

# The gathering brainstorm

It is unregulated, untested, more dangerous than its proponents would have you believe — and soon to become even more powerful. **Mark Anslow** reports on the inexorable march of Wi-Fi

In early summer of 1997, computer scientist and former Dutch military radar engineer Vic Hayes joined the end of a long line of scientists and smiled at the camera. The shutter clicked, celebrating the official launch of the first international Wi-Fi standard.

Known officially as IEEE 801.11, what Hayes had created was a universally accepted way of linking up computers by using high-frequency microwave radio waves. Once connected, the machines could then share information, including internet access and email.

Originally designed to connect together cash-registers at checkouts, the ambitious scientist made no secret of his desires for the new technology. 'I see Wi-Fi being used for everything eventually,' he was quoted as saying, but not even he could have predicted how widespread his invention would become.

By 2008, experts predict that there will be 53 million Wi-Fi enabled devices in Europe alone. One in every five UK adults already owns a Wi-Fi enabled laptop, and 80 per cent of secondary schools in the UK have installed the technology throughout their buildings. McDonald's recently announced that free Wi-Fi facilities would be available in all its restaurants, and the growing 'Mu-Fi' initiative — where entire municipalities receive Wi-Fi coverage — has already made Norwich the UK's first 'Wi-Fi town'.

The technology is sold to the public as the ultimate convenience tool: it allows you to grab a coffee and check your email on the go, to print photos without using a wire or listen to music on speakers not even attached to a computer. In schools, teachers can already give lessons using Wi-Fi white-boards, and in

the near future hand-held Wi-Fi terminals will enable children to 'interact' with digital lesson. In the words of the technology's industry group, the Wi-Fi Alliance: 'Simply put, Wi-Fi is freedom.'

But freedom at what cost?

Wi-Fi appeared on our shelves without having to undergo any tests or safety checks whatsoever. This was partly achieved because Vic Hayes and his team developed Wi-Fi to use an unlicensed part of the radio spectrum — freed-up airwaves designed to encourage more widespread public use of wireless technology. As long as the technology met basic requirements on interference and compatibility, consumers were free to buy and use Wi-Fi devices as they and the manufacturers saw fit. In the UK, the spectrum used by Wi-Fi (2.4 gigahertz) became available for unlicensed use in 2000.

Denis Henshaw, professor of physics at the University of Bristol, finds it remarkable Wi-Fi-enabled equipment could have come to market without having to undergo any trials.

'If you are a drug company marketing a new drug, you have to go through years of testing to



## How microwaves affect us

There are many different theories on how electromagnetic radiation interacts with our bodies, but pulsed microwave radiation, such as that used by Wi-Fi and mobile phones, is thought to affect the body's cells in a unique way.

Although microwaves oscillate (change direction) many thousands of times each second, the carrier pulses which convey your voice or emails along the signal actually oscillate at a much slower rate, only hundreds of times a second. This slower rate allows the pulses to interact with protein vibrational receptors, like microscopic hairs, on the membranes of our cells. The cells interpret this unusual stimulation as a foreign invader and react as any organism would – by closing down the cell membrane. This impairs the flow of nutrients into the cell or waste products on their way out. It also disrupts inter-cellular communication, meaning that clusters of cells that form tissues can no longer work as effectively together.

The increase of trapped waste products can lead to an increase in the number of cancer-causing 'free radicals'. Worse still, a chemical known as 'messenger RNA' inside the cell passes on this 'learned response' to daughter cells, meaning that the cell's offspring also learn to interpret microwaves as an external threat and react in the same way.

This disruption in the cellular processes is thought to lead to the many and various symptoms of electrosensitivity, and the build-up of free radicals released when the cell dies could be connected with the increase in tumours seen in those exposed to frequent doses of microwave radiation.

Special circumstances can enhance the process even further. The effects are likely to be worse in people with damaged or developing immune systems, particularly children, and certain drugs can dramatically increase the risk of negative microwave effects.

prove your product is safe,' he says. 'If you're a Wi-Fi developer using the 2.4 GHz spectrum, however, you don't need to prove anything.'

Concerns were first raised about the health effects of Wi-Fi as early as 2000. A report by the British Educational Communications and Technology Agency (BECTA), the body responsible for the use of IT in schools, noted that engineers installing some of the first classroom-based systems complained of headaches at the end of the day. The report was never published, but was eventually leaked to *The Times Educational Supplement* seven years later.

In 2003, concerned parents of children in suburban Chicago filed a lawsuit against the Oak Park Elementary School on the basis of concerns over the possible adverse health effects of the school's Wi-Fi network. The father who made the claim, Ron Baiman, said he acted because 'there are a lot of experts who say there are potential risks'.

For years, it was left to distressed teachers or parents with children suffering from repeated headaches to act as unpaid regulators, gathering together scientific papers and lobbying schools to have Wi-Fi systems taken down. In 2006, a school in Chichester made headlines after its headteacher agreed to remove a network at the request of both parents and teachers. The headteacher told *The Times* he had acted out of concern for the parents' views. 'We also did a lot of research,' he added. 'The authorities say it's safe, but there have been no long-term studies to prove this.'

The case was something of a turning point. National newspapers began to pay attention to data collected by campaign groups that had long been fighting the mobile phone industry. The campaigners pointed out that the type of radiation

emitted from Wi-Fi devices, although on a slightly different wavelength, was essentially the same as that used by mobile phones and their transmitter masts. Both systems use high-frequency microwaves that are 'pulsed' rapidly on and off to transmit data.

This pulsed aspect of data transmission is important, because it means that, although a signal might appear to be low-powered when measured over a period of time, it could reach 'spikes' of much higher levels when data is actually being transmitted. Campaigners were also at pains to show that Wi-Fi was just a part of a whole host of technologies using the same microwave system, including baby monitors, DECT cordless phones, and Bluetooth computer devices (see box, page 47).

In May 2007, the BBC's *Panorama* programme investigated the signal strengths used by Wi-Fi equipment. Under the



guidance of mobile phone concern group PowerWatch, the programme measured the intensity of microwaves 150 metres away from a mobile phone transmitter mast, and half a metre away from a laptop computer – realistic distances at which everyday exposure might occur. They found that the radiation from the Wi-Fi-enabled laptop was at least as high, if not higher, than that measured in the main beam of the mast (see box, page 47).

The programme was fiercely criticised by the telecommunications industry, partly because it feared the logical conclusion – that the battery of research built up over the past decade demonstrating very clear health risks from exposure to mobile phone masts could now be translated almost exactly into the risks faced by exposure to Wi-Fi equipment (see ‘Weight of evidence’ box, below).

Concern was further raised by comments made on the programme by the chairman of the Health Protection Agency (HPA), Sir William Stewart. Stewart, former Government Chief Scientist under Margaret Thatcher, had compiled a seminal report on mobile phones in 2000, in which he recommended that the main beam from a mobile phone mast should never be allowed to fall on school premises. He told *Panorama* unequivocally that both phones and masts could be responsible for triggering cancer,

changes in mental function and damaging effects to the body’s cells. He also said that the approach adopted by the World Health Organisation, which directly influences UK health policy, was not ‘an accurate reflection’ of the current science.

The HPA scrambled to calm the storm caused by its maverick chairman. Having first tried to deny Stewart had in fact made any claims against Wi-Fi, the Agency went on to

that determines the maximum safe radio wave dosage for all UK citizens? The International Commission on Non-Ionising Radiation Protection was formed in 1992, but has its roots in an earlier body founded in 1970s.

Alasdair Philips, founder of PowerWatch, describes it as ‘an incredibly conservative organisation’: ‘ICNIRP grew out of the International Radiation Protection Association (IRPA), which was founded in

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change one of its online press releases; now, instead of asserting there was ‘no evidence’ that Wi-Fi could have an effect on health, it stated there was ‘no consistent evidence’. The current HPA guidelines on Wi-Fi, to which all other UK Government departments refer, state: ‘There is no consistent evidence to date that Wi-Fi and WLANs [wireless networks] adversely affect the health of the general population. The signals are very low power, typically 0.1 watt (100 milliwatts) in both the computer and the router (access point) and the results so far show exposures are well within internationally accepted (ICNIRP) guidelines.’

So what exactly is ICNIRP, the institution

1950s and primarily staffed by the nuclear industry. Even when it became separate, ICNIRP retained a strong industry bias. It is highly secretive and access to the Commission is by invitation only.’

In 1998, ICNIRP published the document by which all countries with a seat on the Commission – which includes most of Europe and the US – still set their non-ionising radiation guidelines today. In the section that examines the relationship between cancer and exposure to microwaves, the ICNIRP authors cite seven studies to support their conclusion that radio waves do not increase tumour rates. None of these was conducted

### Weight of evidence

All studies listed below have found adverse health effects from microwaves at levels similar to those emitted by Wi-Fi equipment:

**Santini et al, 2002:** 530 people living near mobile phone masts reported more symptoms of headache, sleep disturbance, discomfort, irritability, depression, memory loss and concentration problems the closer they lived to the mast.

**Oberfeld et al, 2004:** 97 people living near mobile phone masts reported more symptoms of fatigue, irritability, headaches, nausea, loss of memory, visual disorder, dizziness and cardiovascular problems the higher their level of microwave exposure.

**Eger et al, 2004:** A three-fold increase in the incidence of malignant tumours was found after five years’ exposure in people living 400 metres from a mobile phone mast.

**Wolf & Wolf, 2004:** A four-fold increase in the incidence of cancer among residents living near a mobile phone mast for between

three and seven years was detected.

**REFLEX, 2004:** A four-year study on human cells found that, after exposure to low-power microwaves, they showed signs of DNA damage and mutations that were passed on to the next generation.

**Abdel-Rassoul, 2007:** Residents living beneath and opposite a long-established mobile phone mast in Egypt reported significantly higher occurrences of headaches, memory changes, dizziness, tremors, depressive symptoms and sleep disturbance than a control group.

**Bortkiewicz et al, 2004:** Residents close to mobile phone masts reported more incidences of circulatory problems, sleep disturbances, irritability, depression, blurred vision and concentration difficulties the nearer they lived to the mast.

**Hutter et al, 2006:** 365 people living near mobile phone masts reported higher incidences of headaches the closer they lived to the masts.

**Stewart report, 2000:** Research conducted by HPA chief William Stewart advised the main beam of a mobile phone mast should not be allowed to fall on any part of a school’s grounds.

**Hecht & Balzer, 1997:** A huge review of studies concluded a vast array of health effects, including insomnia, brainwave changes, cardiovascular problems and increased susceptibility to infections.

**Carpenter & Sage, 2007:** Concluded that an maximum outdoor exposure limit of 0.6 V/m should be set, and that Wi-Fi systems should be replaced with wired alternatives.

**ECOLOG-Institut, 2000:** Found evidence for increases in immune and central nervous system damage, and reduced cognitive function. Recommended an exposure limit 1,000 times lower than current guidelines.

**Kolodynski & Kolodynska, 1999:** School children living near a radio location station in Latvia suffered reduced motor function, memory and attention spans.



after 1997 – the date when Wi-Fi was first introduced – and in fact two were conducted before the 1980s.

Three of the studies in the ICNIRP report involve the exposure of military or civilian personnel to high-power radar systems; another investigates an incident during the Cold War in which Soviet agents irradiated the US embassy with microwaves, while another investigates the effects of old-fashioned cathode ray-tube computer monitors. One study looks at the effects of radio transmissions, but was later shown to have drawn seriously flawed conclusions. The authors of the only study of the seven to have investigated the health effects of mobile phones admit their research was not designed to show the long-term impact of handset use, which is where any cancerous effects would be found.

Later analyses of many of these papers show ICNIRP deliberately misquoted or misconstrued the original authors' conclusions, disguising evidence of tumours when the research offered a clear link to microwave exposure.

When, later in the same guidelines, ICNIRP dismisses the evidence for DNA damage by microwaves, it points to papers written by the UK's National Radiological Protection Board and the World Health Organization (both of which act on the advice of ICNIRP), as well as a paper by parent organisation, the IRPA.

ICNIRP appears at the centre of a hub of like-

minded bodies determined to corroborate each other's research.

The flaws in ICNIRP's guidelines did not go unnoticed. The year they were published, 16 internationally recognised scientists signed the Vienna Resolution, which accused the ICNIRP researchers of ignoring the fact that 'numerous studies published in recent years did show biological effects below their recommended limit values.' In 1999, when Australian scientists came to examine ICNIRP recommendations they concluded that the guidelines 'cannot be said... to constitute a precautionary measure'. Australia consequently refused to join the Commission and developed its own standards.

These substantial concerns, as well as the fact that most of the research on which ICNIRP's guidelines are based was published before Wi-Fi had even left the laboratory, have not been heeded by any of ICNIRP's signatories. The UK's regulators still use and defer to the 1998 guidelines, which set levels designed only to prevent 'thermal effects' (or heating up) due to microwave radiation. In fact, most of the negative effects now attributed to microwaves occur at levels far below those in the ICNIRP guidelines, and are known as 'non-thermal effects'. These include effects on the blood-brain barrier, an increase in the production of cancer-causing free radicals, a decrease in bodily melatonin, and disruptions in intra-cellular communication (see 'How microwaves affect us' box, page 44).

In response to the media outcry, and the public admissions by William Stewart, the HPA announced in October 2007 that it would launch a programme of research into the

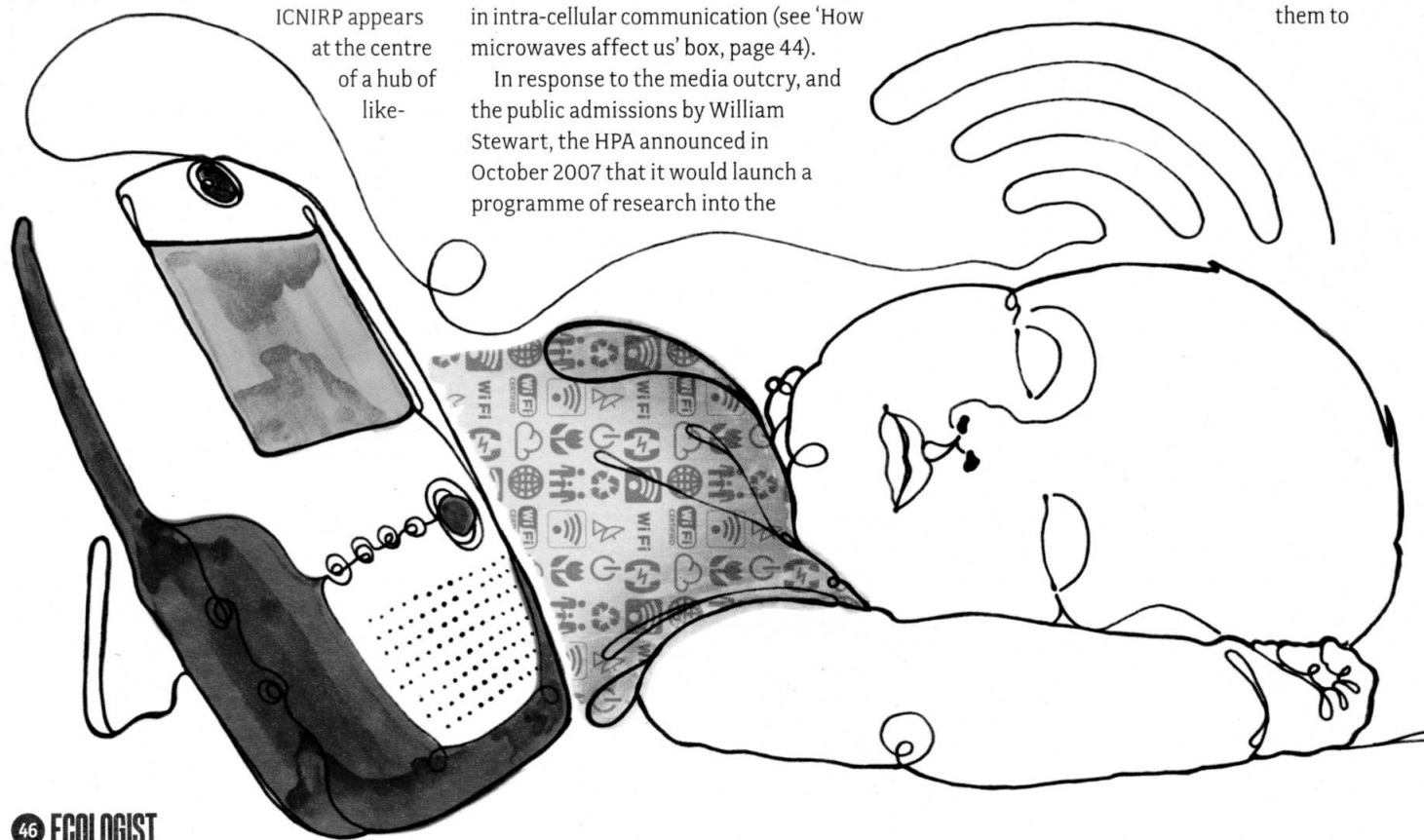
## What can we do?

**Government needs to:** call for an immediate review of the ICNIRP exposure guidelines, inviting non-industry researchers to the table, and require schools to remove Wi-Fi installations and replace them with wired alternatives.

**Industry needs to:** develop wireless devices that operate at far lower power levels and extensively market wired alternatives to wireless products.

**You need to:** (1) disable the wireless transmitter on your family's laptop/ computer via the software; (2) remove as many microwave devices from your home as possible, and investigate wired alternatives; (3) contact the groups listed at the end of this article for help in lobbying your children's school or your workplace to remove Wi-Fi equipment; (4) aim to use your mobile phone for as little time as possible.

health effects of Wi-Fi. Initial optimism for the proposal quickly faded when campaigners discovered that the project would merely 'measure exposures to radio signals from wireless computer networks', and compare them to



'international guidelines'.

'This research has already been done,' says Graham Philips of PowerWatch. 'To spend £300,000 of taxpayers' money on measuring exposure to Wi-Fi and then comparing the data to 10-year-old ICNIRP guidelines is a complete and utter farce.'

If recent cases of research into the health risks of mobile phone transmitter masts are anything to go by, Philips is right to be angry. In July 2007, the results of a two-year research project joint-funded by the Government and the mobile phone industry were published. The study, run by researchers in a flagship facility at Essex University, had set out to investigate whether people who claimed they suffered health effects because of microwave radiation (known as 'electrosensitives') could tell if a hidden mobile mast was switched on or off at any given time. At a high-profile launch in London's Science Media Centre – from which representatives of pressure groups and non-mainstream media were banned – the researchers told the press that no significant results had been found and that any electrosensitives who claimed they were affected by radiation should start to look for other, psychological, causes for their distress.

Faced with tight deadlines and information from a supposedly reliable Government research programme, the journalists repeated to their editors and readers exactly what they had been told at the launch. But the study, which has been cited worldwide to dismiss health concerns over microwave radiation, is now mired in controversy.

Basic errors in arithmetic have been found and admitted by the researchers. The scientists also confess that they failed to recruit enough participants, and as such the study's statistical power (the ability of research to predict 'real world' effects) falls below that considered acceptable in social science. In addition, because so few participants were found, the researchers were unable to 'screen' them to see if their symptoms corresponded to the known attributes of electrosensitivity.

The researchers also began the experiment by spending three months using equipment designed to simulate a mobile phone mast, which was not sending out realistic signals. The laboratory equipment was missing a crucial frequency that exists in real-world mobile mast broadcasts and is thought to contribute to headaches and other

neurophysiological effects. Alasdair Philips was invited in to correct the equipment, but data collected using the incorrect settings was still used in the final analysis.

When the *Ecologist* challenged one of the paper's lead authors, Professor Elaine Fox, over why her team had chosen to tell the world's media that electrosensitivity – a condition medically recognised by the Swedish government – was a myth, she told us: 'It seems unreasonable to conclude that there is an effect, when almost 900 sensitive people have been tested under double-blind conditions (Rubin et al, meta-analysis, 2005; Regel et al, EHP, 2006, and Eltiti et al, EHP, 2007). These studies are extremely expensive and it now seems more reasonable to start looking for other causes, given the growing evidence.'

A fair defence, until examined more closely. Rubin et al's 'meta-analysis', which was published, notably, in the *Journal of Psychosomatic Medicine*, is simply a review of

up for failings in earlier studies, so then to defend the study by citing earlier ones seems dubious at best.

Ultimately, however, the HPA's new investigation into the risks of Wi-Fi will be of little importance. The reason for this lies not in the airwaves, but in the bundle of data cables that runs beneath your feet.

Internet capacity in the UK is at breaking point. Soaring demand for video services, internet radio, file swapping and web phone services has meant that an ageing system of copper wires originally installed only for telephone calls can no longer cope. In a report by the consultancy firm Deloitte, it was estimated that 2007 may in fact see the internet reach 'peak capacity'.

No government, much less one that depends upon the success of a 'knowledge economy' such as the UK's, can afford to let this happen. To lose speed and capacity on your internet network translates into lost business, innovation and tax revenue.

## 'ICNIRP dismisses evidence for DNA damage by microwaves. It is at the centre of a hub of bodies determined to corroborate each other's research

25 studies of varying quality, of which only seven exposed participants to mobile phone-type radiation; of these, three studies actually had found evidence of adverse health effects. Elaine Fox also fails to mention that the Regel et al study in fact concludes that some subjects *were* able consistently to tell whether a mobile mast was switched on or off, and that in its conclusion, the paper admits that an effect on brain function could not be discounted.

Moreover, the study run at Essex University had been specifically commissioned to make

Desperate to encourage ways around this bottleneck, the UK's communications regulator, Ofcom, announced in summer 2007 that it was planning to auction off a slice of the microwave spectrum around the 2.5 GHz frequency.

The industry nearly fell over itself with excitement. Ofcom knew that this particular frequency band was perfect for a new type of wireless broadband service known as WiMAX. Described by the industry as 'Wi-Fi on steroids', WiMAX uses centrally placed

### Strength of microwave technologies

Mobile phone held next to head:	10 - 150 V/m
DECT cordless phone held next to head:	10 - 80 V/m
Microwave oven at 1m:	1 - 6 V/m
Wi-Fi laptop on lap:	1 - 5 V/m
Wi-Fi router at 0.5m:	1 - 2 V/m
Mobile phone mast at 150m:	0.5 - 2 V/m
DECT base unit at 0.5m:	0.5 - 2 V/m
Digital baby monitor 1m from baby	0.3 - 2 V/m
Bluetooth device at 50cm:	0.3 - 0.7 V/m
DECT base unit at 3m:	0.2 - 0.4 V/m
Wi-Fi router at 5m:	0.1 - 0.2 V/m
Source: PowerWatch	

masts (like mobile phone masts) to transmit high-speed internet across towns and rural areas, thereby bypassing capacity problems in using BT's old-fashioned copper wires and the disruption from digging up roads and gardens to lay new cables.

In order to achieve wider coverage, the WiMAX masts are allowed to operate at power levels significantly above those of

of a WiMAX transmitter, and many thousands of will be using a WiMAX-enabled laptop. Ofcom is already encouraging WiMAX systems in the UK, allowing telecoms companies to 'increase power levels' on rural transmitters in what is described as an effort to 'close the digital divide'. The technology is now moving far faster than it can be tested or regulated.

When the spectrum auction was first

**'Ofcom is already encouraging WiMax systems in the UK. The technology is now moving far faster than it can be tested or regulated'**


conventional masts, and the receiver units, which Intel is preparing to build into laptops from 2008 onwards, have been authorised to emit microwaves at up to twice the power level of conventional Wi-Fi equipment.

By 2008, when the HPA will only be halfway through its 'inquiry' into the health effects of conventional Wi-Fi, the chief executive of Intel, Paul Otellini, estimates that 150 million Americans alone will already be within range

announced, an Ofcom spokesman told an industry reporter: 'Our whole approach to spectrum management is that the market is better placed to decide how to use spectrum than the regulator'.

The German government is advising its citizens to limit their exposure to Wi-Fi systems wherever possible, and to use wired alternatives. The local government in Salzburg, Austria, has set legally binding limits for

radiation from masts that is thousands of times below international standards. The Swedish government officially recognises electrosensitivity as a medical problem. The Australian government has rejected the ICNIRP guidelines on microwave exposure as inadequate.

In the UK, however, the final decision on which powerful new Wi-Fi technologies are allowed into our homes, schools, offices and towns will rest with a powerful coalition of IT developers, internet service providers and lame duck regulators. 

**Mark Anslow is the *Ecologist's* senior reporter.**

#### **For more information:**

**PowerWatch:** [www.powerwatch.org.uk](http://www.powerwatch.org.uk)

**Mast Sanity:** [www.mastsanity.org](http://www.mastsanity.org)

**HESE project:** [www.hese-project.org](http://www.hese-project.org)

**Safe Wireless Initiative:** [www.safewireless.org](http://www.safewireless.org)