

Grid Edge Policy

Regulation • Energy • Consumers

31 Years is a long time:
exploring how wearable
technology could change the
way we look at heat.

As attempts to de-carbonise our future are accelerating, it is vital that we examine how new technologies could change what the consumer requires from heat. The purpose of this paper is to summarise where wearable technologies are now, what consumers' attitude will likely be towards these new technologies and what the likely outcomes are by 2050.

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31 Years is a long time...

Anticipating how the world might change is crucial in all industries. Inadequate planning and preparation, or planning and preparing for the wrong outcome, can lead to wasted investment and a competitive disadvantage. As the world of technology evolves at an ever-accelerating rate, this task becomes all the more complex, and meanwhile all the more crucial. In industries that require vast investment in infrastructure ahead of time, such as the energy industry, the time-scales on which companies and regulators have to plan make this a particular concern.

A current issue to which this applies is the question of how we should heat our homes in the future, given the need to de-carbonise to meet the challenge of climate change. The discussion of whether to implement the infrastructure to support electric heating, district heating, or hydrogen heating is ongoing. Given the potential scale of investment and current ambitions on de-carbonisation, the expectation is that this will take until 2050, regardless of which approach is undertaken¹. What this means is that the energy industry is planning for a world that could have very little resemblance to the world we live in today. New technologies could completely change the way that consumers require and use heat, and examining the potential for this, and its potential impact on how the industry should be preparing for the future, is vital. At present our thinking is bounded by trying to do essentially what we do now but in a low carbon way – not looking afresh from the customer perspective at what they want and need and how that might change in future.

One question to ask when addressing the issue of heating is therefore whether the arrival of ‘smart’ clothing could have an impact on how consumers remain warm in future? As technology becomes more integrated into every aspect of our lives, it is highly likely that, within the broad time scale of 31 years, this integration will extend into our currently not-so-smart clothing. Keeping in mind that Tim Berners-Lee only invented the World Wide Web 29 years ago², the idea that, within that same time scale from now, we will look back on an epoch when we required different clothes for inside and outside as equally extraordinary, is far from unthinkable.

But will the general populous really embrace technology in this way? Thankfully, books are still a more common sight than Kindles³, so perhaps this nostalgia and love for simplicity will extend to clothing as well; certainly, this is not impossible, but there is little evidence for this comparison being fair to draw. Realistically, E-readers were hardly revolutionary for their time, and being released around the same time as smart tablets were gaining popularity, they felt out-dated before they even had the time to gain traction. In short, there are failures in every industry, E-readers being a fine example of where technology has failed to overpower nostalgia. But the number of examples of where technology has prevailed vastly outweighs the number of examples of where it has not. Certainly, it is hard to imagine panicking in the morning because you forgot to charge your last clean T-shirt, but the future is always difficult to imagine, and now more than ever.

So where is wearable technology now? Simply put, in its very early stages. Undeniably, the notion of wearable technology is becoming more realistic, with Google and other big technology companies

¹ https://www.ofgem.gov.uk/system/files/docs/2016/11/ofgem_future_insights_programme_-_the_decarbonisation_of_heat.pdf

² http://www.bbc.co.uk/history/historic_figures/berners_lee_tim.shtml

³ <https://www.tomsguide.com/us/is-the-ereader-dead,review-5158.html>

investing vast capital into the field of wearable tech (both directly and indirectly through investing in underlying technologies)⁴, but, for now, it is yet to really make its mark.

One key exception, however, that acts as strong evidence of how responsive the consumer market can be to wearable technology would be in the case of smart watches, which act as an intermediary device between customers and their phones, as well as providing other functions such as monitoring heart rate and calorie count. In theory, the popularity of these devices backs the notion that wearable tech has a strong place in our future, with wealthy members of society swapping out their designer Rolexes for less flashy, but more purposeful, 'smart' watches. It took time for the technology to develop. However, once the notion became a genuine possibility, the obstacle of charging your watch every night, and the power of luxury brands, proved little competition for the practical advantages the technology offered, with Apple anticipated to match Swiss Watchmakers' 24 million units sold annually in 2018⁵. What starts as a high-end product can then evolve to serve a mass market as we have seen with smart phones themselves. Given this, if the technology develops well enough, and the purpose of the smart clothing is sufficiently clear and wide-ranging, there is no reason to believe this same mentality will not extend into other areas of wearable technology.

On a separate note, a key reason why technology companies are keen to ever-more integrate their products into our lives is the increased volume of data it leaves available to them, helping them understand how we live our lives and how they can continue to make money off of us. Smart clothing would be no exception, and as a general rule, if there is money to be made, technology companies are incredible at convincing the consumer that the product is worth it.

So, how can we know that heat will be on the agenda in this sort of technology? The truth is, we can't say how big an impact it will have but there is enough evidence of work being taken forward in this space to view it as inevitable that it will have some role. There are additional benefits to the underlying technology becoming available in the wider world - with smart blankets and clothing that can efficiently control temperature potentially being extremely useful in, for example, military and medical scenarios⁶. Moreover, research is already being undertaken into this idea as highlighted in a New Scientist article entitled "Smart clothes adapt so you are always the right temperature".⁷ There are even early products being released onto the market⁸. Given all this, the likelihood that the technological means would be unavailable is slim.

Working under the assumption that the technology would be available, the question becomes not why it would be integrated into the smart clothing products we anticipate to be marketed by the year 2050, but why it wouldn't. Cost and inefficacy or inconvenience of the technology itself would be a fair reason for companies not to integrate it, but these issues would be expected to resolve themselves in time with further research. From this viewpoint, it is hard to summon a reason why the technology would not become integrated at some point, and likely before our conversational cut-off of 2050.

The best argument against this is that not knowing how the world will look this far into the future is a double-edged sword. Just as our basic assumptions about how the general populous will treat

⁴ <https://www.investopedia.com/stock-analysis/043013/get-ready-wearable-technology-revolution-glw-fsl-armh-syna-aapl-goog-sne-ihs-csiyo.aspx>

⁵ <http://fortune.com/2018/02/22/smartwatch-apple-fitbit/>

⁶ <https://blog.peigenesis.com/the-rise-of-smart-clothing-and-body-sensors-for-military-use>

⁷ <https://www.newscientist.com/article/2074964-smart-clothes-adapt-so-you-are-always-the-right-temperature/>

⁸ <https://emelandaris.com/>

heating their homes could be wrong at its core, likewise our most basic assumptions about how they will treat technology could also be wrong. Trends are generally cyclical, and though technology usage (and concurrently development and investment) has been growing exponentially for all of the recent past, it is not impossible that this trend could die down, or at least slow, in years to come, casting the theoretical mass usage of wearable technology, and smart temperature-regulating clothing with it, into doubt. However, the vast majority of long-term investment decisions seem to be leading with the assumption that technology will continue to reign supreme, and so applying this approach to our thinking about the energy industry does not seem a bad place to start.

So, how would the technology look? Well, as mentioned, there is some smart heating clothing already on the market, though it is very limited, and reasonably simple in nature, at this stage. A good example of this would be the 'SMART COAT' by 'Emel + Aris', a UK-based company. The coat uses a smart heating system of polymers spread throughout the coat, which release far infra-red radiation to warm the body, with three different heat settings. There is only a small amount of actual wiring used, which connects the 100-gram Lithium-ion battery to the coat. To some degree this gives an idea of how this sort of technology may work though, on the surface, this coat only really looks to be one or two steps up from a good old-fashioned electric blanket (the first version of which was released all the way back in 1912⁹), though it must be said it's considerably more stylish.

Though heating would likely be a component of how smart clothing would keep its wearers warm, it seems likely that implementation of nanotechnology to alter the insulating properties of the clothing would play a more significant role¹⁰, and would allow for this type of technology to be incorporated into lighter items of clothing such as shirts and trousers rather than just jackets. The same technology could also transform how we insulate our homes but that's a topic for another day.

Another way in which the smart clothing technology could vary quite significantly from this early example would be in the likely case of automated temperature control, with temperature sensors in and outside of the clothing being used to maintain a specific pre-set internal temperature, rather than using adjustable heat settings, as the existing market prototype does. An advantage of this, and why this notion is important in the discussion of whether these technologies could affect how energy consumers remain warm, is that it would allow the wearer to rely on the same item of wearable technology regardless of weather conditions, and whether they are inside or outside of their home. It is this ability that would set the smart technology apart from other not-so-smart items of clothing such as jumpers being worn inside. If the wearable technology successfully maintains the wearer's body temperature regardless of these factors, the wearer is less likely to be concerned with the temperature of their home, and would, in turn, require significantly less heat for their homes in general. If the comfort that they feel within their own homes is unaffected, which would largely depend on the quality of the product provided, the economic benefit of relying less on central heating would provide a further benefit to the consumer.

Assuming these sorts of technologies emerge, dependence on indoor heating could drop sharply, and with it, the nature of the conversation being had now regarding the ways in which homes will be heated in the year 2050. It is also worth noting that, even in the scenario that the effect of these is not profound enough to fundamentally change how we approach heating our homes in 2050, the use of this technology could still lower our energy consumption, which would deliver environmental benefits regardless. This is, in fact, the goal of US Government research agency ARPA-E, who are funding research into expanding 'the comfortable temperature range in buildings', allowing for

⁹ <http://visionlaunch.com/who-invented-electric-blankets/>

¹⁰ <http://news.cornell.edu/stories/2015/01/doe-awards-3m-air-conditioned-clothing>

decreased but not eliminated use of heating (and cooling) systems in buildings. As a part of this they are funding research into thermally responsive textiles, for example.¹¹

But would this be healthy? Clearly, more efficient maintenance of body heat outside the home could have positive impacts on the wearer's health. However, could this really be the case in the home? To some degree, the answer to this question depends on two main factors, the temperature of the home itself, and the age/health of the wearer¹². The World Health Organisation recommends that rooms should be kept at 18C for 'normal, healthy adults who are reasonably dressed', which could become the norm if the smart clothing was effective. However, they also recommend that room temperatures do not fall below 20C for those with vulnerable health, and that homes below the temperature of 16C increase the likelihood of developing a respiratory illness.

The reason for this is that they claim low temperatures create a damp environment when water in the air condenses on windows and walls, and that this damp environment aggravates the respiratory system. The damp can also lead to health problems when mould develops, and the spores are inhaled. The cost of these issues could seriously outweigh the benefit of swapping from heating your home to heating your person, from an economic and personal standpoint, if not properly combatted. Suggestions on how to counter this issue include maintaining a lower but more constant temperature in the home throughout the day, as sudden rises and drops in temperature seem to be what leave the home most susceptible to damp developing. Alternatively, the use of de-humidifiers throughout the home to prevent the water building up in the air in the first place, could reduce or eliminate these issues¹³.

Finally, there are claims made for the health benefits of far infra-red heat (essentially like the warmth of the sun) which really need to be better understood if we are looking for healthy heating solutions for the future.

So where does this all leave us? Most importantly, with a new question: could smart clothing alter how consumers use energy? And arguably with a definite answer: yes, it *could*. We can say with a great deal of confidence that wearable technology has a place in our futures, and temperature regulation could be a significant part of this. Existing technologies may seem clunky and ineffective, but early-stage technology often does, and this is little reason to dismiss the notion this early on. A key component in technology becoming truly wearable, to the extent that its comfort is indistinguishable from the not-so-smart clothing we wear today, will be in the development of nanotechnology, a major field of technological advancement that will prove key to revolutionising countless industries. In this sense, when it comes to the availability of the underlying technology, the question is not if but when, and 31 years is a long time.

¹¹ <https://arpa-e.energy.gov/?q=news-item/keeping-your-cool-arpa-e>

¹² <https://www.sciencemediacentre.co.nz/2008/06/18/cold-houses-and-impact-on-health/>

¹³ <https://www.angieslist.com/articles/can-dehumidifier-protect-my-home-mold.htm>