 million consumers they state that they have saved the equivalent of turning the US State of New Hampshire's power off for one year (i.e. 1.3 million homes) (Tinjum, 2014).

Cleanweb Market Drivers

From 2000 to the present day there have been a number of market developments which have encouraged the coming together of web technology and the beneficial environmental goals of clean technology. A timeline is provided in Appendix B.

Policy

Over this period since 2000 the international environmental policy arena could be summarised as Start-Stop. The UN Kyoto Protocol came into effect in 2005 and the EU

Emissions Trading Scheme was launched. Both of these aimed to limit global GHG emissions. This international policy success built momentum in the following years which saw a significant expectation mount for the 2009 United Nations Climate Change Conference (COP15) in Copenhagen. In a flurry of activity leading up to the Copenhagen Summit there was significant expectations that a new agreement to cap global greenhouse gas emissions would be struck for the second commitment period of the Kyoto Protocol from 2013-2020. In the event no agreement was reached and only an Accord was published, but not adopted. Consequently, there is now no global climate change agreement that is legally binding.

This failed attempt to reach agreement on an environmental issue of such global significance has meant that other policy initiatives, such as the protection of biodiversity, have all moved at a slower pace over recent years. Many people in the business world have instead looked to business and charitable initiatives to move forward on significant environmental issues.

Extreme Weather & Global Mega Trends

One of the challenges in addressing climate change as a political priority is that there is not an international scientific consensus linking increasing global greenhouse gas emissions with changes to our local weather today. For most people, our continued use of fossil fuels does not appear to impact their day to day lives.

Where this attitude is changing is in the visible human impact of the increasing number of extreme weather events. The insurance industry is quick to highlight the increasing number of extreme weather events, in terms of extreme rain, wind and temperatures causing health problems and damage to property. In 2005 Hurricane Katrina devastated New Orleans making global news headlines and emphasised the catastrophic impact that extreme weather can have on everyday lives in USA. In October 2012, Hurricane Sandy in New York reinforced the impact that extreme weather events can have on people and the economy (Singer, 2012). During the winter 2013-14 there were a number of extreme weather events around the globe, including “biblical” flooding in the UK leading to a #Floodhack event to find new Cleanweb solutions. These very public weather events put changes in the global climate front of mind (Met Office, 2014).

The other mega trend which influences the Cleanweb is the movement of people into cities. According to WHO now, for the first time, more people live in urban areas than in rural areas (Global Health Observatory, n.d.). October 2011 saw the global population reach seven billion and the majority of these are in cities (Biello, 2011). This high concentration of people in cities requires an increased demand for infrastructure which means basic needs like buildings, energy, transport and food delivered in a sustainable way. This concentration also provides the opportunity for collaborative or shared services which can use city resources more efficiently. When extreme weather events impact on cities the connection between the need to act sustainably in cities to mitigate climate change can become visceral.

Publications & Research

The growth of the Internet has unarguably reshaped our social and economic landscape. There have been numerous publications which have shaped technology and business thinking in this area. In 2002 B.J. Fogg published *Persuasive Technology: Using computers to change what we think & do*, which formed the central thesis for the MIT Persuasive Media lab and has influenced application development across many sectors (Fogg, 2002). This text is important because its thesis is at the heart of most web applications available on the market today, including those used by Cleanweb companies. Fogg has in his research broken down many myths about using technology for behaviour change, boiling this down into some clear tenets for success including the need for being very specific about the simple behaviour that is being changed.

Where IT comes together with Cleantech is through the work of market analyst, Gartner, who shone a light on the environmental impact of IT in 2007 with their report *Green IT: The New Industry Shockwave* (Mingay, 2007). This was complemented in 2008 by the GeSI *Smart2020* Report which covered both the environmental impact of the global ICT industry, specifically in terms of GHG emissions, and importantly for Cleanweb the many benefits that could be delivered by ICT for Sustainability (The Climate Group, 2008). Further reinforced by the OECD report *Greener & Smarter: ICTs, the Environment & Climate Change* in 2010 (OECD, 2010) and the New York Times 2012 article *Power Pollution & the Internet* which exposed the power hungry nature of technology companies built on the need to accumulate, store and analyse data (Glanz, 2012). The first *ICT for Sustainability* conference was hosted in Zurich in March 2013 and the second will be held in Sweden in 2014. In 2014, GeSI produced an updated SMARTter2020 report which estimated that (GeSI, 2014):

ICT-enabled solutions offer the potential to reduce GHG emissions by 16.5%, create 29.5 million jobs and yield USD 1.9 trillion in savings.

This use of IT for addressing some of our intractable global environmental challenges responded to the work of the IPPC, such as the IPPC *Fourth Assessment Report* which provided clear scientific evidence that climate change was caused by human activities, in particular the burning of fossil fuels (IPCC, 2007). Together with the *Stern Review on the Economics of Climate Change* which emphasised the high adaptation cost of inaction on mitigating climate change these publications provided the evidence for a clean policy mandate to act globally on Climate Change (Stern, 2007).

The hope that internet economics and web-based business models could be transformational in accelerating our ability to reinforce our detrimental impact on the environment is addressed in other works. Chris Anderson popular book *Free: The Future of a Radical Price* describes the nature in which web technology is rapidly reducing the marginal cost of services, an idea which Sunil Paul tapped into for his vision of the Cleanweb (Anderson, 2009). Anderson described how the internet is changing the marginal cost of delivering services to consumers using Apple's iTunes as a prime example of how this has disrupted the music industry. This line of thought is explored further in the 2011 publication *The Third Industrial Revolution: How lateral power is transforming energy, the economy and the world* by Jeremy Rifkin (Rifkin, 2013). Rifkin makes a more explicit connection between this new economic future and the benefits for energy supply and the environment.

These works formed the basis for recent efforts to crystallise this thinking in business opportunities for the Cleanweb. Cleantech Group & Pure Energy Partners published *Sparking the Cleanweb* in 2013 highlighting examples of investment grade Cleanweb companies and corporate activity in this sector (Eisenberger & Rashid, 2013). This was followed by CB Insights *The New Clean Tech – 20 VC backed companies that nobody calls clean tech (but probably should)* and featured twenty Cleanweb companies (CB Insights, 2014).

Business Initiatives

Whilst global policy initiatives to address environmental issues languish in a lack of consensus and inaction there are a number of business initiatives which are happening independently and in response to regional policy initiatives. In terms of greening the impact of ICT there have been a number of recent initiatives in the past few years. On 8 September 2011, Google published its carbon footprint for the first time to show that it was starting to take responsibility for this environmental impact (Clark, 2011). In 2012, GreenQloud launched their data centre service as a 100% renewable powered green cloud hosting company (Koetsier, 2012); and in February 2014, the world's largest solar thermal project was turned

on in Ivanpah Dry Lake, California. This was funded by Google as part of their growing investment in renewable energy to provide security of supply.

In terms of using IT for environmental goals Cleanweb London (now Cleanweb UK) was formed on 26 September 2011. The Cleanweb UK meetings over the next few years saw the formation of Cleanweb companies Mastodon C (2012) and Open Utility (2013) with support from Bethnal Green Ventures and the Open Data Institute. In February 2012, Blake Burris founded The Cleanweb Initiative in Austin, Texas to create a global network of Cleanweb innovation hubs.

The timeline Appendix B shows the business entrepreneurs who have succeeded during this period.

In terms of investment in Cleanweb companies the Israeli venture capital firm, Terra Venture Partners, announced in 2013 their intent to raise a fund to invest in Cleanweb companies (Maag, 2013). January 2014 saw the launch of Rockstart Smart Energy Accelerator to support Cleanweb startup companies. In the same month, the Ashden Awards recognised Cleanweb companies Abundance Generation and Demand Logic at their annual awards. Abundance Generation won the Gold award and went on to win a Guardian Sustainable Business Award.

3 Portrait of UK Market

The Cleanweb UK Network

In September 2011, Cleanweb London was founded as a monthly meetup. Initiated by James Smith, a core group of founder organisers quickly assembled including Chris Smith, Jason Neylon and Jack Townsend. This was a grassroots movement of developers and web specialists who wanted to explore how IT could be used for environmental good. In early 2014 the Cleanweb UK group had an email list of 700 members who meet monthly in London at a variety of venues holding 50-100 people. There are now offshoots in Scotland and plans for regional groups in Manchester and the West of England around Bath & Bristol's regional cleantech and ICT clusters. Cleanweb UK is connected to the international Cleanweb Initiative and is the largest Cleanweb hub outside of the USA. Cleanweb UK is also part of an informal Cleanweb Europe network, which has hubs in Amsterdam, Barcelona, Berlin, Liege and Rome.

Cleanweb UK Survey

For this project a survey was undertaken to gather feedback from the UK Cleanweb community. A detailed survey was developed in SurveyMonkey and an invitation was sent to the 700 people on email distribution list of Cleanweb. In the course of one month from May-June 2014, 70 people completed the survey. The findings of this survey have been used through this report. A summary of the respondents is shown below.

Respondents

Figure 5 and 6 below show that the majority of respondents to the survey were small companies with less than 250 employees. Several large organisations with more than 2,500 employees did complete the survey, including responses from Cisco and Siemens.

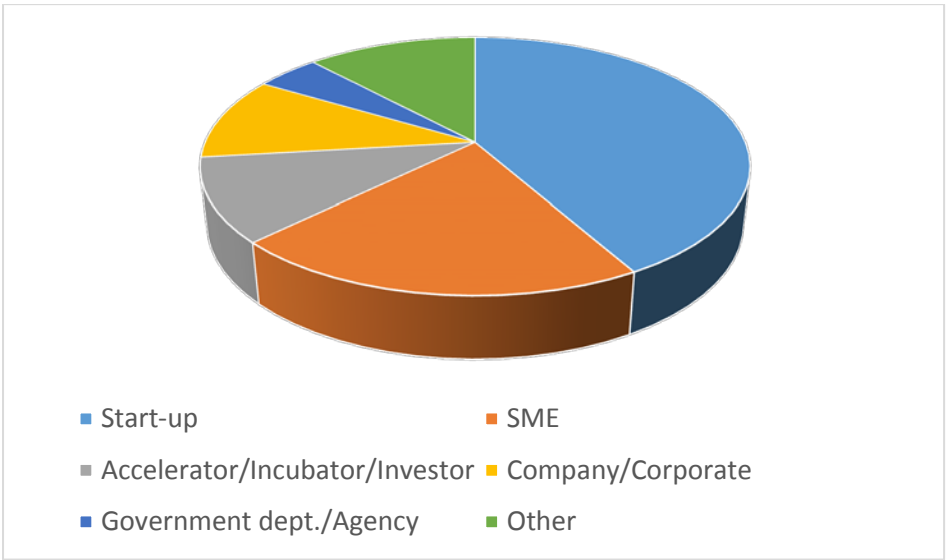


Figure 5. Respondent organisation types (Respondents: 68)

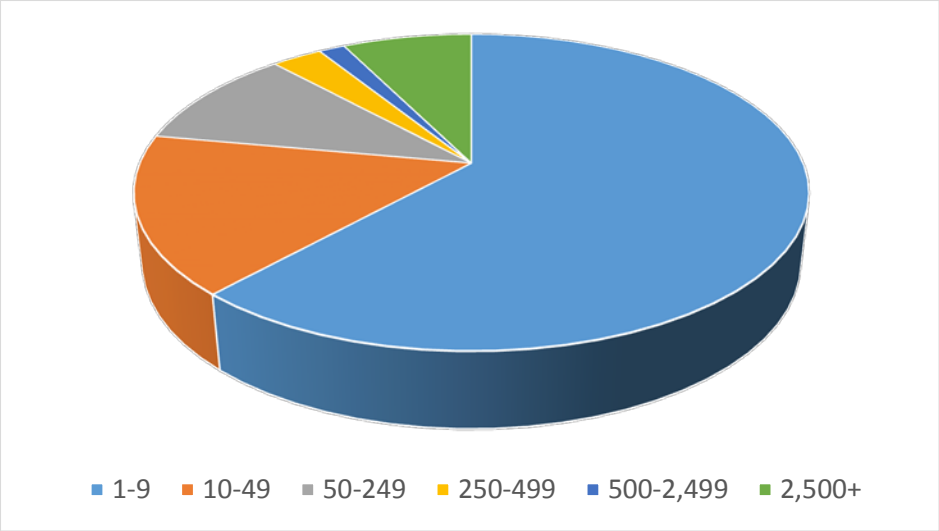


Figure 6. Respondents by number of employees (Respondents: 68)

Identifying a Cleanweb UK company

A number of survey questions were posed to establish whether organisations could be identified distinctly as belonging to a Cleanweb group companies which shared similar characteristics, regardless of whether they used the term to describe their organisation. The most dominant characteristic shared by almost three-quarters of respondents as show in Figure 7 is that they *support a change in the behaviour of a person or in the operation of a things*. Two thirds of the survey respondents *utilise IT for connecting people or things* and *almost one half increase the productive use of natural resources or address another environmental challenge*. Over half were *revenue generating* and just under half had a *scalable business model or technology that can rapidly address a significant market opportunity*.

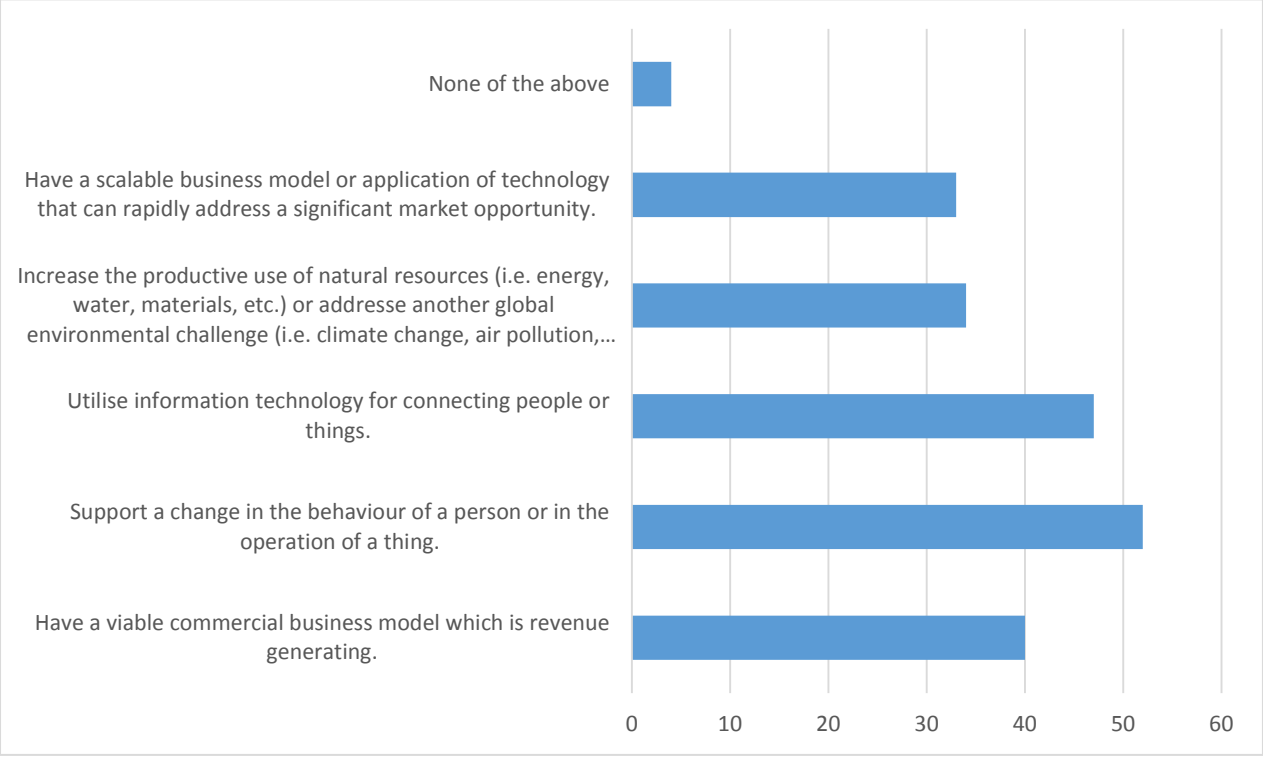


Figure 7. Which Cleanweb characteristics does your organisation have? (Respondents: 70)

Figure 8 shows the responses to the same question from the sub-group of SMEs respondents. These companies showed a stronger fit with these characteristics than the total group of respondents. For this sub-set, 58% of the respondents agreed that they showed all five characteristics compared to 47% for the larger group. Whilst 75% of start-ups/SMEs had four of the characteristics compared to 49% for the whole set.

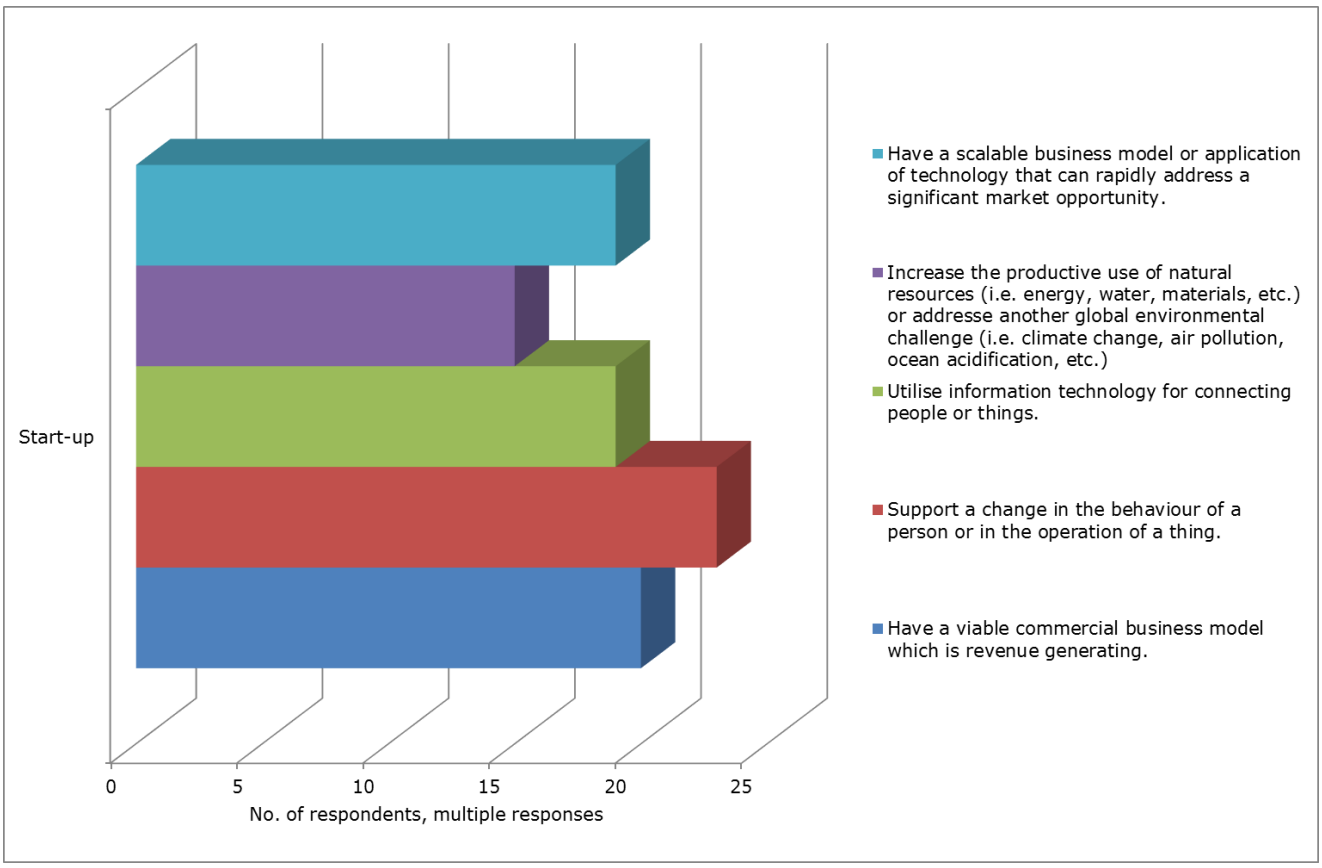


Figure 8. Which Cleanweb characteristics does your organisation have? (Respondents: 24)

Cleanweb UK Companies

From this research approximately 250 Cleanweb companies were identified who are operating in the UK and using web technology to address environmental challenges – see Appendix C. These Cleanweb companies are predominantly SMEs. These companies were found in the Crunchbase database which is predominantly focused on startup companies seeking investment and is not representative of more established SMEs working in this area. The most successful twelve of these companies have raised, on average, £5.75M of investment each between the years 2008-2013.

In the previous chapter the best know global Cleanweb companies were covered. For the UK, the better known Cleanweb companies are shown in the Figure below and are summarised in Appendix D.

Figure 9. Most Known & Exciting Cleanweb Companies

The seven UK companies from Figure 9 – Open Utility, Loco2, Mastodon C, AlertMe, Energy Deck, Abundance Generation and Carbon Culture - who have a strong profile in the Cleanweb community are different to the Cleanweb companies who have received the most investor interest. Using the Crunchbase list of Cleanweb companies 40 companies were identified who can have recorded investor details. Of these 40, the UK companies most successful at raising investment were mainly B2B rather than B2C companies such as Nest and Zipcar. The top 12 companies are described in Appendix D and are listed below. Between them they have raised £69M since January 2008.

1. Wireless Energy Management Systems International (WEMS)
2. Lysanda
3. PowerOasis
4. amee
5. CityMapper
6. Masabi
7. Open Energi
8. i2O Water
9. enModus
10. Green Energy Options (GEO)
11. Achilles Group
12. Water Innovate, part of Bluewater Bio

The investors who took an interest in more than one of these Cleanweb companies are Ombu Group, Slovak Business Agency's Fond Fondov (now known as the National Holding Fund, NHF), Hermes GPE Environmental Innovation Fund, the East of England Low Carbon Innovation Fund and Oxford-focused Oxford Technology Management.

Bethnal Green Ventures, Climate-KIC, ODI and SETSquared are the incubation/acceleration programmes that have seen the most early stage activity amongst Cleanweb UK companies.

Cleanweb UK Market Segmentation

Based on a review of Crunchbase data, the Cleanweb UK membership, Oriol Pascual's Cleanweb company database, desk research and the results of the survey completed for this

study a set of approximately 250 active Cleanweb start-up companies in the UK has been used for this research – see Appendix D.

These companies have been categorised by Jack Townsend using a taxonomy he has developed for his Web Science PhD at the University of Southampton. This taxonomy and categorisation in summarised in Appendix E. It shows the most active segments of the Cleanweb market, which are:

Providing

- *Resource Optimisation & Control in Building Efficiency*: e.g. EnergyDeck, enModus, and WEMS
- *Resource Optimisation & Control in ICT*: e.g. 1E
- *Resource Optimisation & Control in Electricity*: e.g. Open Energi
- *Telepresence*: e.g. Acano

Connecting

- *Collaborative Consumption in Transport*: e.g. Blablacar and Zipcar
- *Sustainability eMarketplaces in Food*: e.g. FarmDrop, FoodTrade and SeedPod
- *Reuse Marketplace*: e.g. BuyMyWardrobe

Assessing

- *Sustainability & Carbon Accounting*: e.g. Trucost
- *Sustainability Ratings & Comparison in Consumer Goods & Manufacturing Supply Chains*: e.g. Achilles Group and amee
- *Data Platforms & Standards in ICT*: e.g. Love Hz and Open Street Map

Guiding

- *Navigation & Realtime User Guidance*: e.g. Citymapper and GreenRoad Technologies

Green in IT

- *Green IT*: e.g. PowerOasis

Innovating

- *Analysis for Planning & Decision-Making in Renewables*: e.g. Bloomberg New Energy Finance

This analysis for the UK is useful to compare with Cleanweb innovation in other countries. For instance, the UK has relatively few companies who are providing *Collaborative Financing & Fundraising for Renewables & Energy Efficiency*. These are Abundance Generation, Repowering London and Trillion Fund. Abundance Generation is the largest with over £6.5M invested in renewable energy projects. The success of similar companies in the USA would suggest that there could be more potential for the UK companies with the right market support.

In the USA there are a number of fast growth companies in this area, in particular SolarCity (Munsell, 2014) which has a market capitalisation on 1 August 2014 of approximately $6.84B. SolarCity has used web technology and a range of residential Power Purchase Agreements (PPA) to aggregate a large number of small renewable energy projects (Michels, 2014).

Based on their success in attracting and aggregating customers the company has been able to offer three loan financing facilities (SolarCity, 2014). Once these facilities have been utilised for installing solar PV projects the company can then refinance this funding in the securitization market. These securities have value because of the assets deployed and their future income stream from free solar electricity.

This web based approach to provide financing for energy projects has now extended to energy efficiency with companies like BetterVest and GreenCrowding coming to market in Germany.

Cleanweb as a Label

The survey respondents were also asked what terms they would use to describe their own organisation, including whether they would use the term Cleanweb. The most popular terms were *Tech for Good*, *Clean Technology* and *ICT/Web for Sustainability*. Followed by Cleanweb. This result is indicative of the fact that these first three terms have been used for longer in the UK with Cleanweb being a newer term. These terms may be more useful but none of them have been adopted as a dominant phrase. Cleanweb may gain more momentum as a short-hand for these other terms.

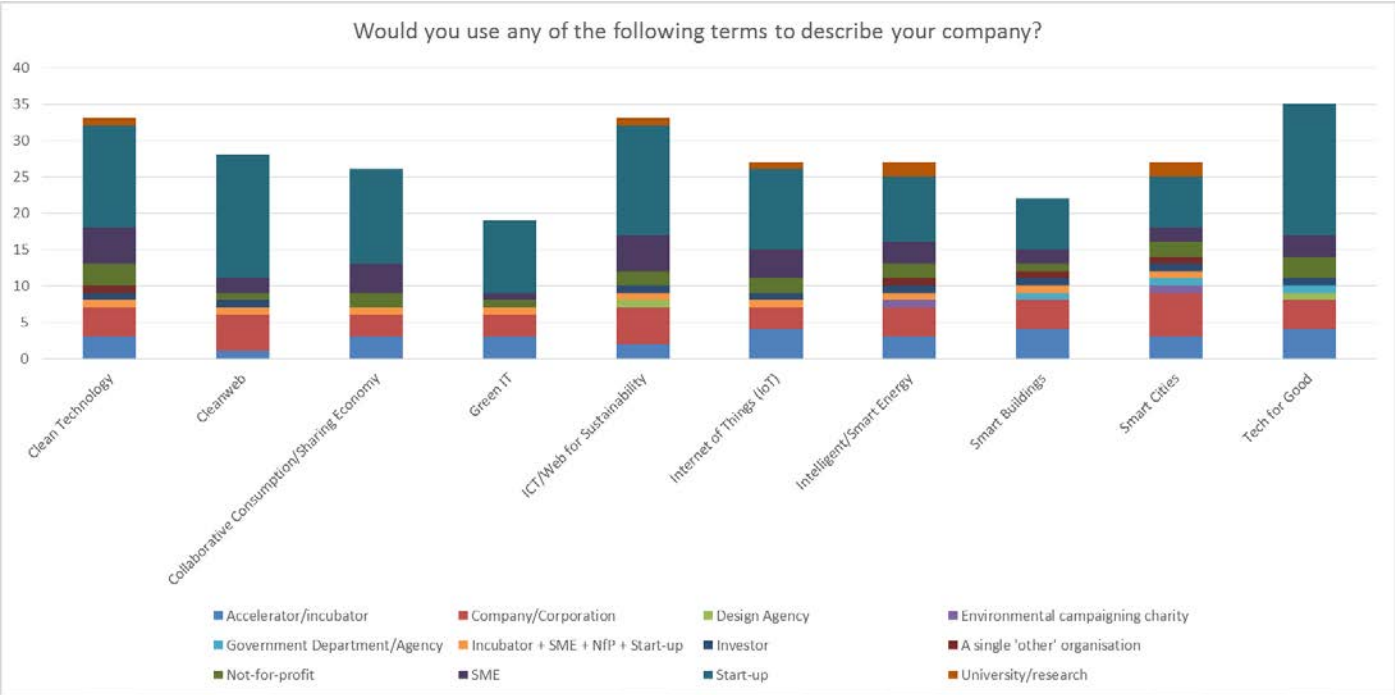


Figure 10. Which terms do you use to describe your company? (Respondents: 68)

Over half of the survey respondents were already convinced that the emerging Cleanweb sector is the next big thing, but to further prove the value of the Cleanweb label survey respondents want to see *more evidence of sustainability impact to prove the technologies' promise*; *major investors and corporations backing Cleanweb startups* (in Europe); and *government policies in support of the Cleanweb sector*.

The most quoted source of Cleanweb market information was Cleanweb UK and Gigaom, but many survey respondents did not have a good source.

Cleanweb UK Growth Needs

Of these SMEs, 58% had grown in the last year and had added an average of 3 recruits in the past year. The majority (67%) also expected to grow further in the next 12 months adding additional recruits. Recruitment was one of a number of priorities they were looking to fund in the next 12 months. Figure 11 below shows that the top three funding requirement for over 60% of respondents was *Sales & Marketing*; *Technology Development*; and *New Recruits*. With half of respondents recognising that *Scaling their Infrastructure* would also be a likely cost of growth.

These needs could be the same as startups from other domains. There are two distinct differences for Cleanweb companies. The first is the domain expertise required for both Sales & Marketing and from New Recruits. This expertise is a knowledge of customer markets in terms of both the business challenges those customers face and the environmental challenges they face. The second difference is that Cleanweb companies combine cleantech and web technology requirements. This means that for Technology Development and for Scaling their Infrastructure an understanding of both Cleantech and web technology is required to move quickly. At the moment support for Cleanweb companies comes either from a Cleantech or a Web technology perspective, and rarely a combination of the two.

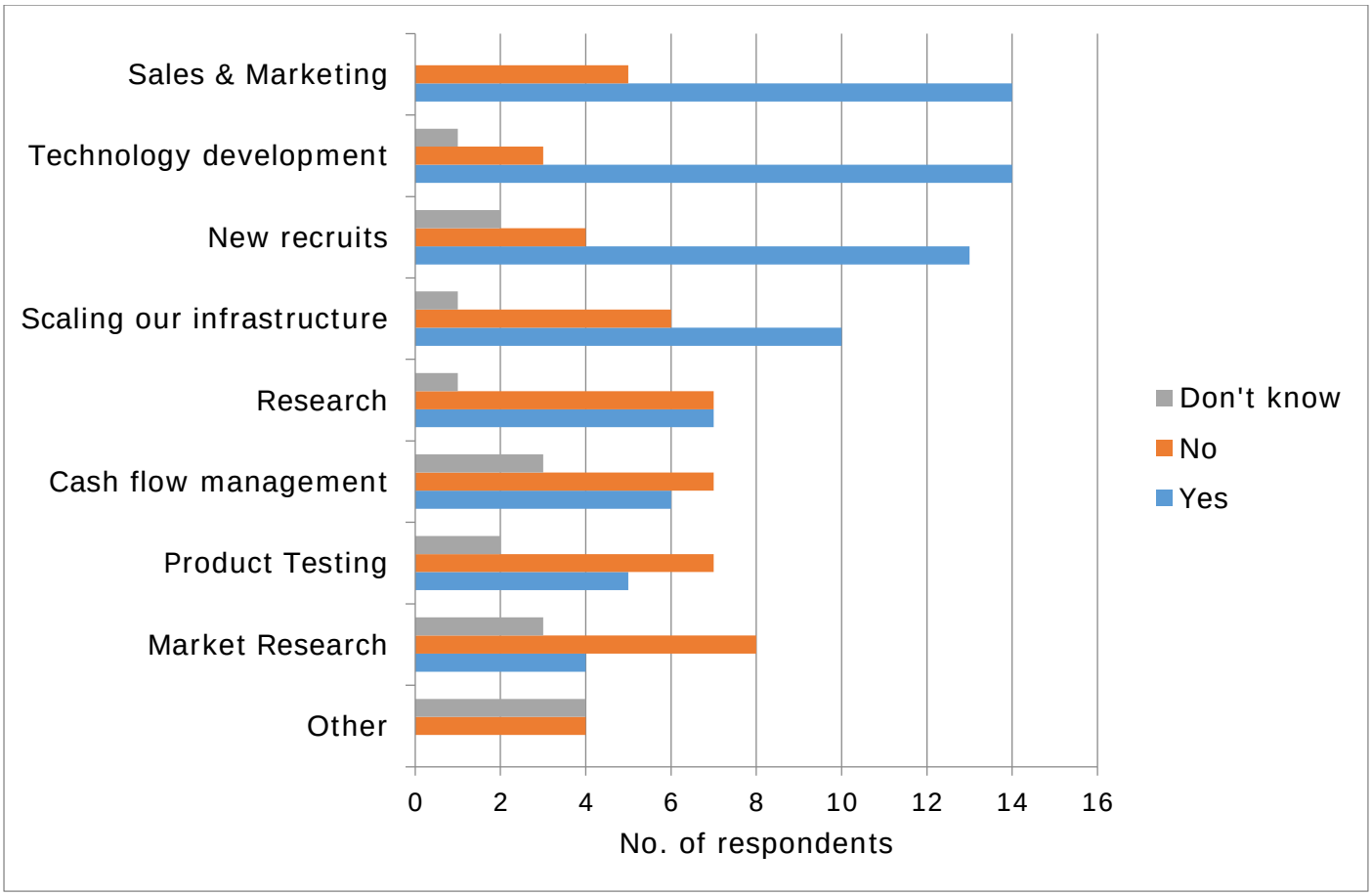


Figure 11. Funding need in next 12 months (Respondents: 20)

These identified funding needs are consistent with the challenges faced by these companies over the last 12 months. The top four challenges shown in Figure 12 are connected. These companies need to have a strong business proposition which can be the basis of telling a compelling story to customers. If the story and the proposition are not compelling then they will struggle to get the attention of customers, particularly if they are a new, relatively unknown company. This business discipline is not unique to Cleanweb companies. Where there is a difference is in shaping a proposition and story. This has an important requirement

to have knowledge of a specific customer market, which could be both a sector understanding and an appreciation of their organisation in particular the environmental pressures facing their sector and their organisation. Anecdotal evidence suggests that this vertical sector knowledge and the environmental domain knowledge is where some of these Cleanweb businesses struggle to make their mark.

"Green big data was Mastodon C's original proposition, but clients didn't value this as a differentiator. We have had to pivot to big data analytics. What we need is a view of the market drivers for low to zero carbon services. For instance, convening a meeting between clients and startups to help us identify who we should sell to."

Fran Bennett, CEO, Mastodon C

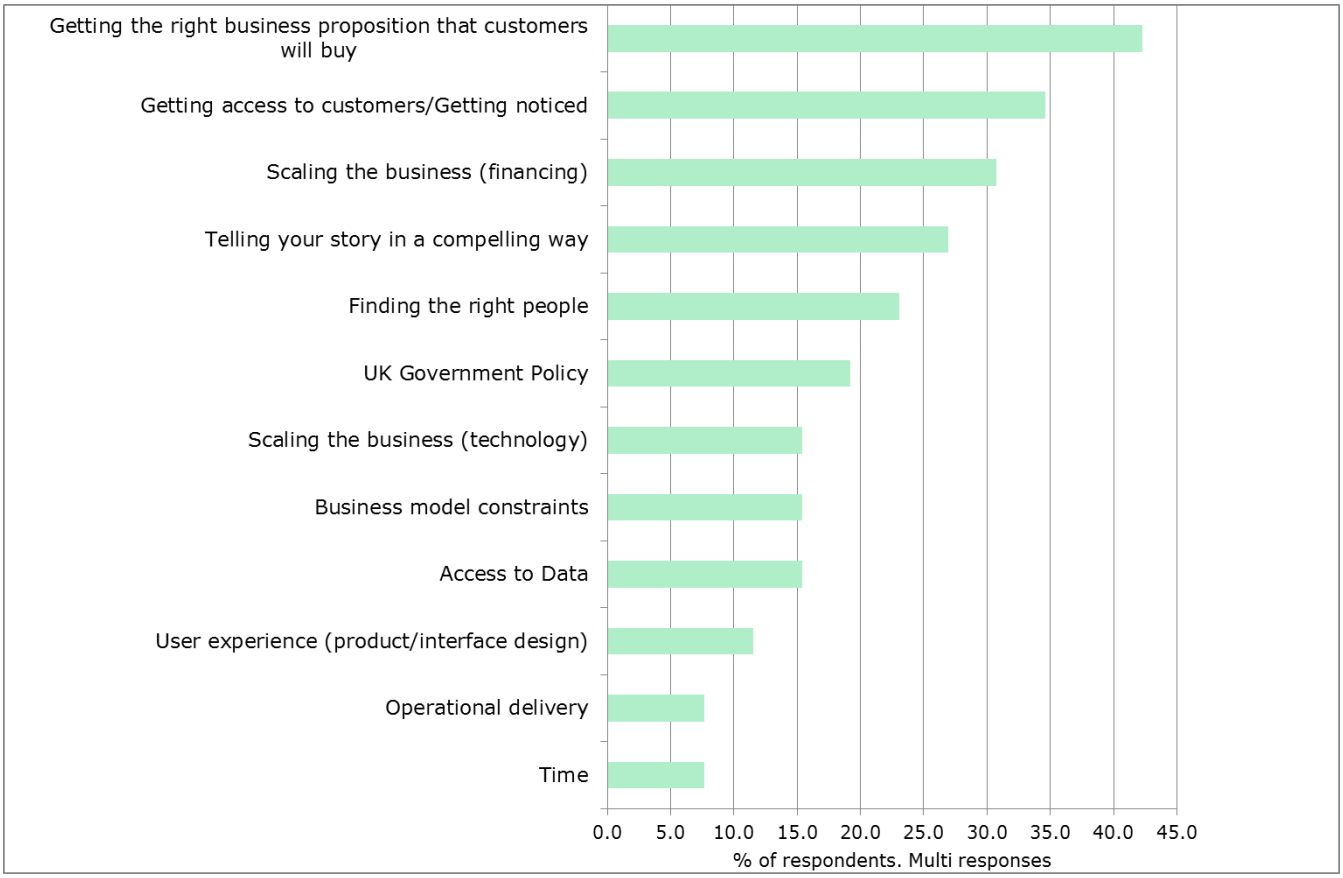


Figure 12. What have been your business challenges in the past year? (Respondents: 21)

"Getting the right proposition & pricing into the right customers is the challenge. Most sustainability teams just don't have budget and there is a narrow niche of truly innovative and leading companies. However CFOs and other executives are getting more involved as the business risks and financial implications of climate change grow."

Tyler Christie, CEO, amee

Funding Cleanweb UK Growth

In funding this growth, the main funding requirement fell into two ranges: *£150,000-£500,000* (31%) and *£1,000,000-£3,000,000* (25%). A smaller number of respondents identified funding needs up to £150,000 (19%) and in the range £500,000-£1,000,000. With only one respondent, who has already raised Angel funding and a first round Venture Capital (VC) funding, identifying a larger need of £3,000,000-£10,000,000. This suggests that the funding needs of Cleanweb UK startups is presently at an earlier stage than the majority of VC investment, which is usually looking for deal sizes above £3,000,000. Some early stage VC investment could be appropriate for the £1M-£3M range. This may be because the Cleanweb sector and Cleanweb companies are relatively young, but it could also be because software companies can be less capital intensive to grow at an early stage.

Private investment, including Angel investment and Venture Capital, was one of the preferred funding methods (shown in the Figure below). The first choice preferred funding option was *Grant* funding, perhaps because it is often perceived as "free money". The new funding option of *crowd funding* was being explored by Cleanweb UK companies. A number of UK Cleanweb companies, including NearDesk and FarmDrop, have successfully used the crowd funding platforms SEEDRS and CrowdCube to raise £1.2M and over £400,000, respectively. The least favoured option was *Loan* finance, which might reflect the perceived cost of this finance compared to the other options when put in the context of the scale of funding required and the level of risk.

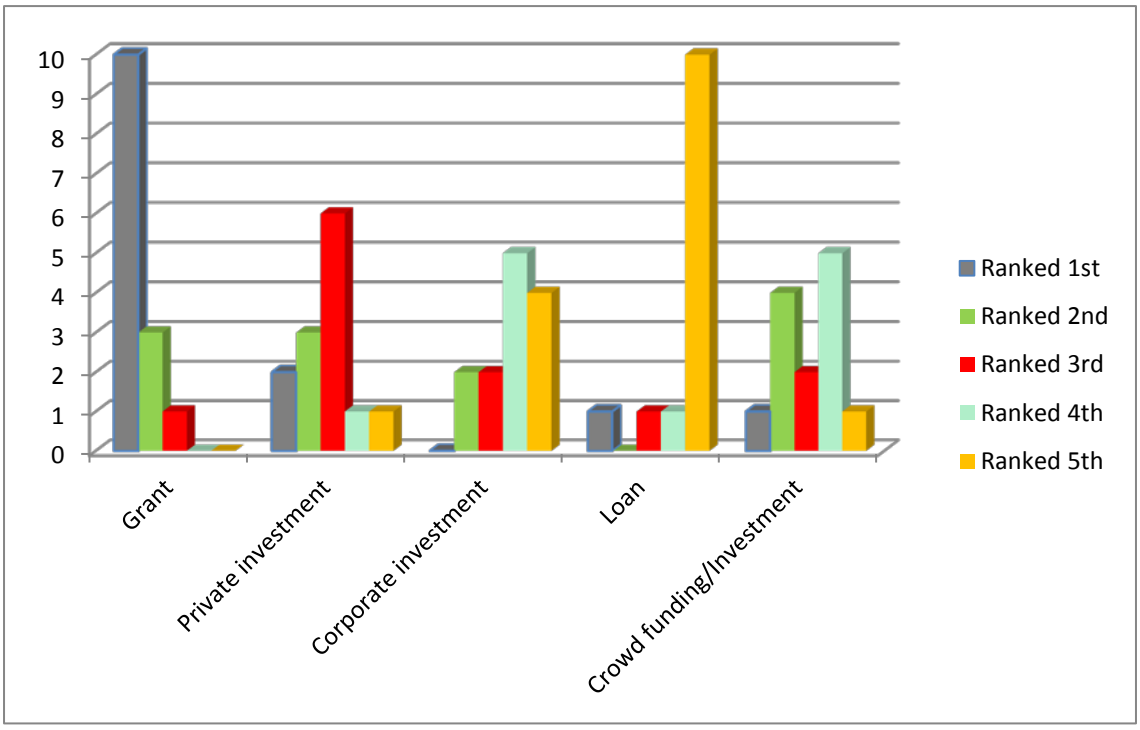


Figure 13. What form of finance do you prefer?

The good news is that grant funding organisations like the Technology Strategy Board (now InnovateUK) and the European Commission do provide funding for Cleanweb companies. Both Demand Logic and Energy Deck have been recent beneficiaries of InnovateUK grant funding under the *Future Energy Management for Buildings* Programme (Watt, 2014).

"[Cleanweb] has significant growth potential as a sector in the UK economy and therefore a key target for us to support."

Mark Wray, Lead Technologist – Low Impact Building, Technology Strategy Board / InnovateUK

4 Emerging Trends

The Cleanweb sector is in a fledgling state. Yet, there is a growing recognition that this combination of cleantech and web technology offers a new evolution in our battle with global environmental challenges. In fact, as traditional cleantech investment appears to be on the decline the investment in Cleanweb is on the increase (Lenchner, 2014). GreenTech Media's recent NextWave Greentech Investing conference provided a strong focus on Cleanweb investment opportunities. This brought together Cleanweb companies like Nest and RideScout with investors like Black Coral Capital, Mohr Davidow Ventures (MDV) and Shell Technology Ventures. Many of these investors stated an interest in companies addressing energy & climate change challenges.

In his talk at this conference, Josh Green from MDV, explained the history of cleantech being the first *investment philosophy* applied to venture capital so it is not a traditional vertical sector approach (Green, 2014). Therefore, it is a collection of technologies operating in different sectors and with separate ecosystems. As a result, any weaknesses in one of these technologies can tar the whole cleantech grouping despite the fact that there are some significant success stories. Green spoke about the re-categorisation of venture capital (VC). He highlighted that capital light and highly disruptive (>25% change in key financial/economic metrics) businesses are appealing, which pointed Green towards the Internet of Things; data analytics for energy; and productivity software. These "hot topics" for VCs all fit with the Cleanweb.

The vision for the Cleanweb is driven by the growing body of evidence that the cost of silicon-based solar PV technology is following a similar path to the cost of silicon chips in computing. Web technology is already showing how service delivery can grow with a low to zero marginal cost of adding new customers (Anderson, 2009). Cost breakthroughs are now expected in other areas, such as energy storage, which is expected to change the way in which distributed energy technology and electric vehicles interact with the power grid. This confluence of the web and cleantech is a central tenant of Jeremy Rifkin's vision for a *Zero Marginal Cost Society* (Rifkin, 2014) which outlines a radical evolution of our economic system moving up beyond capitalism.

We see digital as a key enabler. We think that information technologies help create the kind of change we need in two vital ways: 1) provide the right information at the right time in the right place; 2) provide platforms to self-organise. We are also looking for applications that change needs or meet them in very different way, e.g. helping people find a parking space is not smart - removing the need for the car is.

To understand these economic opportunities there is a need for domain and sector knowledge. This need for a vertical focus is being reflected in the startup world of incubators and acceleration programme which are attempting to replicate the success of the Y-Combinator programme (Christiansen, 2009). In Amsterdam, the Rockstart accelerator launched in early 2014 a cohort of smart energy startups with backing from the City of Amsterdam's Amsterdam Investment Fund and Dutch utility company, Nuon Energy. Oil & gas accelerator programme, SURGE, in Austin, Texas has also launched a call for Cleanweb startups focused on the energy sector. The UK Department of Energy & Climate Change

(DECC) has an Energy Entrepreneurs Fund *to support the development of technologies, products and processes in energy efficiency, power generation and storage*.

In the survey undertaken for this report the respondents were asked a series of questions to focus in on the domains and sectors they work in. Given the importance in the Cleanweb area to show a measurable environmental impact a key question for the survey was *Which environmental challenge does your company address?* The responses shown in Figure 14 below highlight that the most dominant focus was on *Climate change & clean energy* and *Sustainable & resilient cities* – i.e. approximately half of the respondents. A third of the respondents were focussed on *Sustainable agriculture, farming & food*, *Education in sustainable development* and *Public/Private sector environmental governance*. These environmental challenges were chosen to reflect the UN Sustainable Development Goals (SDGs) which are due to be launched in 2015 (UN Sustainable Development Solutions Network, 2014).

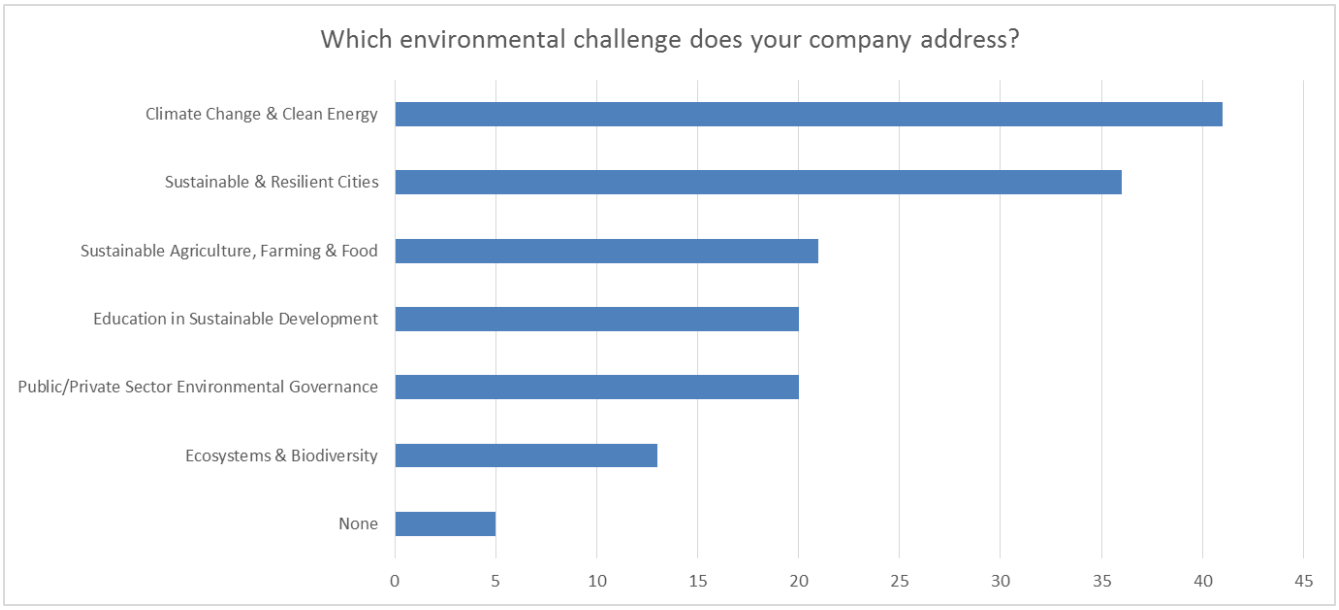


Figure 14. Which environmental challenges does your company address? (Respondents: 66)

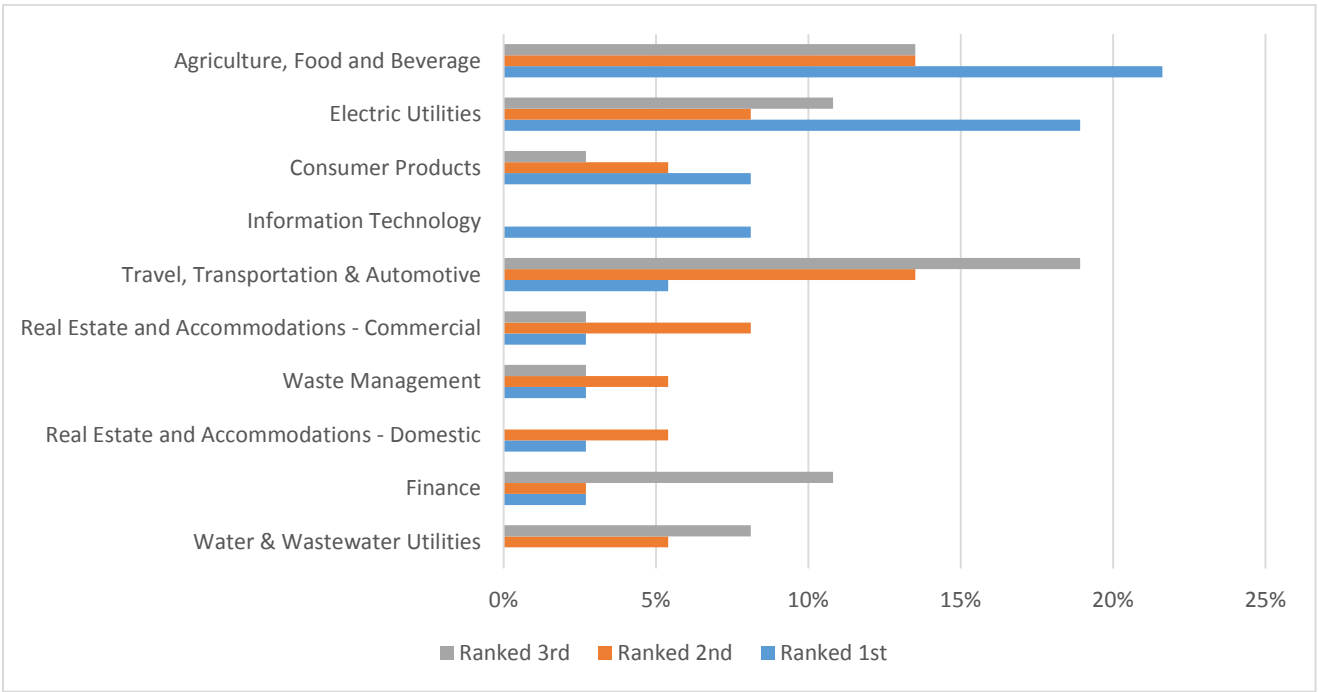


Figure 15. Top 3 Sectors with the most commercial opportunity for Cleanweb innovation (Respondents: 37)

The survey also asked in which sectors do the greatest commercial opportunities exists for Cleanweb innovation. The *Agriculture, Food & Beverage* sector was ranked 1st (48% of respondents ranked this 1st-3rd), closely followed by *Electric Utilities* (38%) and in third *Travel, Transportation & Automotive* (38%) as shown in Figure 16.

Agriculture, Food & Beverage Opportunities

The identification of the *Agriculture, Food & Beverage* segment as the number one priority is not reinforced strongly by the findings summarised in sections 4 & 5, where most Cleanweb activity appears to be related to energy. There are some noticeable exceptions in the UK, including the B2C companies categorised in this area in section 5: CropDrop, FarmDrop, FoodTrade, JustEat, and SeedPod. These companies are attempting to provide a direct route from food production to customers in an attempt to disrupt the UK food retail market dominated by Tesco, Wal-Mart's Asda, Sainsbury and Morrisons. They are also seeing their market share threatened by Co-op, Waitrose, Aldi, Marks & Spencer, Lidl and Iceland.

Most of the food brands we know in the UK are owned by a small group of multinationals. These are Coca Cola, ConAgra, Danone, General Mills, Johnson & Johnson, Kellogg's, Kraft, Mars, Mondelez, Nestle, PepsiCo, P&G and Unilever. Suppliers to these multinationals will be seeking opportunities for innovation and efficiency in their supply chain. An opportunity for Cleanweb agricultural technologies.

Further upstream in the area of food production, the agri-tech segment is an active area of innovation. This includes B2B focussed Cleanweb companies like eCow and Grassometer, both highlighted by respondents to the survey. WeFarm, a peer-to-peer communication service to help farmers in developing countries, is an app from the Cafedirect Producers' Foundation that recently won the Google Impact Challenge UK 2014, which is supported by Nesta.

The UK Government in July 2013 published A UK Strategy for Agricultural Technologies, with *Big Data* being a component part and an open data example being NERC's British Geological Survey *mySoil* app using Met Office data (HM Government, 2013). As a result of this Strategy InnovateUK was, over the summer 2014, considering consortia proposals to establish a *Centre of Excellence in agri-informatics and sustainability metrics* (Technology Strategy Board, 2014). In addition, the TSB has established a £70M Agri-Tech Catalyst with DFID and BBSRC, the bioscience research council. On a regional basis, the New Anglia Local Economic Partnership of Norfolk & Suffolk with the Greater Cambridge Greater Peterborough Enterprise Partnership, has a £3.2M Agri-Tech Growth Initiative (Greater Cambridge / Greater Peterborough Enterprise Partnership, 2013).

Other UK companies that are following in the footsteps of Cleanweb forerunners are WeatherSafe who provide software to coffee growers; and Oasis LMF, which has developed an open framework for modelling the financial risk impact of climate change funded by Climate-KIC and a group of London-based insurers, reinsurers and brokers.

Energy is an important input to the Food supply chain alongside land, water and other agricultural inputs.

Electricity Supply & Energy Services Opportunities

The survey findings on the second place for commercial opportunities is reinforced by the desk research summarised in section 4 & 5 of this report as well as the categorisation of the Crunchbase data described in section 5. Showing that reducing the environmental impact of electricity generation and energy use is a priority area for the Cleanweb sector.

"When I came back from Iraq in 2007 I was determined to get as smart as I could about what was going on with the energy sector, with cleantech and how private industry could spur it."

Joseph Kopser, CEO & Founder, RideScout

Given the importance of the global environmental challenge of climate change & sustainable energy it is likely that this should remain a focus for the Cleanweb sector in the UK. Maximising this commercial opportunity for the UK may not be as straightforward as this evidence of activity suggests.

"The UK's "Energy Island" strategy end result is that you are not embracing change, you are preventing change. I don't see any innovation coming out of the UK, there is no market here. In contrast, Germany & the Nordics have clarity in the market."

Gerard Reid, Founding Partner, Alexa Capital

The UK is presently undertaking an Electricity Market Reform, which is introducing new mechanisms for the trading of energy – i.e. *Contracts for Difference* and the *Capacity Market*. These changes are intended to secure the UK's energy strategy as an "Energy Island" providing investment from the largest six utility companies to fund up to £110B between the years 2013-2020 (DECC, 2014). Most of this investment will be in centralised power generation, transmission and distribution, with a small amount for energy demand reduction. A £20M Electricity Demand Reduction (EDR) pilot will be run by DECC in 2015. Fifty million smart meters will be installed from 2014-2020 providing a source of big energy data from homes and commercial premises.

Whilst new, smaller energy services companies are active in the UK market, such as renewable energy suppliers Ecotricity, Good Energy and Ovo Energy, the vast majority of the UK market will continue to be supplied by the 'big 6' who also control most of the generation capacity. The Big 6 include Centrica's British Gas, EDF Energy, E.ON, RWE's npower, Iberdrola's Scottish Power and SSE. This dominant position for the Big 6 provides little incentive for them to innovate in energy efficiency in the UK.

In contrast, Germany's Energiewende is continuing to stimulate a distributed electricity generation market involving a high percentage of community ownership – see figure below.

The changes in the German energy market over the last 5 years has coincided with a precipitous fall in the share price of the Germany utilities, for instance E.ON has seen its share price fall by 75% (The Economist, 2013). It comes as no surprise that the UK's Big 6 would like greater security as the nation's energy suppliers.

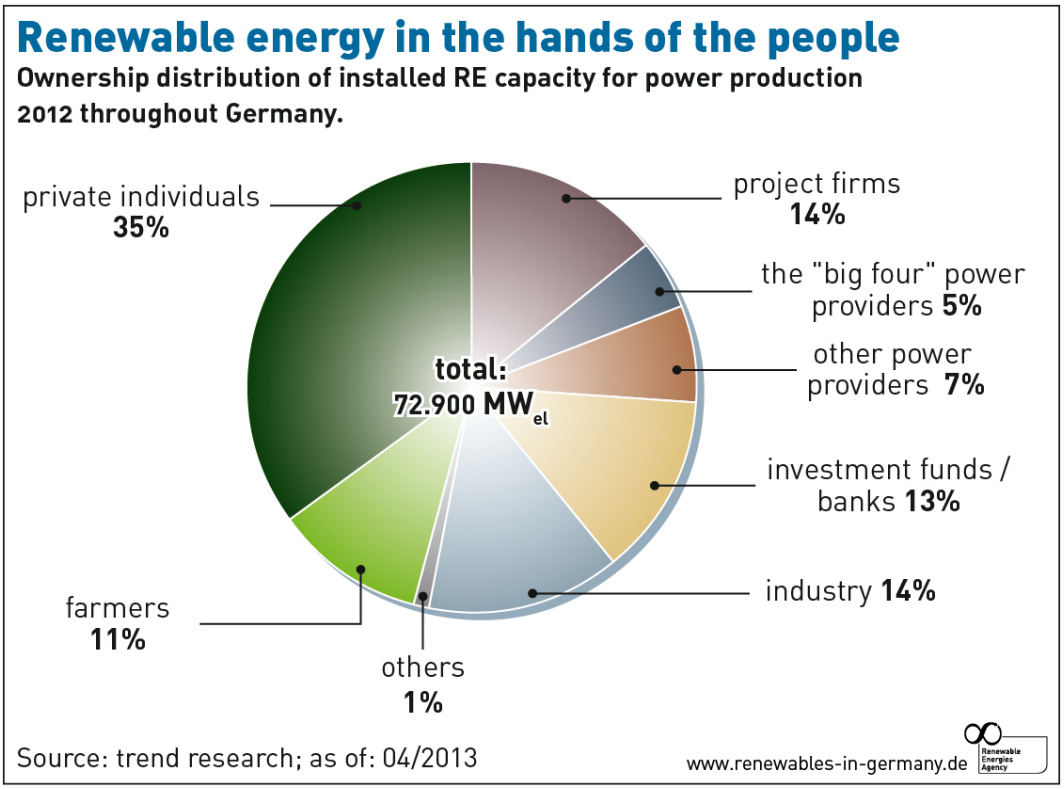


Figure 16. Renewable Energy Ownership in Germany (Copyright German Renewable Energies Agency)

The drive for efficiency improvements and emissions reduction in the UK will cascade down from the European Directive on Energy Efficiency and the expected 30% efficiency target to 2030. The UK's *Energy Efficiency Strategy* was published in 2012, which estimated a potential for 196TWh in 2020 (equivalent to 22 power stations or an 11% reduction in business-as-usual consumption) of "socially cost-effective energy efficiency" savings (DECC, 2012). In addition, the expected rising cost of energy should also see a pull from customers who want to control their energy costs.

The Climate Act 2008 and the resulting Carbon Budget will continue to reduce greenhouse gas emissions in the UK. This will involve continued investment in off-shore wind as well as attempts to build new nuclear generators and explore reserves of unconventional sources of oil and gas, like fracking for shale gas.

In the US, where there are more stringent state regulations, Centrica's subsidiary Direct Energy is innovating with Siemens Smart Grid Division's Demand Response Management System (DRMS). This is based on technology which Siemens acquired from Cleanweb company eMeter. It will provide Direct Energy's customers with the opportunity to reduce their energy demand at certain times of day in return for a payment. This is what the UK EDR pilot will explore in 2015. The US Demand Response (DR) market is already estimated to be of the scale of $3B, suggesting that the UK is behind the curve of this innovation (Gardett, 2013). One of the leading US Demand Response services provider, Enernoc, recently acquired German DR provider Entelios and Irish aggregator, Activation Energy, as well as UK Cleanweb

software company EnTec USB (EnerNOC, 2014). The innovators in the UK market are Kiwi Power, STOR Generation, REstore, Flexitricity and Open Energi.

Travel & Transport Opportunities

The travel and transport opportunities for the Cleanweb are similar to Food & Energy divided into B2C and B2B opportunities. The food and transport segments share an interest in collaborative consumption models. With the innovators in the transport sectors including the vehicle sharing companies like Blablacar, bnbBoat, Carpooling, E-Car Club, Funryde and Liftshare.com. Whilst companies like Carbon Voyage, CityMapper, Geosho, Loco2 and TransportAPI are focussed on providing better information for those consumers wanting to use public transport.

For the B2B market there are solutions for fleet operators, like ALK Technologies and GreenRoad.

Underpinning local and regional sustainable travel and transport plans in the UK, there is the Department of Transport's *Door to Door: A Strategy for improving sustainable transport integration* (Department of Transport, 2013). This begins to address the issue of data sharing and integration as well as attempts to provide integrated smart ticketing systems. A £17M Transport Systems Catapult has been set up by the Technology Strategy Board to fund innovation in this area. It also includes an intent to provide more real time, open data for wider usage.

Sector Representation

The survey asked respondents which sectors they operate in, with the option to select up to 3. Most of the respondents selected only one sector in which they saw their company operate, whilst a smaller number of respondents selected 2 or 3. Almost half placed themselves in IT.

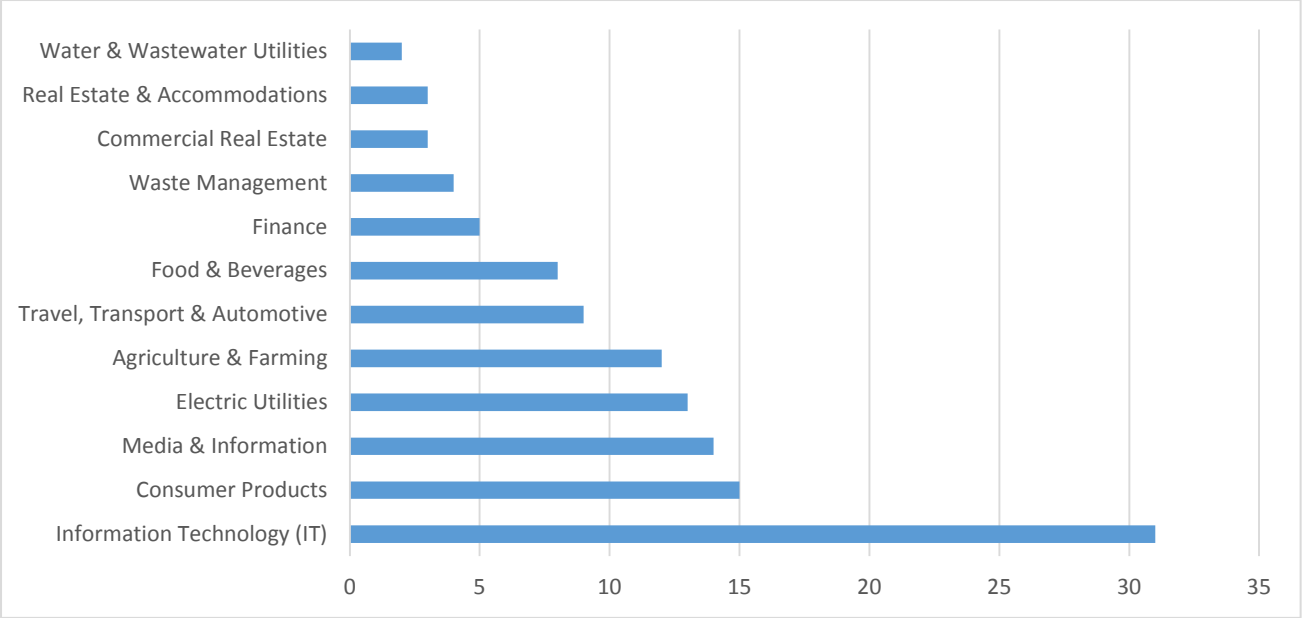


Figure 17. Which sectors does your organisation operate in? (Respondents: 67)

A number of others sectors, not included in the question list, were added by respondents including: Industry, Healthcare, Design and engineering, Low-carbon clean technology, Solar, Energy (generation & efficiency), Education, Local government, Cleanweb, Environmental Goods & Services, Nature and Urban Technology.

Cleanweb: From Startup to Commercialisation

The UK Government has introduced a number of policy measures to encourage new businesses to start in the UK in recent years with 2013 seeing a record number of 526,446 (Startup Britain, 2014). In the figure below it shows where these entrepreneurial hotspots are in the UK. This emphasises the success of policy measures under the present government to create new businesses. Cleanweb SMEs are distributed across the UK, although existing UK technology clusters appear to be seeding Cleanweb startups including London, Bristol & Bath, Manchester, Cambridge and Oxford.

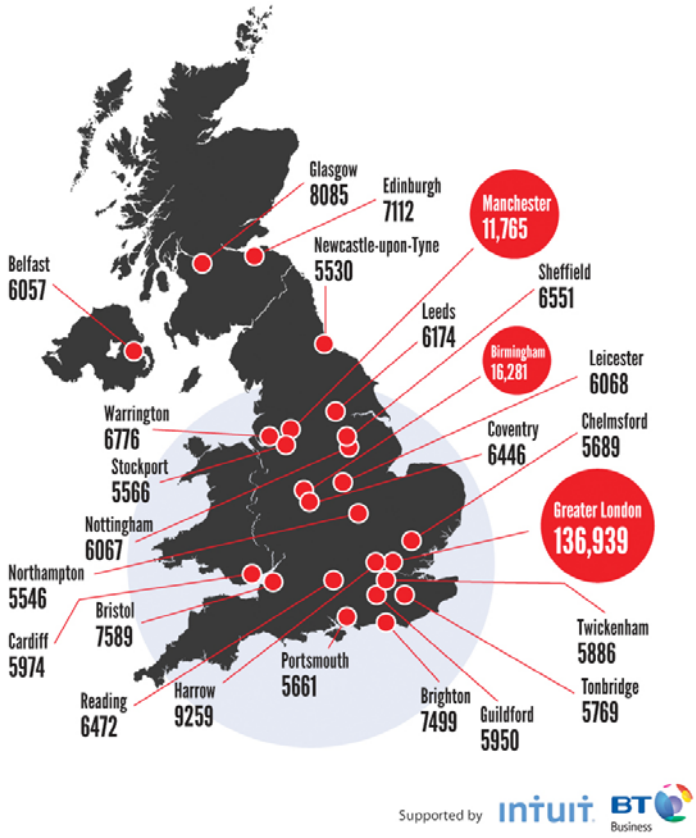


Figure 18. UK Entrepreneurial Hotspots (Copyright. Startup Britain)

The challenge that the UK is less successful at is taking these startups to large scale commercialisation. This is a barrier that The Global Cleantech Innovation Index 2014 identifies (Parad, 2014). In assessing 40 companies around the globe this study ranks the UK as 6th in the world. From the assessment methodology the UK is strong in three key areas: General Innovation Drivers, including Cleantech Specific Innovation Drivers; and Evidence of Emerging Cleantech Innovation, such as early-stage private investment, high impact companies and environmental patents. Where the UK is scored much lower is in terms of *Evidence of Commercialised Cleantech Innovation*, where we are in the bottom half of this league table behind Slovenia, Romania and the Czech Republic. The leader in this category is Denmark and other European countries in the top 10 include Norway, Spain, Finland, Sweden and Germany. Relative to its size, Denmark has the largest number of publicly traded cleantech companies, most notably Novozymes, Vestas, Rockwool, Grundfos and Danfoss.

This relative weakness is not unique to the cleantech sector. If you look at the UK software sector it is difficult to name a listed software company despite all of the investment in TechCity. Sage is the one exception in the FTSE 100, whilst Mind Candy is often cited as the privately-owned poster child of UK digital innovation since the acquisition of Autonomy by HP in October 2011.

If Cleanweb SMEs follow a similar path to Cleantech companies then this would suggest the future for their growth could be one of private ownership or acquisition by a foreign company, particularly for venture capital-financed growth. This is important because it will influence how investors in Cleanweb companies see the possible exit options.

5 Challenges and Enablers for Growth

Challenges to Growth

In the short term the challenges that Cleanweb SMEs are facing are more specific to them as described in section 4. The figure below shows the biggest challenges that these companies have faced in the past 12 months – *Getting the right business proposition that customers will buy* and *Getting access to customers / Getting noticed*. For the corporations active in this space many of them quoted *technology innovation* with *applied market knowledge* as a reason why their customers were buying their product or service. These are challenges that can be overcome with specific business support, in particular with Cleanweb domain knowledge and experience, including customer contacts. Without addressing these challenges and securing those early customers and revenue then it will be difficult to access finance to scale the business.

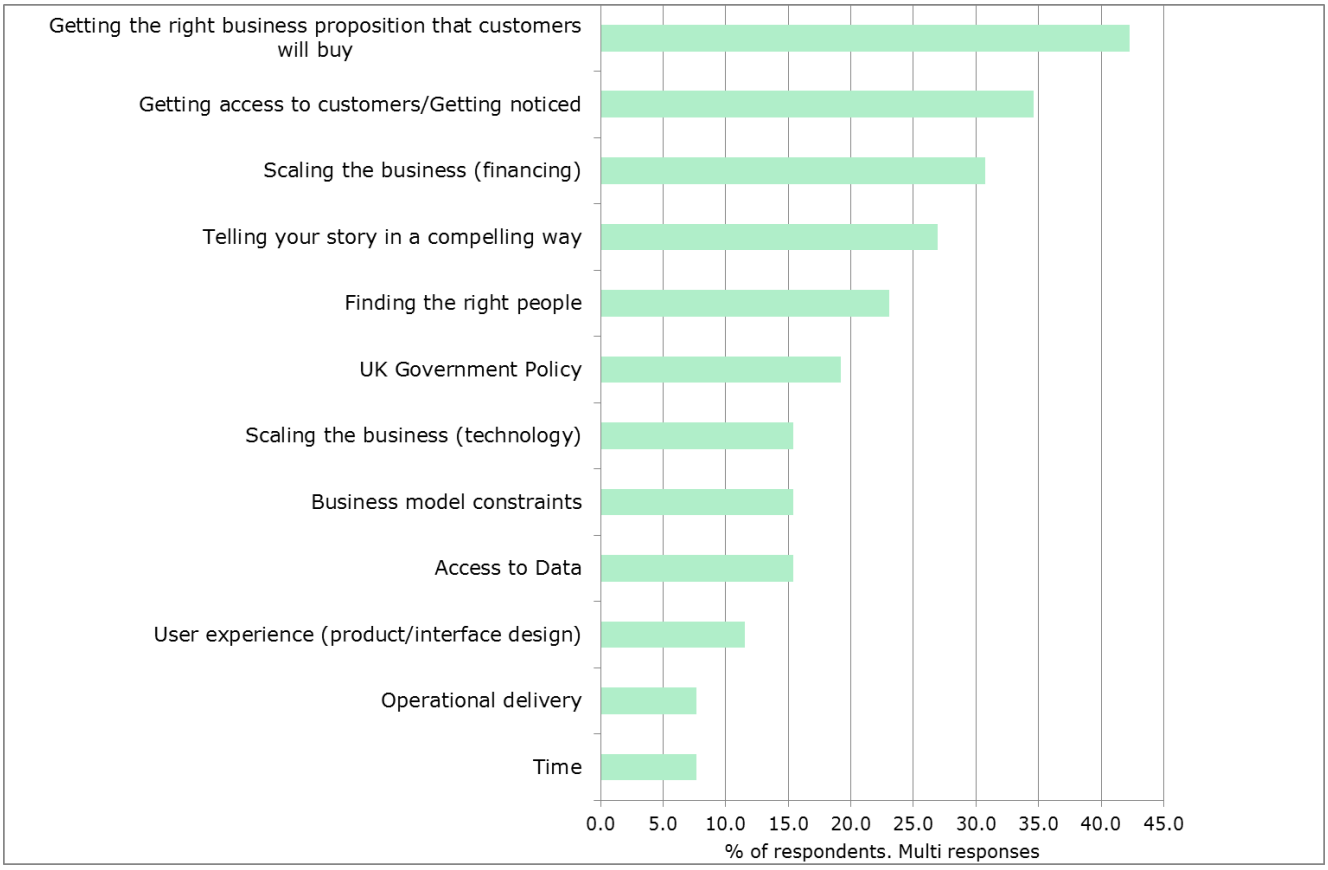


Figure 19. What have been your biggest challenges to growing in the past 12 months? (Respondents: 26)

Of the 21 Cleanweb companies which answered the survey question – *Do you expect your business to grow in the next 12 months?* – all of them said *Yes*. The majority, 85%, think that they will grow by at least 20%, and over half think they will grow by more than 100%. This growth will help enable these companies to breakeven, when 78% have yet to do so & half of those expect to break even in the next 12 months.

Recruitment & Skills

For most, 76%, this forecast growth will translate into new staff. This recruitment is in addition to those staff who have already been brought on in the last 12 months. On average this has been three new staff per company for the surveyed companies. Based on the survey responses the most in-demand skill sets are *Sales & Marketing* and *Web & Software development*. Recruitment is one of the reasons why additional financing is required. The skills sets required in this recruitment are:

Business	Technical	IT Skills
Sales & marketing, including identification of real market demand / need and telling a great story	Web & software development, best application of digital	Big data tools & technologies, including data management & analysis, and algorithms
Business development	DevOps	Wireless connectivity & mobile communications, inc. 3G and Internet of Things
Commercial	Lean development / rapid prototyping	Cloud computing
Account Management	Application	Broadband speed & capacity
Operations / Project management	Back end	Service access via browser & mobile apps
Fundraising	Service design, UI/UX design & user focused development	Security
	Data analysis / science	Artificial Intelligence (AI) and Machine Learning
	Hardware development	

Policy Changes

To support the growth of the Cleanweb sector there are some proposed policy changes which would support this growth. Policy measures that demonstrate a clearer commitment for business to address sustainability will support the adoption of technologies that provide a measurable change in environmental performance. Mandated corporate reporting on supply chain environmental performance, a carbon tax and incentives for investing in Cleantech, energy & resource efficiency were all suggested by the survey respondents as measures that would send the right message to business customers.

Energy was the second policy area where greater direction and certainty is sought. More stability in UK energy policy is seen as beneficial in developing new Cleanweb technologies and addressing customer needs. The implementation of the EU Energy Efficiency Directive would drive demand for Cleanweb companies. Incentives and price signals for energy efficiency and the adoption of smart energy efficient devices were specific areas identified for more policy. Better governance of the existing market competitiveness, enforcement of building regulations and real time monitoring of building performance were all seen as desirable areas for improving growth.

Policies in support of sustainable ICT, Transport and Food technology were also raised as the other priority areas for the Cleanweb sector.

Access to open data is important for many of the Cleanweb companies in the survey, with 82% saying they use open data. For corporations this was less important with 67% saying they did not use open data.

UK Research as a Source of Cleanweb Innovation

The University of Southampton has established the first research centre for Web Science and the first Cleanweb PhD is being researched there by Jack Townsend. Townsend's paper entitled *Web for Sustainability: Tackling Environmental Complexity with Scale* was presented at the 2nd International Conference on ICT for Sustainability (ICT4S) in August 2014 (Townsend, 2014). This paper is the first attempt to produce an academic explanation of the nature of the Cleanweb. It includes a matrix to show examples by web means and environmental ends shown in the figure below.

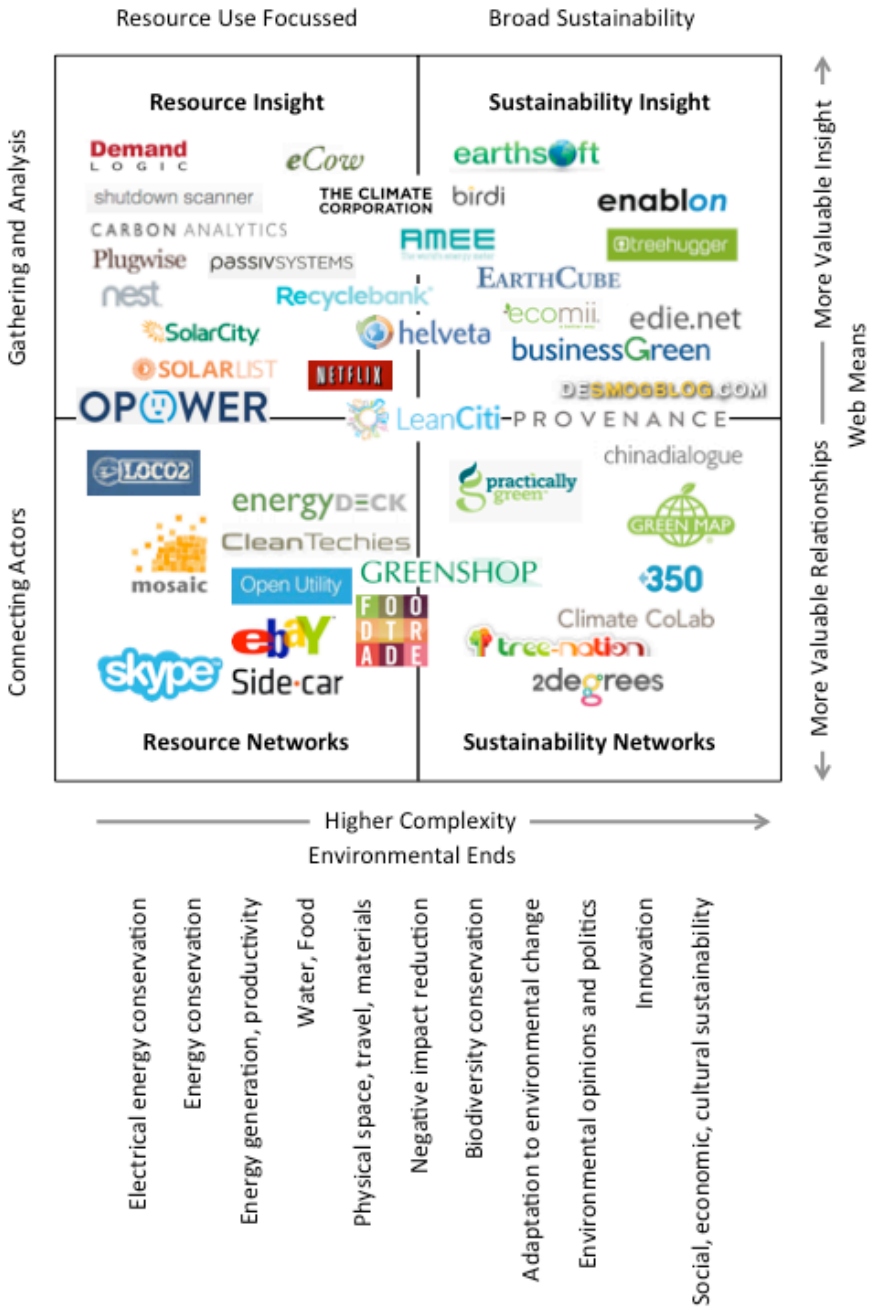


Figure 20. Web for Sustainability Matrix (Copyright. Jack Townsend)

Across the rest of the UK, Cleanweb research is fragmented across a number of disciplines. The survey tried to identify existing research as well as research needs. In Appendix F there is a list of existing areas of research and the UK research institutes & organisations involved.

One of the largest research teams looking at the application of Cleantech is the Centre for Low Carbon Futures. It is a collaboration between the five Universities of Birmingham, Hull, Leeds, Sheffield and York. This centre has secured research funding from a range of international sources as well as funding from the UK research councils. They divide their research into five themes:

1. Climate smart cities
2. Energy storage
3. Energy & food
4. Energy & water
5. Energy in the supply chain

The Centres most Cleanweb-relevant research is a series of three report on *The Economics of Low Carbon Cities*, which focus on sector specific opportunities for low carbon investment (Gouldson, et al., 2013).

SETSquared is the Number 1 *University Business Incubator in Europe* and is 2nd globally. It is run for the Universities of Bath, Bristol, Exeter, Southampton and Surrey. SETsquared have already seen EnModus and PowerOasis emerge from their support programme. These five universities have a number of research institutes relevant to Cleanweb including:

- University of Bristol's Cabot Institute, BRITE Futures Institute dedicated to Technologies for the Environment, Centre for Communications Research and Department of Computer Science
- University of Bath's Centre for Advanced Sensor Technology, Centre for Energy and the Design of Environments, Centre for Sustainable Power Distribution and Centre for Space, Atmospheric and Oceanic Science
- University of Exeter's Centre for Ecology & Conservation and Centre for Geophysical & Astrophysical Fluid Dynamics with Exeter Climate Systems
- University of Southampton's National Oceanography Centre and Web Science Institute

A number of future research needs were identified by the survey:

- How to enable people to adopt new green infrastructure and new technology
- ICT to reduce food environmental footprint, to support building retrofit and to support biodiversity friendly practices in city & country
- Sectoral analysis around issues affecting sustainable supply chains
- Efficacy of smart domestic heating technology alternatives
- Electricity/energy storage technologies
- Alternative wireless communications technologies, other than 3G

Cleanweb Infrastructure: Networks & Grids

It is necessary to think about the growth of the Cleanweb in the context of the physical infrastructure that it is utilising for communication and the action of change. There are two networks that are highly relevant to Cleanweb applications and that is the Internet and electricity network. These two worlds are starting to merge through *smart grid* initiatives. This leads to a vision of an integrated power and communications network that will be more

dynamic and distributed. In demonstrating the future direction of this network confluence there are two examples from earlier in the report – Nest Lab and Veniam Works – which demonstrate how this technology evolution is fundamental for the direction of growth for the Cleanweb.

There is an interesting parallel between the Nest thermostat as a network node in a home and the Veniam *Box* technology used as a node in a car. With both technologies there is the potential to offer a variety of web services using this connected infrastructure. The difference in business models is stark as Veniam Works attempts to deploy large budget, multi node vehicular networks to fleet operators, public transport authorities and governments. Whilst Nest has succeeded by making their thermostat a desirable consumer product, selling and installing those first and then connecting other devices second as part of a longer term vision.

These two types of network offer smaller scale networks than macro networks which are deployed nationwide, for instance high speed broadband fibre networks. Nest is using existing broadband and Wi-fi infrastructure to provide a domestic, micro network. Veniam is integrating multiple networks to offer a new area, micro network.

These developments in network technology mirror developments in the power grid. Both sets of innovation have the ability to buck the existing macro infrastructure that is in place for ICT and for power. In developing continents we are already seeing the use of mobile communications and distributed power generation leapfrog the technology development path traditionally taken by developed countries characterised by national telephone networks and national power transmission and distributed grids.

Microgrids have been around for many years dating back to a concept of Thomas Edison (Singh, 2014). These are electricity grids which are created to link power generation to electricity uses in a small geographic area, such as a university campus or an industrial facility. These microgrids can be connected to a national grid, but can also operate independently (Bossart, 2012). They could be aggregated to form a macrogrid. A nanogrid is even smaller and is common today, for example USB-powered devices off a PC or an electricity system in a car (Nordman). These nanogrids can be aggregated to form a microgrid.

Robin Chase of Veniam Works is one of the people that sees these two worlds of smaller, distributed ICT networks coming together with smaller, distributed power grids. The addition of the two makes for a *smart grid* that is enriched by multiple sets of data and not just smart meters. This is one of the principal reasons that the energy sector is one of the ripest areas for Cleanweb technology development and service innovation.

In the UK there are a number of start-ups who are exploring opportunities in this area, including AlertMe, ContinuumBridge, Love Hz and Neul.

6 Support Needs of Cleanweb UK Companies

In response to the survey, over half of the Cleanweb SMEs said that they were not yet over their initial startups pains. The others stated that they were and that they had already received useful support from mentors and incubation/acceleration programmes, including Bethnal Green Ventures (BGV), Climate-KIC, Open Data Institute (ODI) and SETsquared. Some startups have even looked overseas at specialist programmes like Rockstart in Amsterdam.

Looking ahead, these Cleanweb companies were asked what support they will need in the future. This was categorised based on the archetypes developed for the Nesta *Good Incubation* report (Miller & Stacey, 2014). The results shown in the figure below suggests that two-thirds of the respondents were Scalers:

Scalers are ventures with a working service whose basic business model is sound and unlikely to change drastically as they grow. Their challenge is how to operate at scale rather than rethink their model. Scalers are facing the practical realities of implementing growth strategies.

Scalers need to put in place the operations needed to deliver at scale and find the team and finance to enable it to happen at the right pace.

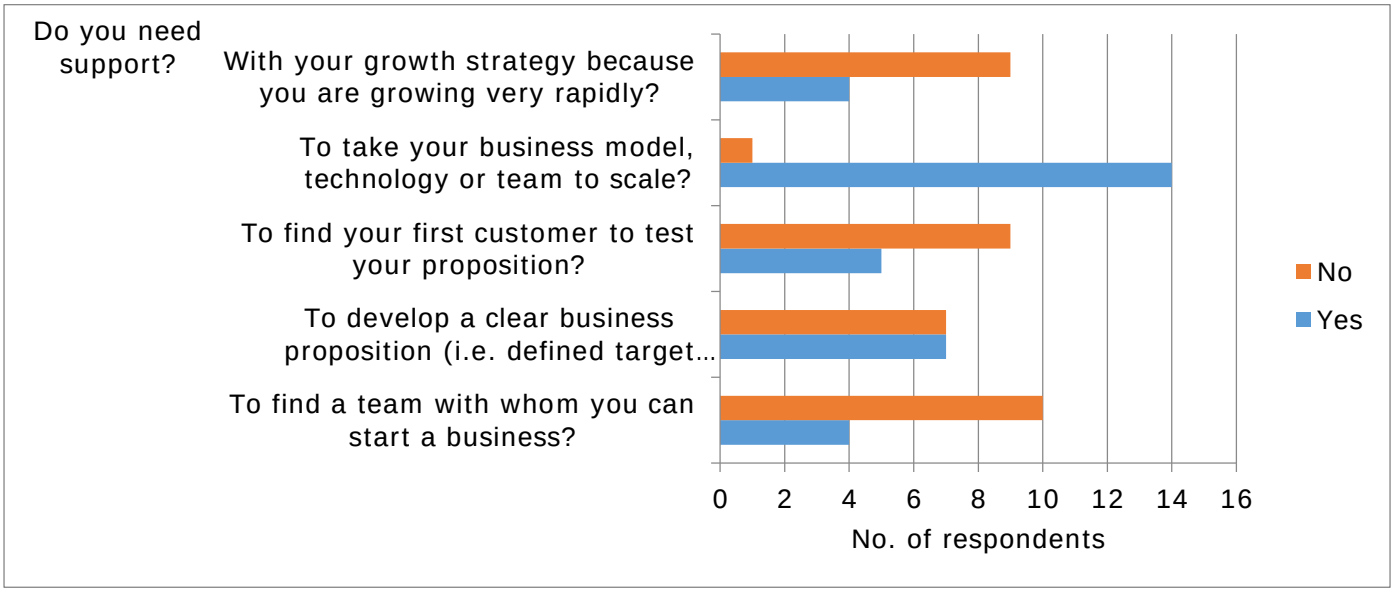


Figure 21. What type of startup support do you need? (Respondents: 21)

The *Good Incubation* report suggests that *Scalers* have these needs:

- Help with investor relationships
- Legal support
- Flexible office space
- Optimisation
- Recruitment advice

Many of the incubation / acceleration programmes mentioned above provide support in terms of investor relationships – see table below. Some will also provide flexible working space and there are other organisations that specialise in this area including the Impact Hub network, Cleanweb services like NearDesk and regional organisations like the EngineShed in Bristol, University of Bath Innovation Centre and Innovation Birmingham. Angel networks, like ClearlySo, Envestors and the Green Angel Investors, focus on raising capital through investor networks.

Pro bono or low cost legal support is harder to come by even though it is much needed. Many of the incubation / acceleration programmes do have access to limited legal support.

Incubation & Acceleration Programmes

Programme	Investor Relations	Legal Support	Office Space	Optimisation	Recruitment Advice
Bethnal Green Ventures	✓	✓	✓	✓	✓
Climate KIC	✓	✓	×	✓	✓
ecoMachines	✓	✓	×	✓	✓
IDEALondon	✓	✓	✓	✓	✓
ODI	✓	✓	✓	✓	✓
SETsquared	✓	✓	✓	✓	✓
Upstarter	×	✓	×	✓	✓
Webstart	✓	✓	✓	✓	✓

Awards & Competitions

Getting access to customers was another clear need for Cleanweb SMEs. One means of getting independent recognition for a Cleanweb service is through a national or international award. Those which are most relevant for UK Cleanweb companies are Ashden Awards, British Gas Connected Homes, Climate-KIC Clean Launchpad, Guardian Sustainable Business and Shell Springboard. Each of these offer a cash prize and exposure to investors and customers.

Finance & funding

Funding and finance for the development of new Cleanweb technology and whilst startups are building their customer base is critical. There are a broad range of incubation and acceleration programmes which now exist to provide small amounts of initial funding. If a startup cannot gain access to one of these programmes that their initial growth can be very slow. Once Cleanweb startups leave these programmes though they are often well placed to move onto a second programme, but many are left to fend for themselves. At this stage of development startups tend to seek out grants from charities focused on environmental and social objectives, like Nominet. Whilst others turn to angel networks, such as the ClearlySo and

Green Angel Investor Network, or crowd funding sites to raise an initial £150k-£500k. Loans, whilst not popular with startups, are also sought from the main retail banks and more socially aware banks like Unity Trust Bank, although this is difficult without proven revenue. This type of finance is particularly relevant for growth campaigns and recruitment. Larger amounts of equity investment, between £500k-£3M, appears to be more difficult to secure as it is between the scale of angel and crowd funding, and the larger interests of venture capitalist firms who tend to take an interest from £3M upwards.

For technology development there are other sources of funding available in grant form, in particular from InnovateUK. They have catalyst funding for Agri-tech, Energy & Transport Systems. This funding is not always available for software development rather than hardware technology development, but these programmes are broadening their scope and it is important that this continues for the Cleanweb sector to grow. Similar European Commission R&D funding is available under the Horizon 2020 programme which has a strong focus on SME innovation, the use of digital technologies and environmental goals. DECC's Energy Entrepreneurs Fund is particularly relevant for Cleanweb businesses in the energy sector.

In seeking investment, Cleanweb founders should be aware that the usual generic priorities in selecting companies to invest in are:

- Management team
- Growth potential
- Business model

Depending on the stage of investment, investors will also give priority to:

- Proven technology
- Proven revenue
- Protected / Protectable IP
- Market leadership
- Market disruption potential

"To identify differentiated services that are scalable and have a proven customer base. Led by an ambitious and grounded management team."

Few investors have yet raised funds specifically to support Cleanweb companies so there is still a very broad range of competition for any available finance, across the web technology and cleantech spectrum. If a significant UK investor, like Bridge, Index, Zouk or WHEB, were to raise funds specifically for the Cleanweb sector this would be a significant recognition of the potential of this market.

Many corporations are looking to SMEs for innovation in their supply chains and for new services. This is an area where there is the potential for more collaboration in the Cleanweb sector as indicated by the interests of Cisco, Google, Siemens and Shell in this market.

Cleanweb UK

For the Cleanweb sector to grow successful there are lessons to be learnt from successful business Clusters in the UK. A Nesta study of the Silicon South West cluster identified four pillars required for successful growth (Marston, Shanmugalingam, & Westlake, 2010):

1. Provide a forum for the exchange of ideas about the Cleanweb to stimulate growth & competition both at events & online
2. Create links with Universities, funders, investors, suppliers & customers
3. Be a focal point for collective actions to champion the needs of the UK Cleanweb sector, e.g. promotion, and facilitate specialist support for the sector, e.g. training, standards, etc.
4. Collect & disseminate data relevant to the growth of the sector

Cleanweb UK presently provides (1) a forum for the exchange of ideas. There is a gap in addressing the other 3 pillars and this is mainly due to resources as Cleanweb UK is a voluntary organisation with a primary focus on grass roots meetings. For the UK Cleanweb sector to gain momentum, funding and action is required to provide these other pillars of support to the sector.

7 Recommendations & Further Work

The findings from this study have identified a number areas for further work as well as a need for actions to support the sector in growing and having the maximum impact for environmental good. The UK has an excellent opportunity to take a lead internationally in supporting and attracting Cleanweb businesses. There is an important track record in high tech and clean tech relevant to Cleanweb growth. This would contribute to UK economic growth and job creation.

For the Cleanweb sector in the UK to continue to build momentum there is a need for a stronger identity for the sector to enable a greater cohesion between the disparate activities which are taking place. The common purpose uniting all of these Cleanweb activities is the use of technology to deliver an environmental benefit.

Cleanweb UK as an organisation does provide a valued hub for those people interested in this sector. The sector needs more to reach a larger scale and impact, which this network may not be able to fulfil as a grassroots, volunteer-led organisation. It was set up to provide a forum to organise interesting meetings for the exchange of ideas and should continue this valuable role.

The Nesta report on successful business clusters, *Chips with Everything*, identified four pillars which are required to support the business in these clusters (Marston, Shanmugalingam, & Westlake, 2010):

1. Provide a forum for the exchange of ideas about the Cleanweb to stimulate growth & competition both at events & online
2. Create links with Universities R&D, funders, investors, suppliers & customers
3. Be a focal point for collective actions to champion the needs of the UK Cleanweb sector, e.g. finance & funding, promotion, and facilitate specialist support for the sector, e.g. training, standards, etc.
4. Collect and disseminate data relevant to the growth of the sector, including an online directory of Cleanweb companies

Cleanweb UK does provide some of these activities, but is limited by resources. To build support for the Cleanweb sector there is a need for an organisation which can gather and share evidence of the environmental benefits of the sector; the interest and value for corporations and investors; and government policy in support of Cleanweb innovation and growth.

Cleanweb UK Recommendation 1: The first recommendation for this report is to identify the right organisation, or to create one, which can deliver growth services to the sector and the sources of funding which would make this possible. These services include: providing a forum to stimulate growth; creating links with universities, funders, investors, suppliers and customers; being a focal point for collective action to champion the needs of the sector; and the collection and dissemination of data relevant to the growth of the sector.

To support the existing Cleanweb companies there is a need to identify clear pathways to scale for successful business growth and for environmental impact. This is a combination of activities, but some dominant themes have been identified.

- Grant funding for early stage Cleanweb technology R&D (up to £1M) probably from InnovateUK and the European Commission, focussing on the intersection between Cleantech, Web technology, the Internet of Things and / or Collaborative Consumption.
- Access to growth finance either via grant, crowd finance or early stage venture capital (£1M+), dedicated to Cleanweb objectives of economic growth and environmental benefit.
- Sales & Marketing, in particular skills developments in telling the story of compelling business propositions which also have an environmental benefits, recruitment of relevant Cleanweb skill sets and access to customers such as at sector events where buyers have an interest in business and environmental benefits.
- Technology development combining knowledge of Cleantech, web technology, Internet of Things and/or Collaborative Consumption.
- Recruitment and access to good people, in particular in sales & marketing and software development with experience in relevant markets of Cleantech, web technology, Internet of Things and/or Collaborative Consumption.
- Investors relations, including impact investors, which is often provided to those companies who have accessed incubation and acceleration programmes.
- Legal support, in particularly IP protection, tax and HR. For startups there is a need for a pro bono pool of expertise.
- Flexible office space, for which a number of options exist. Ideally co-located with other Cleanweb business who have similar challenges.
- Mentoring for optimisation of the business and technology as the companies grow to scale recognising the specific content for Cleanweb companies.

The existing incubation programmes mentioned above can provide mentoring support for skills development and often have good investor relations. Some offer office space, which is often for a limited period of time.

Business Recommendation 2: A Cleanweb acceleration programme is required to help take these businesses to scale by providing or signposting to the services list above. This should include follow-on funding and guidance on commercialisation at scale, including IPO.

Cleanweb companies would benefit from clearer guidance on the business challenges facing customers in each sector. They would also benefit from access to these customers. The sectors of particular interest are: energy services; energy generation & transmission; agricultural production; food retail; IT services; cities; corporate governance; and finance.

Business Recommendation 3: Prioritise the most active Cleanweb markets (i.e. energy, food, transport, cities, etc.) and host a series of customer-led sector events to identify key business challenges they face with regards to environmental impact and to present Cleanweb solutions suitable for each of these markets. Share these challenges so that follow-up activities can be planned, such as a Cleanweb Challenge to fund innovative solutions.

A number of multinational corporates are actively supporting Cleanweb startups and SMEs. This study was only able to reach a small number of these large companies. Further investigation is required to better understand these corporate activities and how the innovation taking place in SMEs/startups can be matched with these corporations.

Business Recommendation 4: A study to focus on corporate support for Cleanweb innovation with recommendations on how to closely involve these corporations in the Cleanweb ecosystem to support innovation.

In supporting the Cleanweb sector, a clearer policy framework in support of the sector's objectives is required. This is both sector-specific supporting the growth of technology business with this environmental purpose and public benefits; and could also be sector specific, for instance:

- Clearer policy on the support for the use of web technology for delivering energy efficiency at scale and community energy finance.
- Similarly for sustainable transport, agriculture & food, IT and cities.
- Strong policies to encourage corporate investment in Cleanweb technology, for instance mandatory reporting on sustainability impacts in the corporate supply chain.
- Incentives for investment which have a public benefit, such as environmental improvements.
- EU Energy Efficiency Directive implementation.
- Support for smart domestic heating & measurement of tech efficacy.
- Mandatory monitoring of real time building performance.

Policy Recommendation 5: A more detailed review of Government policies which support the UK Cleanweb and where gaps exist in supporting the sector's growth.

There is a diversity of Cleanweb applications, but many of the technical components are shared by different companies. The main components where there is an opportunity for collaboration in research, development and innovation are:

- Sensors and meters
- Open data APIs
- Communication protocols
- Communication networks – i.e. broadband & wireless alternatives, inc. mesh
    - Macro – national infrastructure
    - Micro – local scale
- Power Network – Grid interfaces
    - Interaction between Macro, Micro & Nano grids
- Hardware-software architecture
- Cloud data hosting
- Data management & storage
- Data visualisation
- Service design
- User Interface (UI) & User Experience (UX), including Mobile applications
- Social collaboration
- Security

The Cleanweb taxonomy described in Appendix E could provide a useful starting point for understanding the common groupings for how similar technologies are being used for Cleanweb propositions. This taxonomy could be developed further to enable this identification and prioritisation of common technology areas.

Policy Recommendation 6: A more detailed study to understand how these common technologies can be applied for different environmental goals. Facilitate the exchange of best practice models from one economic system to another, i.e. from energy to transport to food.

The UK has a number of IT/High tech clusters, in particular in London and in the Bath & Bristol region. This existing technology could be applied to deliver Cleanweb services. A further study to identify in more detail the Cleanweb business opportunities in different

customer sectors would provide evidence for these existing clusters to identify new business development opportunities, both in the UK and overseas.

Policy Recommendation 7: An assessment of Cleanweb market opportunities to marry against existing IT/High tech expertise which exists in the UK. To ensure that the domestic potential for exploiting existing technology expertise to deliver environmental benefit is realised, particularly in the context of the UK's response to the UN Sustainable Development Goals. This could be an extension of study recommended in 6 above.

The use of Open Data by Cleanweb startups/SMEs is more important than for large corporations. Easy access to this data through standard APIs should enable new Cleanweb technologies to be built faster.

Policy Recommendation 8: As part of the Government Open Data Strategy to consider Cleanweb applications to make available the most useful data sets via standard APIs.

This study has drawn on international development in the Cleanweb arena, but the analysis has focused on the UK market. In doing so a number of important emerging trends have been identified. There is no comparative study for other countries or regions, although Cleanweb hubs exist around the world. For inward investment purposes a comparative market assessment for other countries, in particular the USA and Germany, would help to identify similarities and differences between the UK and other markets. Also, for export purposes to support commercialisation at scale, a study of international target market for UK Cleanweb businesses would aid the growth of the sector.

Policy Recommendation 9: Two comparative market studies to identify inward investment opportunities and export potential for the Cleanweb sector.

8 Conclusions

In conclusion this report shows that there is significant innovation activity in the UK in the use of web technologies to address environmental challenges. This activity may not yet be self-labelled as Cleanweb and may be known as Cleantech, Web for Sustainable or Tech for Good but the purpose is the same in finding ways to efficiently use energy and resource, and to protect our environment. There are a number of lighthouse activities, such as Cleanweb UK, incubation programmes and grants, around which Cleanweb companies are attracting but the overarching nature of the Cleanweb sector is fragmented in focus. This is detrimental to economic growth and the potential environmental benefit from this innovation.

The opportunity exists for policy actions to be taken to provide a catalyst that ensures UK research, development and innovation in Cleanweb technologies is commercialised successfully and taken to scale. The UK could become an international leader. This is technology which is capital light and can be scaled quickly by businesses under the right conditions. Cleanweb businesses are already taking off in the USA and the UK could be the leader in Europe. There is a groundswell of activities embodied in Cleanweb UK and this needs to be married with top-down support measures as set out in the recommendations

Taking forward the recommendations in this report could be facilitated by Nesta. The actions themselves must be taken by the UK Government, British businesses and the Cleanweb community.

Appendices

A. Methodology

To complete this study the following steps were completed:

- Open data from Crunchbase was analysed to identify UK Cleanweb companies. This was supplemented by additional Cleanweb company data from Oriol Pascual, Jack Townsend and Sonny Masero to create a directory of approximately 250 UK Cleanweb companies.
- A survey was completed by 70 Cleanweb UK members to provide a primary data set. The views of these people were sought on emerging trends and the support required for this emerging market.
- Ten semi-structured interviews were completed with a group of Cleanweb stakeholders including: UK researchers, a Corporate Chief Sustainability Office (CSO), Cleanweb CEOs, an investor & funders who are active in the Cleanweb market, to gather views on the emerging market trends.
- A desk study of cleantech and web tech incubator and acceleration programmes was undertaken to identify the support available to Cleanweb companies.

The time budget available for this project was twenty days.

B. Cleanweb Timeline

2000-2010

- Zipcar, a car sharing service was formed in January 2000 which allowed customers to rent cars by the hour in cities. Zipcar raised $174M through an IPO in 2011 (Spears, 2011). Zipcar was sold to Avis for $500M in March 2013 (Primack, 2013).
- In 2002, B.J. Fogg published *Persuasive Technology: Using computers to change what we think & do* which formed the basis of the MIT Persuasive Media lab and has influenced application development across many sectors (Fogg, 2002).
- Silver Spring Network was founded in July 2002 providing smart grid management software to market. Silver Spring raised $81M in an IPO in March 2013 (Fehrenbacher, 2013).
- More Associates was founded in the UK 2003 and later created Onzo, a domestic smart meter, and Carbon Culture, which applies gamification techniques to behaviour change for organisations who want to reduce their greenhouse gas (GHG) emissions.
- Recyclebank was formed in 2004 allowing consumers to get benefits to encourage recycling. In March 2011 they topped the Wall Street Journal's list of top 10 Cleantech companies taking the spot vacated by Tesla (Debaise, 2011).
- The UN Kyoto Protocol came into effect in 2005 & the EU Emissions Trading Scheme was launched. Both aiming to reduce global GHG emissions.
- Later the same year Hurricane Katrina devastated New Orleans making global news headlines and emphasises the catastrophic impact that extreme weather can have on everyday lives.
- The Climate Corporation was founded in 2006 to provide granular weather forecast information to farmers and was sold to Monsanto for $930M in October 2013 (Vance, 2013).
- SolarCity was founded in July 2006 to provide new financing & installation for domestic solar PV installations. The company's IPO was in December 2012 (Farrell, 2012)
- Loco2 was founded in the UK in the same year to provide an integrated pan-European train booking service for the first time.
- In October 2006, the *Stern Review on the Economics of Climate Change* was published emphasising the high adaptation cost of inaction now on mitigating climate change (Stern, 2007).
- Market analyst, Gartner, published in 2007 their report *Green IT: The New Industry Shockwave* creating substantial interest in the environmental impact of IT (Mingay, 2007).
- In the same year, the first *Sustainable Human Computer Interface (HCI)* conference was held and the *Centre for Sustainable Communications* was founded in Sweden.
- The IPPC *Fourth Assessment Report* was published this year and provided clear scientific evidence that climate change was caused by human activities, in particular the burning of fossil fuels (IPCC, 2007).
- Opower was founded in 2007 to encourage domestic energy efficiency savings. Taking small savings of 2%-4% to international scale. They now have over 24M consumers using their service through 90 utilities saving the equivalent of turning the US State of New Hampshire's power off for one year (i.e. 1.3 million homes) (Tinjum, 2014).
- In 2008, GeSI published the often referenced *Smart2020* Report which covered both the environmental costs of the global ICT industry, specifically in terms of GHG

emissions, as well as the many benefits that could be delivered by ICT for Sustainability (The Climate Group, 2008).

- IBM started their *Smarter Planet* initiative in this year.
- A milestone academic text is published by Hilty called *Information Technology & Sustainability: Essays on the relationship between IT and Sustainable Development* (Hilty, 2008).
- AirBnB was founded in August 2008 to allow sharing of spare rooms/homes as an alternative to hotels.
- In 2009, Chris Anderson published *Free: The Future of a Radical Price* (Anderson, 2009). Setting out how the internet is changing the marginal cost of delivering services to consumers using Apple's iTunes as a prime example of how this has disrupted the music industry.
- Uber followed in March 2009 to enable car ride sharing and was valued in June 2014 at $18.2B (Rusli & Macmillan, 2014).
- Nest Labs was founded in 2010 by ex-Apple employees Tom Fadell & Matt Rogers to develop and launch an intelligent domestic thermostat. A smart fire alarm followed. The company was sold to Google in January 2014 for $3.2BN (Winkler & Wakabayashi, 2014).
- September 2010 saw the OECD publish their report *Greener & Smarter: ICTs, the Environment & Climate Change* (OECD, 2010).
- According to WHO now, for the first time, more people live in urban areas than in rural areas (Global Health Observatory, n.d.).
- GreenQloud launched their data centre service as a 100% renewable powered green cloud hosting company (Koetsier, 2012).

2011

- 4th March 2011 - Recyclebank topped the WSJ list of top 10 cleantech companies taking the spot vacated by Tesla's IPO.
- 6th April 2011 - First article on the Cleanweb published by Katie Fehrenbacher on 'Sunil Paul on the Cleanweb' in Gigaom.
- 14th April 2011 - Zipcar IPO raises $174M
- 21st April 2011 - Sunil Paul introduced the Cleanweb to the audience at Gigaom's Green:Net 2011 event in San Francisco
- September 2011 - Sunil Paul co-founded Side.cr as CEO
- On 8 September 2011, Google published its carbon footprint for the first time to show that it was starting to take responsibility for this environmental impact (Clark, 2011).
- On 26 September 2011, Cleanweb London (now Cleanweb UK) was formed. The Cleanweb UK meetings over the next few years saw the formation of Cleanweb companies Mastodon C (2012) and Open Utility (2013).
- October 2011 saw the global population reach seven billion people and the majority of these are in cities (Biello, 2011).
- The first Green Hackathon took place in Stockholm, Sweden.
- 2011 also saw the publication of Jeremy Rifkin's The Third Industrial Revolution: How later power is transforming energy, the economy and the world (Rifkin, 2013).

2012

- In February 2012, Blake Burris founded The Cleanweb Initiative in Austin, Texas to create a global network of Cleanweb innovation hubs.
- In March 2012, Sunil Paul & Nick Allen present *Why Cleanweb will beat Cleantech* at SXSW in Austin (Paul & Allen, Why Cleanweb Beats Cleantech, 2012). This is followed in April with the publication of *Inventing the Cleanweb* in the MIT Technology Review (Paul & Allen, 2012).
- On 22 September 2012, the New York Times published *Power Pollution & the Internet* exposes the power hungry nature of technology companies built on the need to accumulate, store and analyse data including Facebook and Google (Glanz, 2012).
- In October, Hurricane Sandy in New York reinforced the impact that extreme weather events can have on people and the economy (Singer, 2012).
- The Open Data Institute (ODI) is opened in London by Tim Berners-Lee.

2013

- In March 2013, the first *ICT for Sustainability* conference was hosted in Zurich. The second will be held in Sweden in 2014.
- Israeli venture capital firm, Terra Venture Partners, announced their intent to raise a fund to invest in Cleanweb companies (Maag, 2013).
- December 2013 saw the first EU R&D Funding call to mention Cleanweb technology (European Commission, 2013).
- During this winter there are a number of extreme weather events around the globe, including “biblical” flooding in the UK leading to a #Floodhack event to find new Cleanweb solutions.

2014

- January 2014 saw the launch of Rockstart Smart Energy Accelerator to support Cleanweb startup companies.
- In the same month, the Ashden Awards recognised Cleanweb companies Abundance Generation and Demand Logic at their annual awards. Abundance Generation won the award and went on to win another Guardian Sustainable Business Award.
- Columbia University’s Earth Institute launch the first Massive Online Course (MOOC) on *The Age of Sustainability* led by Jeffrey Sachs.
- CB Insights published *The New Clean Tech – 20 VC backed companies that nobody calls clean tech (but probably should)* and featured twenty Cleanweb companies (CB Insights, 2014).
- Cleantech Group & Pure Energy Partners publish *Sparking the Cleanweb* highlighting examples of investment grade Cleanweb companies and corporate activity in this sector (Watanabe, 2014) (Eisenberger & Rashid, 2013).
- In February 2014, the world’s largest thermal projects was turned on in Ivanpah Dry Lake, California. This was funded by Google as part of their growing investment in renewable energy to provide security of supply.
- In the same month, US Cleanweb company EnerNOC acquired German and Irish Cleanweb companies, Entelios and Activation Energy respectively.
- Facebook acquires Whatsapp for $19B putting a spotlight on the runaway valuations of technology companies (Solomon, 2014).

C. Cleanweb UK Start-up Company List

1E
10:10
2degrees
38 Degrees
Abundance Generation
Acano
Achilles Group
AirBnB
AlertMe
ALK Technologies
altcom
amee
Arup
Attenda
Badgeville
Barclays Cycle Hire
Bethnal Green Ventures
Bglobal
BIW Technologies
BlaBlaCar
Bloomberg New Energy Finance
bloomtrigger
Blue & Green Tomorrow
bnbBoat
Boatbookings.com
Bright North
Business Green
BuyMyWardrobe
Bytemobile
Cadmeleon
Cam On Net
Carbon Analytics
Carbon Culture
Carbon Disclosure Project
Carbon Genie
Carbon Visuals
Carbon Voyage
CarbonGenie
Carmen data
Carpooling
Causehub.io
Changify
Charity Engine
Cisco
City Green Cars
Citymapper Limited
CitySync
Clean Energy Prospector
Cleanweb Conversations Podcast
Climate-KIC
CloudApps
CO2 Estates
CodBod
CodBodTech
Community Energy Manager
Community Infopoint
Compare and Recycle
CompareMySolar
Compliance & Risks
Comply Serve
Conservation Careers
ContinuumBridge
Controls Plus
Convergent Home Technologies
Conveyancing Data Services Ltd
Credit 360
CropDrop
Crowdicity
CSR
Databarta Ltd
Datakind
Datamonitor
Demand Logic
Derceto
Digital Contraptions Imaginarium
Ditto Reuse
Donation4Charity.org
e2v Technologies
EAEM
eBay
E-Car Club
Eco Market
Ecodesk
Ecometrica
eCow
Edie.net
Enablon
Energy Shed
EnergyDeck
EnergyGuardian
Engine Shed
ENMAT
enModus
Envizi
EP&T Global
Escher Group
eSight Energy
Ethical consumer
EVRYTHNG
eWeek Europe UK
FarmDrop
FarmGeek
Fast Lynx Internet Service Pvt Ltd
Figbytes
Folk Labs
Fonefixed

FoodTrade
Forum for the Future
Futerra
GALOS
Gensuite
Geosho
Given London
GlobalServe
GoEuro
Google Nest
Green Car Guide
Green Energy Options
GreenRoad Technologies
Greenshop
Greenstone Carbon Management
Guardian Environment
Gumtree
Healthy Planet
Heatmiser
Helveta
Hire Jungle
HIS
Holmes Media
home4eco
Homely
Hub Culture
Hubbub
i2O Water
IBM Smarter Planet
inAccess Networks
Infinity SDC
Innocentrix
Innoverne
ipadio
IT Green
Ito World
Jennic
Joulo
JustMeans
Kanichi Research Services
Kiln.it
Kilsyth Ltd
KiwiPower
Landshare
Last.fm
LeapFrog Investments
Liftshare.com ltd
Loc8.com
Locatable
Loco2
Loop Labs
Love Hz Ltd
LYDA
Lysanda
Magenta Technology Ltd.
ManageCO2
Masabi
Mastodon C
Medra Capital Ltd
Memset
Metwit
Microsoft
Mila
Mincom
Modern Water
My Society
My Yard Software
Mydex
myJoulo
MySkip.com
nCube
Nest Labs (now part of Google)
Nesta
nLyte
Nominet UK
OggaDoon PR & Media
Open Corporates
Open Data Institute
Open Energi
Open Utility
OpenSensors.io
OpenStreetMap
OpenTRV
Openxtra
Opower
Orchard
PassivSystems
PE INTERNATIONAL
PennWell Corporation
Pilio
PleaseCycle
Plugsurfing
PowerOasis
Process System Enterprise
Project Dirt
Provenance
pv magazine
PV-Tech
Rainstor
Raspberry Pi
Recyclebank
Recycled Future
Red Engineering Design
RedMonk / GreenMonk
Renewable Energy Focus
RENews
Rent My Items
Repowering London
Restart Project
Riverbed Technology

Rivo Software
Savi Technology
Saypage
Sbl Infotech UK Limited
Scaled Networks Ltd
Sedex Global
SeedPod
Sefaira
Sell My Old Mobile Phone
SensorTran
Shaspa Research
Shutdown scanner
Sian's Plan
SilverRail Technologies
Skipso
Skype
Smart Carbon Control
Smarter Grid Solutions
Solar Power Portal
Spotify
Storenextdoor
Streetbank
Streetlife
SunReports
Sustainable Venture Development Partners
Teliris
The DoNation
The Lost Outpost
The NewsMarket
tickerTXT
Top Dollar Mobile
Trakeo
Transport API
Tricycle
Trillion Fund
Trippa
Trucost
Udopt
UK Drainage Network
UK Gleaning Network
Uplogix
Upstarter
UsedEverywhere.com
Utilidex
Utiligroup
Utilitywise
Verdantix
Verisae
ViaPost
VID Communications Ltd
VMWare
VoulezVousDiner
Warp IT
Water Innovate
WebStart
WEMS
Winnow
Xively (formerly Pachube)
Youreko
Zexu
Zipcar (now part of Avis)
Zogix

D. UK Cleanweb Company Profiles

Abundance Generation

Abundance is a FCA-regulated investment company which provides a platform for individuals to invest in renewable energy projects. Abundance was founded in London in 2011 by Karl Harder, Bruce Davis and Louise Wilson (Hawkins, 2014). Wilson's background in finance at UBS Investments was combined with Harder's knowledge of the environmental services market and Davis' experience of consumer market research and brand development. Investment to finance the company was initially raised from Nesta, the Panahpur Foundation and ten angel investors. Since then, Abundance claims to have invested over £6.5M in renewable energy projects. In recognition of their pioneering efforts in energy innovation Abundance won a 'Gold' Ashden Award and the 2014 Impax Ashden Award for Energy Innovation (Webster, 2014). They also won the 2014 Guardian Sustainable Business Award for Innovation in the 'Net Positive' category (Sidenius, 2014).

AlertMe

AlertMe is a smart energy and home monitoring system that enables a customer to control home appliances via their smart phone. AlertMe is a competitor to Nest Labs Intelligent Thermostat. It is the software technology behind British Gas' *Hive* service and Lowe's' *Iris* connected home service in North American. AlertMe was founded by computer scientist Pilgrim Beart and entrepreneur Adrian Critchlow in Cambridge in 2006. Whilst still a Director, Beart is now CEO of Internet of Things (IoT) software startup *1248* – founded in 2013 and recently raised £250,000 in seed funding (Lomas, 2014). AlertMe is now led by Chairman, Ron Mackintosh, and since February 2010 CEO, Mary Turner who was previously CEO of Tiscali UK. The company has been successful in two funding rounds: $13M in June 2009 from Index Ventures, Good Energies and VantagePoint Capital Partners; and another $23.8M in October 2010 from the same investors plus British Gas and SET Venture Partners. In 2013, AlertMe was one of seventy-one fast growth UK companies in the Deloitte Technology Fast 500 and was named third in the Deloitte UK Fast 50 (AlertMe, 2013).

Carbon Culture

CarbonCulture provides an online community platform to encourage behaviour change in organisations to reduce greenhouse gas emissions. It was founded in London by Luke Nicholson and spun out of More Associates in 2009. More Associates had previously created Onzo, the domestic smart meter company, which has recently reposition as a broader IoT sensor data analytics apps provider. CarbonCulture has been angel funded to date and is working with a number of central government departments and local authorities, including the Greater London Authority (GLA).

EnergyDeck

EnergyDeck provides an energy management community platform for commercial real estate and social housing. The aim being to support these communities to take action on energy reduction and greenhouse gas emissions. The company was started in London in 2011 by Benjamin Kott, who was previously Google's Clean Energy Advocacy Manager & Green Business Operations Manager in EMEA. EnergyDeck has to date raised $200,000 in Angel investment and are presently raising a second round. In 2013, at the UK's Green Corporate Energy event they won the public vote to be selected as the Idea Idol Champion.

Loco2

Loco2 provides a website for booking international train travel across Europe. The mission of the company is to making booking a train as simple as booking a flight. The aspiration is that this will reduce greenhouse gas emissions by encouraging people to get the train rather than fly. The company was founded by Cleanweb veteran (i.e. ex-amee Business Development Manager) and open data advocate Jamie Andrews, his sister Kate Andrews and Jon Leighton in London in 2006. In 2013 they raised £300,000 of seed investment via Angel investor

network, Envestors (subsidiary of Braveheart Investment Group), and a further round followed in 2014 to building on successful customer acquisition (FinSMEs, 2013). The Chairman of Loco2 is slow travel advocate, provocateur and author of *Only Planet*, Ed Gillespie.

Mastodon C

Mastodon C provides a big data analytics services. In 2012, founders and friends Fran Bennett and Bruce Durling decided to combine their big data science & development experience from a variety of corporate roles including Google and Ask.com. They joined Bethnal Green Ventures' (BGV) incubation programme with £20,000 of equity investment. The original intent was to offer a green big data service and they succeeded in building a dashboard at London's Green Hackathon (Durling, 2012), but found that this green differentiation was not significant enough for clients. In April 2012 they joined the Open Data Institute's (ODI) startup programme. Mastodon C has now moved on to provide a big data analytics service for clients including Open Health UK and the Energy Savings Trust.

Open Utility

Open Utility provide an online marketplace for renewable energy generators to connect directly with customers. The founders met at a Cleanweb UK meetup and they are mechanical engineer James Johnston, open source developer and Cleanweb veteran (i.e. Carbon Culture & More Associates' Technical Lead) Andy Kilner and user experience designer, Alice Tyler. In 2013 they joined the Bethnal Green Ventures startup programme, receiving £20,000 of equity investment and starting the company. Over the last eighteen months they have won the Nominet Trust's *Social Tech, Social Change* Award 2013 and the 1776 Challenge Cup; and Open Utility was runner up in the British Gas *Connecting Homes 2013*. Open Utility is now part of the Climate-KIC startup programme, which provides up to €95,000 of grant funding in three stages, and have moved to be hosted at the ODI start-up programme. Open Utility has just released their first service (Open Utility, 2014).

Wireless Energy Management Systems International (WEMS)

WEMS provides a modular hardware system and software which can be retrofitted to a commercial building as a wireless building energy management system. The company was founded in 1990 in Stockport, Cheshire, by their Technical Director Joe Blower and one other person as Adam International. In September 2012 the company raised £13M from WHEB Venture Partners, WEMS' management and Hermes GPE Environmental Innovation Fund to acquire the company from Maven Capital Partners (ResearchViews, 2012). WEMS is led by Paul Summers, CEO, who has previously run other cleantech businesses.

Lysanda

Lysanda offers a software tool called *Eco-Log* to analyse driver behaviour to improve vehicle fuel consumption and reduce emissions. The company is based in Kelvedon, Essex. Lysanda has raised two rounds of funding: $2.1M from Disruptive Capital Finance's Sustainable Technologies Fund and Logispring in 2009; and £10M from Disruptive Capital Finance and Danny & Edmund Truell in 2011 (FinSMEs, 2011). Their CEO/Chairman of two years, Geoffrey Finlay, left the company in 2013 and is now Chairman of Eyefreight, a Netherlands based company also operating in the Transport Management System market with a strong focus on cost reduction. The Lysanda management team consists of their principal investors, Cédriane de Boucaud of Disruptive Capital Finance and Jeffrey Belkin representing Danny & Edmund Truell, and CFO Hugh Woolley.

PowerOasis

PowerOasis provides power supply and management systems for remote/off-grid mobile phone base systems. The company was founded by Pete Bishop in Swindon after leaving Motorola Networks. The company was originally funded by Bath-based Angel investors and in 2011 received the first of four funding rounds over 19 months totalling $17.7M to February 2013. The investors included Oxford Capital Partners, Yorkshire Fund Managers (YFM) Private

Equity and MTI. In February 2013, Jabil also become a strategic investor putting its contract manufacturing resource in Malaysia at PowerOasis' disposal to enable flexible and low cost growth.

amee

amee is a well-known UK Cleanweb company which hosts a database of corporate sustainability performance information. It is used to assess the environmental credibility of companies, including both corporations and their suppliers. The company was founded in London in 2007 by Andrew Conway and Gavin Starks. Starks remains on the amee board and is now the CEO of The Open Data Institute (ODI). Tyler Christie is now CEO. The company raised $10.8M between January 2008 and November 2013 from debt financing and through the following investors: The Accelerator Group, Union Square Ventures, O'Reilly Alphatech Ventures.

CityMapper

CityMapper is a mobile application providing travel advice in major cities showing the best routes by foot, bicycle and public transport. The company was founded in London in 2011 by Azmat Yusuf and is now run by General Manager, Omid Ashtari (ex-European MD of Foursquare). In April 2014 the company raised $10M from Balderton Capital, Connect Ventures, Index Ventures and Greylock Partners.

Masabi

Masabi provides a technology platform for ticketless public transport with the intent of making public transport as easy to use as possible. The company was founded in London in 2001 by Ben Whitaker (CEO), Tom Godber (JustRide Product GM) and Ed Howson. Between September 2010 and March 2013 the company raised three rounds of investment from m8 Capital, MMC Ventures and Fontinalis Partners. The company has won numerous railway, transport and mobile innovation awards.

Open Energi

Open Energi provides a software based technology service to companies who want to provide dynamic demand response services to the National Grid reducing energy consumption and emissions. The company was incorporated in 1999 as RLtec and have two offices in London and Manchester. Early-stage venture capital was provided by the Carbon Trust's Low Carbon Accelerator with £300,000 in 2009 (Growth Business, 2009). David Stevenson was Open Energi's CEO since 2012. In October 2012, the Ombu Group invested £5M in the growth of Open Energi (Sormani, 2012). BusinessGreen recognised Open Energi's Dynamic Demand technology as *Innovation of the Year 2014*.

i2O Water

i2O Water offers a data management software, sensor and controller technology platform to monitor and control pressure in water distribution systems to avoid wastage. The company was founded in Southampton in 2005 by Adam Kingdon (CEO) and Andrew Burrows (CTO). $7M was raised in a series C funding round in 2009 from Swarraton Partners. i2O has won numerous awards for water management and cleantech innovation.

enModus

enModus develops smart homes software technology and powerline chipsets. The company was formed in Chepstow in 2010 by Andy Heaton (CEO) and Phil Young (CTO). enModus has developed a powerline communications protocol for smart buildings called *Wattwave*. They originally secured £150,000 of Angel funding in 2010 via the SETsquared start-up incubator programme. Since then they have received £2.5M in equity investment from Andromeda Capital and Finance Wales as well as a £300,000 grant from DECC's Energy Entrepreneurs Fund and a grant from the Technology Strategy Board (Temmik, 2013). In April 2014, the Nest Labs' former VP of Operation, John Gilmore, joined the EnModus Advisory Board (Temmik, 2014).

Green Energy Options (GEO)

GEO produces consumer products and apps for improve energy consumption. The company was founded in Hardwick, Cambridge in 2006 by Patrick Caiger-Smith (CEO). From 2008 to November 2013 they have received $2.8M of investment from the Thames Valley Investment Network and the Low Carbon Innovation Fund. In April 2014 they used a successful Kickstarter campaign to crowd fund £20,676 for the production a Nest thermostat competitor called *Cosy* (Green Energy Options, 2014).

Achilles Group

Achilles provides an online platform for managing supply chain risk, including a sustainable procurement service. The company was founded in 1990 in Norway as Gamedean Ltd and become the Achilles Group in 2000 with its headquarters in Abingdon, Oxfordshire. Achilles has been led by CEO Adrian Chamberlain since July 2011. In January 2008 the company raised £2.5M from Ephor Group and First Analysis and in July 2008 HgCapital invested £42M (HgCapital, 2008).

Water Innovate, part of Bluewater Bio

Water Innovate has a wastewater pollution monitoring system called *N-Tox*, which prevents potent greenhouse gas pollution. The company was spun out of Cranfield University's School of Water Science by Professor Tom Stephenson to be based in Bedfordshire. Prior to their acquisition by Bluewater Bio in 2010 they received $1M investment from Nesta Investments, Investment ARM, Oxford Technology Management and Fond fondov in 2005. Bluewater Bio raised $35.8M in March 2012 from Hermes GPE Environmental Innovation Fund and Ombu Group. Adrian Harris is CEO & Co-Founder of Bluewater Bio and Richard Haddon is their Chairman.

Historic Futures

Historic Futures provides an online platform called *String* for supply chain traceability and managing chain of custody. Tim Wilson (Director) founded the company in 2003 in Oxton. In June 2007 they received $1.2M of investment from Oxford Technology Management, Fond fondov and Triodos Investment Management.

E. Cleanweb UK Startup Categorisation

This study employs the Cleanweb Taxonomy of the use of Web and information and communication technologies (ICTs) to address resource and sustainability challenges, developed in a recent research study by Jack Townsend (Townsend, 2014). The taxonomy has two dimensions, the web *means* and the sustainability *ends*, show in Figure 22.

The web means is the way the cleanweb "system" or "solution" works, integrating many computers, human users and data, leading to some change which impacts resource use and sustainability. The web means are organised into six "genres" and below them a number of "subgenres" (Figure 23 below). The six web genres are themselves organised by whether the system provides options for action and deciding between them (planning), or alternatively whether it enables specific sustainability actions (acting). The six genres are also organised by whether they: 1) generate new insight and experiences from web and sensor information (analysis systems); 2) promote sustainable actions and agreements (buy-in systems); or 3) support better design and user organization (composition systems). The six genres can be derived from the Sustainability Opportunity model of the different ways a cleanweb system can enable the taking up an opportunity to be more sustainable by a user or organisation (Figure 24 below).

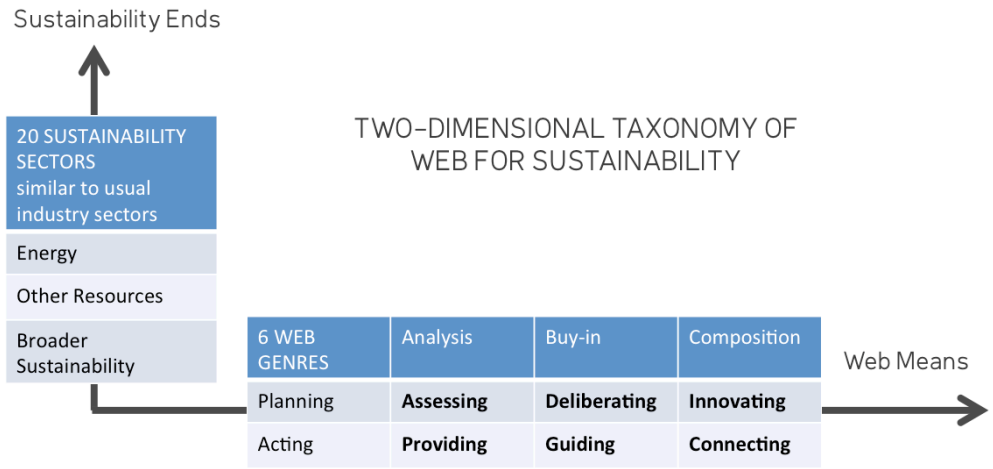


Figure 22. The Cleanweb Taxonomy has two dimensions: sustainability sectors and web genres

	ANALYSIS Generate new insight and virtual experiences from web information and sensor data	BUY-IN Communicate insight and narratives to achieve consent or compliance for sustainability change	COMPOSITION Formulate novel designs and system configurations that could be more sustainable
PLANNING Providing options for action and deciding between them	ASSESSING *assessing sustainability challenges and the sustainability of particular opportunities*	DELIBERATING *communicating and discussing sustainability challenges, and agreeing which opportunities to take up*	INNOVATING *developing novel sustainability opportunities*
Sub genres:	• Environmental monitoring and sensors • Crowd sustainability data and sensing • Data platforms and standards • Environmental informatics • Sustainability ratings and comparison • Sustainability accounting • Life cycle assessment	• News, analysis, opinion and discussion • eEducation, data journalism and educational games • eCampaigning, eMarketing and customer relationship management • Problem prioritisation and agreeing sustainability criteria	• Open innovation and opportunity identification • Analysis for engineering and design • Distributed manufacturing and 3D printing • Collaborative software and revision control • Business intelligence, process management and resource planning • *Hackathons, accelerators, incubators and innovation hubs* • *Investors*
ACTING Enabling specific sustainability actions	PROVIDING *Providing known opportunities*	GUIDING *Guiding behaviour of actor towards taking up sustainability opportunities*	CONNECTING *Finding and linking actors with opportunities*
Sub genres:	• Automated resource optimisation and user control • Virtual products • Telepresence • Transactions and ticketing	• Peer-comparison and gamification • Guiding content for behaviour and opportunity • Resource-use feedback and diagnostics • Navigation and real-time user guidance • Project analysis for adoption and sales	• Collaborative financing and fundraising • Reuse marketplaces • Collaborative consumption and group purchasing • Sustainability eMarketplaces • Sustainability directories • Sustainability social networking and careers • Crowd tasks, human computation and volunteer computing

Figure 23. The six web genres and various subgenres of the Cleanweb Taxonomy. These can be derived from the sustainability opportunity model below.

The sustainability outcome represents the particular resource - such as energy, water of food – or other aspect of sustainability that the cleanweb system positively impacts. It is organised into 20 sustainability “sectors”, which correspond closely to sectors in standard taxonomies of the whole economy, and of cleantech.

The taxonomy began with conversations between leading cleanweb analysts in the EU and USA, and is derived from a qualitative analysis of descriptions of 600 companies and projects, many of them from within the Crunchbase database. The taxonomy is still developing and feedback for improvement is sought.

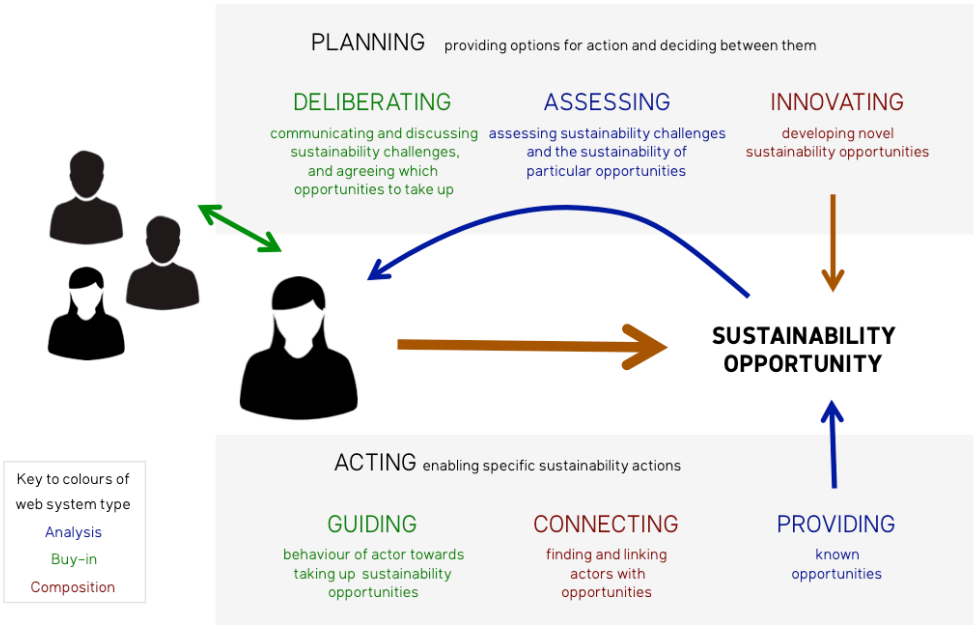
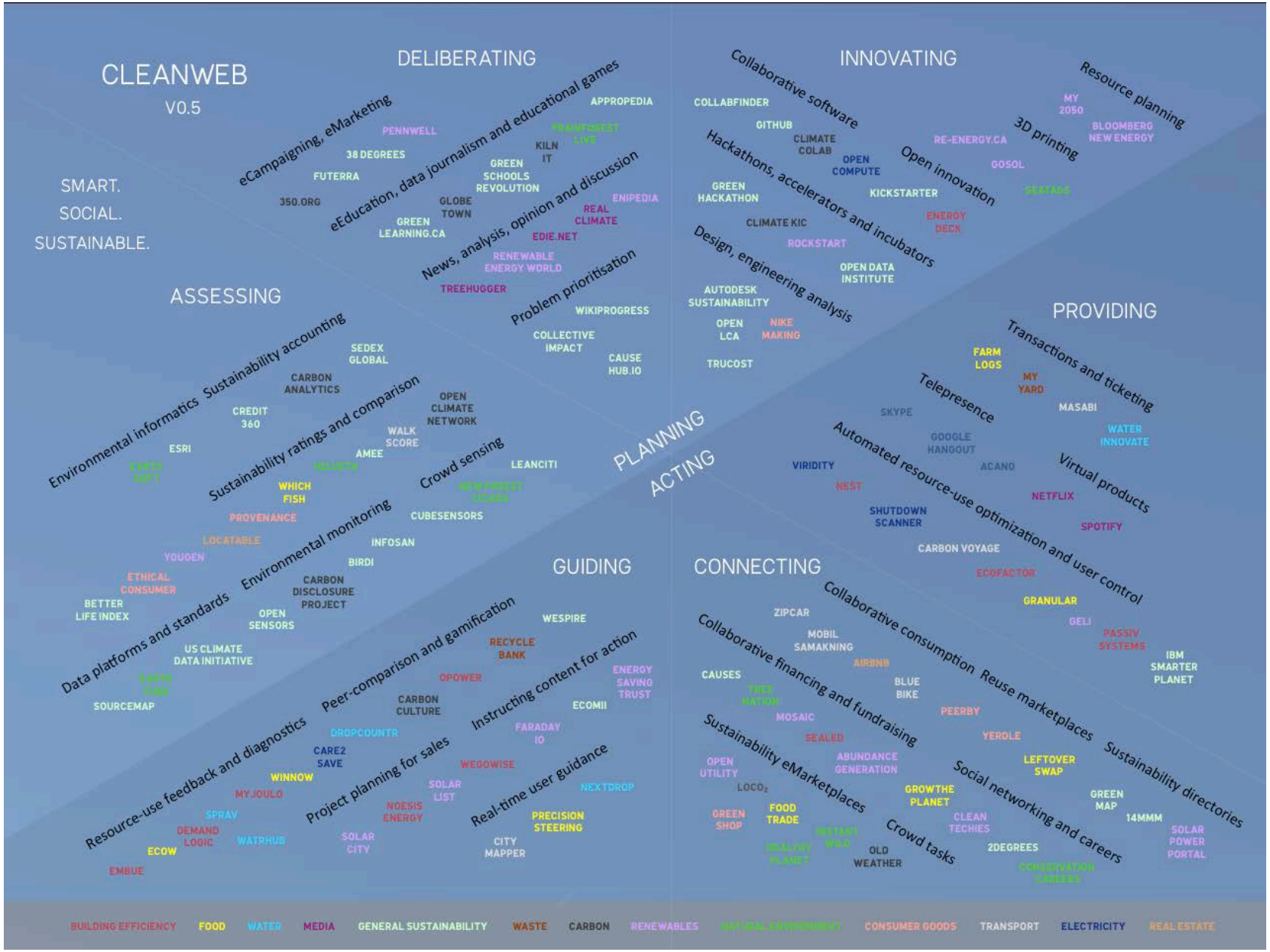


Figure 24. The Sustainability Opportunity Model, for deriving the six genres of cleanweb system

The wind turbine illustration below is a poster summary of the taxonomy applied to Cleanweb companies. The following example matrix shows how this Cleanweb taxonomy can be combined with traditional sector to show whether Cleanweb companies are acting.


CLEANWEB
V0.5
SMART.
SOCIAL.
SUSTAINABLE.
DELIBERATING
INNOVATING
ASSESSING
PROVIDING
GUIDING
CONNECTING
PLANNING
ACTING
eCampaigning, eMarketing
eEducation, data journalism and educational games
News, analysis, opinion and discussion
Problem prioritisation
Collaborative software
Hackathons, accelerators and incubators
Design, engineering analysis
Resource planning
3D printing
Open innovation
Sustainability accounting
Environmental informatics
Sustainability ratings and comparison
Crowd sensing
Environmental monitoring
Data platforms and standards
Transactions and ticketing
Telepresence
Automated resource-use optimization and user control
Virtual products
Peer-comparison and gamification
Instructing content for action
Resource-use feedback and diagnostics
Project planning for sales
Real-time user guidance
Collaborative consumption
Reuse marketplaces
Sustainability directories
Collaborative financing and fundraising
Sustainability eMarketplaces
Social networking and careers
Crowd tasks
APPROPEDIA
PENNWELL
RAINFOREST LIVE
KILN IT
38 DEGREES
FUTERRA
GREEN SCHOOLS REVOLUTION
350.ORG
GLOBE TOWN
ENIPEDIA
REAL CLIMATE
GREEN LEARNING.CA
EDIE.NET
RENEWABLE ENERGY WORLD
TREEHUGGER
WIKIPROGRESS
COLLECTIVE IMPACT
CAUSE HUB.IO
SEDEX GLOBAL
CARBON ANALYTICS
CREDIT 360
OPEN CLIMATE NETWORK
WALK SCORE
AMEE
ESRI
LEANCITI
WHICH FISH
CUBESENSORS
PROVENANCE
LOCATABLE
INFOSAN
YOUGEN
BIRDI
ETHICAL CONSUMER
CARBON DISCLOSURE PROJECT
BETTER LIFE INDEX
OPEN SENSORS
US CLIMATE DATA INITIATIVE
SOURCEMAP
WESPIRE
RECYCLE BANK
OPOWER
ENERGY SAVING TRUST
CARBON CULTURE
ECOMII
DROPCOUNTR
FARADAY IO
CARE2 SAVE
WEGOWISE
WINNOW
MY JOULO
SOLAR LIST
NEXTDROP
SPRAV
NOESIS ENERGY
PRECISION STEERING
DEMAND LOGIC
WATRHUB
SOLAR CITY
CITY MAPPER
ECOW
EMBUE
COLLABFINDER
GITHUB
CLIMATE COLAB
OPEN COMPUTE
RE-ENERGY.CA
GOSOL
MY 2050
BLOOMBERG NEW ENERGY
GREEN HACKATHON
KICKSTARTER
SEATAGS
CLIMATE KIC
ENERGY DECK
ROCKSTART
OPEN DATA INSTITUTE
AUTODESK SUSTAINABILITY
OPEN LCA
NIKE MAKING
TRUCOST
FARM LOGS
MY YARD
MASABI
SKYPE
WATER INNOVATE
GOOGLE HANGOUT
ACANO
VIRIDITY
NEST
NETFLIX
SHUTDOWN SCANNER
SPOTIFY
CARBON VOYAGE
ECOFACTOR
GRANULAR
GELI
PASSIV SYSTEMS
IBM SMARTER PLANET
ZIPCAR
MOBIL SAMAKING
AIRBNB
CAUSES
BLUE BIKE
TREE NATION
PEERBY
MOSAIC
SEALED
YERDLE
OPEN UTILITY
ABUNDANCE GENERATION
LEFTOVER SWAP
LOCO2
GROWTHE PLANET
GREEN MAP
14MMM
GREEN SHOP
FOOD TRADE
CLEAN TECHIES
SOLAR POWER PORTAL
2DEGREES
OLD WEATHER
BUILDING EFFICIENCY
FOOD
WATER
MEDIA
GENERAL SUSTAINABILITY
WASTE
CARBON
RENEWABLES
CONSUMER GOODS
TRANSPORT
ELECTRICITY
REAL ESTATE

Example Matrix: Application of Cleanweb Taxonomy & Sectors	General Sustainability and Resources	Information and Communication Technology	Transport	Building Efficiency	Renewables
Providing **Automated resource optimisation and user control**	IBM Smarter Planet	1E, Bytemobile, Openxtra, Uplogix, Shutdown scanner	City Green Cars, Ito World	Convergent Home Technologies, enModus, PassivSystems, Sefaira, WEMS, ContinuumBridge, OpenTRV, Heatmiser, Google Nest	inAccess Networks
Connecting **Collaborative consumption and group purchasing**			BlaBlaCar, bnbBoat, Carbon Voyage, E-Car Club, Liftshare.com ltd, Zipcar, Barclays Cycle Hire		
Assessing **Sustainability ratings and comparison**		Youreko	Green Car Guide, Carmen data Ltd		CompareMySolar
Deliberating **News, analysis, opinion and discussion**	The NewsMarket, Blue & Green Tomorrow, Guardian Environment, Business Green, Edie.net, EAEM	RedMonk/GreenMonk			pv magazine, PV-Tech, RENews, Renewable Energy Focus
Assessing **Data platforms and standards**	Datamonitor, Sbl Infotech UK Limited, Open Corporates		SilverRail Technologies, Transport API	Utilitywise plc	

F. Cleanweb Academic Research

The existing areas of research include:

- Human Computer Interaction (see ACM Transactions on Computer-Human Interaction)
- Social Computing (see ACM Conference on Computer-Supported Cooperative Working & Social Computing)
- Informatics for Environmental Protection (see EnviroInfo: International Conference for Informatics for Environmental Protection)
- Assessment & reduction of energy use based on internet architecture designs
- Behavioural engagement with energy & environmental issues using ICT
- Clean technology innovation across energy, environment and sustainability
- Energy storage
- Carbon capture & storage
- Smart cities
- Use of social machines to deliver Cleanweb objectives / business models
- Industrial economy (see Journal of Industrial Ecology)
- Life Cycle Assessment (see Journal of Life Cycle Assessment)
- Big Data

Other relevant UK research institutes & organisations include:

- Imperial College
- Leeds Beckett University – Leeds Sustainability Institute
- Open Data Institute
- National Physics Laboratory
- University of Bristol – Computer Science
- UCL – Climate Strategies
- University of Edinburgh
- University of Oxford
- University of Lancaster
- University of Nottingham
- University of Southampton
- Verdantix

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