

WELCOME TO THE EDGE

How Grid Edge Technology Will Help Energy
Companies Improve Customer Engagement
and Create New Revenue Streams

Landis+Gyr
White Paper

June 2018

Landis+Gyr
manage energy better



Empowering Consumers Through Technology

Energy has assumed a prominence in our national consciousness that would have seemed surreal a decade ago. Much of this has been driven by the sharp rise in electricity prices and reliability concerns.

But general distrust of institutions and corporations, evident in many aspects of our national discourse, has been given a particular focus in the energy sector. This has been fuelled by a decade of political wrangling over carbon pricing, the continued dominance of coal in electricity generation, restrictions on gas supply and the slow pace of transition to renewable energy sources.

Higher prices hurt the vulnerable at both ends of the spectrum – people on low incomes and large companies in energy intensive industries.

Amidst all this gloom, however, a good story is emerging. Consumers are waking up to the idea of exercising more control over their consumption and access to energy resources. They're demanding greater choice, with growing interest in distributed renewable supply including batteries, photovoltaics and wind. They want greater grid reliability, better environmental outcomes and more consumption information.

These aspirations are powered by the innovative application of technology. Modern communications and distributed energy resources have enabled the 'Internet of Energy', with enormous potential to reverse the dismal dynamics of the past decade. Australia has the world's best solar and wind resources, which can be firmed up by abundant gas resources and pumped hydro potential.

As Managing Director of Energy Australia, I was proud to be awarded the Australian Government's globally significant Smart Grid, Smart City trial, cataloguing the benefits of technology enabled products and services.

These benefits include more efficient and resilient electricity grids together with a range of advanced customer applications. In many applications, smart meters are the key to unlocking these benefits. Interconnection, data management and innovation will be the drivers.

I am also proud to have been associated with Landis+Gyr – the world's leading energy technology provider – in delivering technology-based innovation to build on the Smart Grid/Smart City promise.

This paper looks at Grid Edge technology and uses new research to show how consumer attitudes are changing. It examines the rapidly evolving business landscape and provides a pathway to a truly interconnected energy system. This is an important milestone in demonstrating how seamless integration delivers cost-effective, efficient energy management across the entire value chain.

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Managing Director, Energy Australia, 2004 to 2012

May, 2018



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1.0 EXECUTIVE SUMMARY

The Fourth Industrial Revolution and the Energy Industry

Digitalisation is reshaping every industry from entertainment and finance to healthcare and telecommunications, disrupting well-established business models and opening up new opportunities. Increasingly viewed by academics worldwide as the ‘fourth industrial revolution’, the transformation taking place is defined as markedly different to the third due to the development of new technologies such as the sensor-based internet of things (IoT), artificial intelligence (AI) and machine learning.

Digitalisation is now also disrupting the energy industry, prompting energy companies to progressively move from analogue to digital networks. Consumers are driving change through their increasing demand for:

- + **DECARBONISATION** – where renewables, storage technology, transport, heating and other aspects of our lives are being progressively electrified; and
- + **DECENTRALISATION** – where more and more consumers are choosing renewables over traditional energy sources, as well as contributing energy to the grid.

As consumers reduce their overall energy use and the amount of electricity they access from traditional energy sources, energy companies must harness the power of digitalisation to better engage a more digitally savvy consumer, play a part in reducing energy costs and create new business models to secure their future success.

How fast energy companies must act is dictated by the speed at which new energy technologies are reaching their respective tipping points:

- + **CONNECTED DEVICES:** Significant decreases in the cost of smart meters and appliances, electric vehicle batteries, utility-scale photovoltaic panels and sensors is occurring as the share of network-enabled household appliances is growing exponentially (see page 10).
- + **SOLAR PV** – Australia leads the world in household solar PV with 16.5 per cent penetration – double that of Belgium, which is second on the list and we are fifth in the world in the growth of industrial and business-scale systems (see page 11).
- + **BATTERY STORAGE** – With the global storage market predicted to double no less than SIX times by 2030, battery storage is a game changer. The Climate Council of Australia estimates the market tripled in 2017, with more than 20,000 new installations. With further dramatic price drops predicted to 2025, household battery storage is soon expected to become commonplace. (see page 12).

Defining all consumer-facing technology that influences the grid, ‘Grid Edge’ technologies are predicted to reach the tipping point in the next three years.

New Consumer Research

Given that consumers are driving change in the energy industry, Landis+Gyr commissioned Essential Research in April 2018 to survey how much Australians understand about the transformation that is taking place and to what extent they believe it is affecting their lives. The survey included more than 1,000 people, with focus groups in Melbourne and Sydney. These included some people who had smart meters and others who did not. We chose consumers who were highly interested in the topic and others who were not.

As part of a body of compelling findings (see pages 14 to 21):

- + **68% of Australians believe energy companies should supply more information to help them better understand and control their energy use**
- + **69% want to know more about what they could do with their smart meter**
- + **88% expect to receive an alert when energy usage suggests they have a faulty home appliance**

Overall, Essential’s *From Energy Consumer to Energy Citizen* report(*) concluded that:

- + Australian consumers recognise that energy transition is upon them – they are embracing renewables and seeing the long-term potential of batteries.
- + Most still regard power as a transaction that they have little control over and all too often find themselves playing the part of aggrieved customer.
- + Some are taking initial steps to becoming more active consumers – seeking out information about the way they use and produce energy.
- + Digital technologies including smart meters have an important role to play in increasing consumer awareness and perceptions of control.
- + Armed with this information there is a pathway for consumers to become even more active players – not just consumers but energy citizens who appreciate the shared value of minimising their environmental impact.

* For full report, please go to www.landisgyr.com

Transforming Consumer Engagement

Global research suggests consumer engagement is similarly undergoing profound change. Digitalisation has significantly altered customer service expectations. Mobile internet technologies are accelerating the pace of this change. Via the smartphone, customer service is now expected to be immediate, always on and tailored to the needs of the individual.

Machine learning too has become a normal part of daily life, with photo recognition, predictive text, voice assistants and apps that make location-based suggestions dictated by personal preferences now coherently integrating with our daily lives (see page 23).

According to The Institute of Electrical and Electronic Engineers (IEEE), as consumer behaviour continues to evolve, so too must mobile internet technology innovation. The IEEE suggests the form and context of mobile communication must change, reaching a state where consumers and businesses connect with each other at the right time and through the right means (see page 23).

Data-driven Change

Smart meters will be an important enabler of change, but when it comes to building positive consumer engagement, what energy companies choose to do with data will prove the difference between success and failure.

Presently, data reads tend to go one way and the benefits of its collection and analysis are yet to be realised by consumers. Providing more granular information about home energy use is the best answer to the question consumers are increasingly asking about smart meter rollouts: *“What’s in it for me?”*

We are now seeing case studies (see pages 26 to 27) that demonstrate it is the energy bill that presents the best starting point for more personalised, two-way consumer engagement. Common to all, these case studies feature an electronic bill available via an app, which communicates disaggregated, or appliance level electricity information to each household so they can better manage their energy use. The ability to detect faults with certain appliances is also starting to gain traction. It is this information consumers should rightly expect when they allow a smart meter to be installed in their home.

Welcome to the Edge

Grid Edge solutions that combine smart meter data with analytics, machine learning and fault anomaly detection offer the best way for energy companies to compete in the new energy marketplace. By integrating this extra intelligence with the electronic bill interface, this ‘bill of the future’ has the potential to become a platform from which energy companies can offer increasingly innovative products and solutions, and build new revenue streams.

History demonstrates that when traditional business models are upended by such comprehensive technological disruption, how consumers have behaved in the past, analogue world is no guide to how they will behave in the future. The insights provided in this paper will deepen understanding of evolving consumer needs and the innovative Grid Edge technologies available to meet them.

Landis+Gyr is committed to helping our customers successfully navigate energy market disruption and stands ready to take the first, vital steps now.



2.0 STATE OF THE ENERGY MARKET TODAY

2.1 The Fourth Industrial Revolution

Digitalisation is reshaping every industry from entertainment and finance to healthcare and telecommunications, disrupting well-established business models and opening up new opportunities. This has shaken the energy industry to its core. As the industry comes to terms with the speed of change, it's already clear that the resulting transformation in how we use and manage energy will be profound.

Scientists, engineers, economists and futurists have given many labels to the changes being delivered by digitalisation – some call it *The Second Machine Age* ⁽¹⁾ while others prefer *Industrie 4.0* ⁽²⁾. Either way, the most recent wave of technological change is nothing short of a revolution.

Although not the first to do so, World Economic Forum founder Klaus Schwab frames this transformation as “*The fourth industrial revolution*”. He says the speed, breadth and depth of change, as well as the impact on global systems and society as a whole, sets it apart from the previous three. ⁽³⁾

In a 2017 review of recent academic papers on the subject, *The Impact of The Fourth Industrial Revolution* ⁽⁴⁾, technologies including the sensor-based internet of things (IoT), artificial intelligence (AI) and machine learning are identified as key differentiators.

The changes taking place have altered consumer expectations completely. Now, as the energy industry undergoes the same transformation, digitalisation has the potential to reshape it. Opportunity is abundant as long as the industry provides informed consumers with the technology innovation and service levels they have come to expect.



We have yet to grasp fully the speed and breadth of this new revolution. Consider the unlimited possibilities of having billions of people connected by mobile devices, giving rise to unprecedented processing power, storage capabilities and knowledge access. Or think about the staggering confluence of emerging technology breakthroughs, covering wide-ranging fields such as artificial intelligence (AI), robotics, the internet of things (IoT), autonomous vehicles, 3D printing, nanotechnology, biotechnology, materials science, energy storage and quantum computing, to name a few. ⁽⁵⁾

2.2 A customer-driven system

A closer examination of energy industry transformation reveals three main drivers:

DECARBONISATION – Supported by renewables and advances in storage technology, transport, heating and other aspects of our lives are being progressively electrified.

DECENTRALISATION – Consumers are increasingly choosing renewables over traditional energy sources, putting them in a position to contribute energy to the grid.

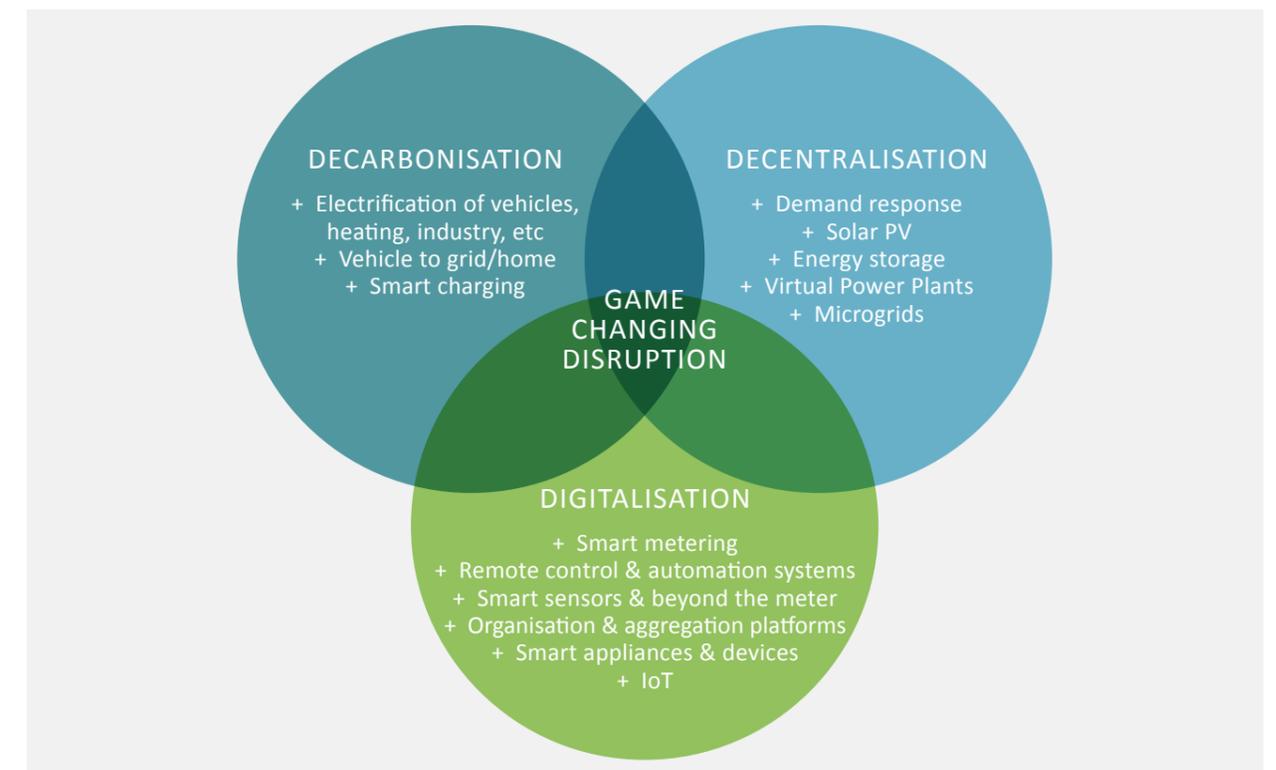
DIGITALISATION – The whole energy system is moving away from analogue networks to improve control for energy companies and consumers using the power of data.

Energy companies have traditionally focused on delivering safe, reliable power and lowering the cost to serve their customers. But this traditional model is being disrupted as consumers respond to the ever-increasing choices available via decentralisation and decarbonisation. These consumers are reducing their overall energy use and the amount of electricity they access from traditional energy sources.

At the same time, almost every other aspect of consumer life has been upended by digitalisation. Everything from finding a flight and booking accommodation to keeping fit or watching a film is faster and easier.

This has dramatically changed the level of service consumers expect from banks, retailers, telcos, energy companies and all other service providers. Energy companies must harness the power of digitalisation to better engage customers, play a part in reducing energy costs and create new business models.

The energy consumer is leading the change.



2.3 How soon is now?

Proof of the speed at which change is happening can be found in statistical analysis of the uptake of a range of digitalised services and devices.

2.3.1 Connected devices

Proof of the speed at which change is happening can be found in statistical analysis of the uptake of a range of digitalised services and devices, and the rapid reduction in the cost of new energy technology. This includes dramatic decreases in the cost of smart meters and appliances, electric vehicle (EV) batteries, utility-scale photovoltaic (PV) panels and sensors. (6) As such the share of network-enabled household appliances is set to grow exponentially. (7) The increased efficiency and effectiveness of IoT will accelerate this growth in connected devices.

Figure 1: Unit costs of key emerging electricity technologies (A)

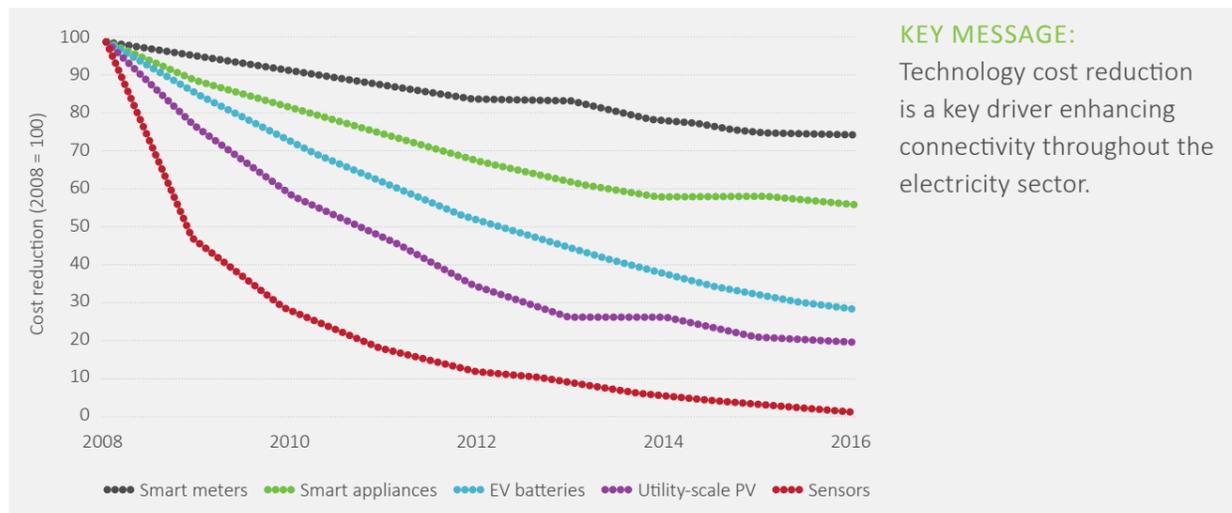
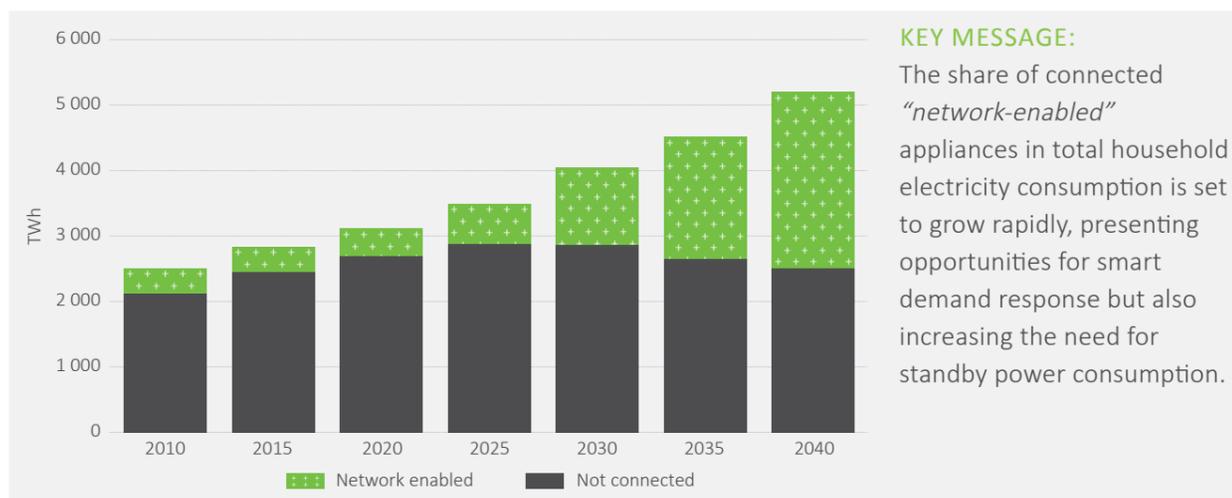


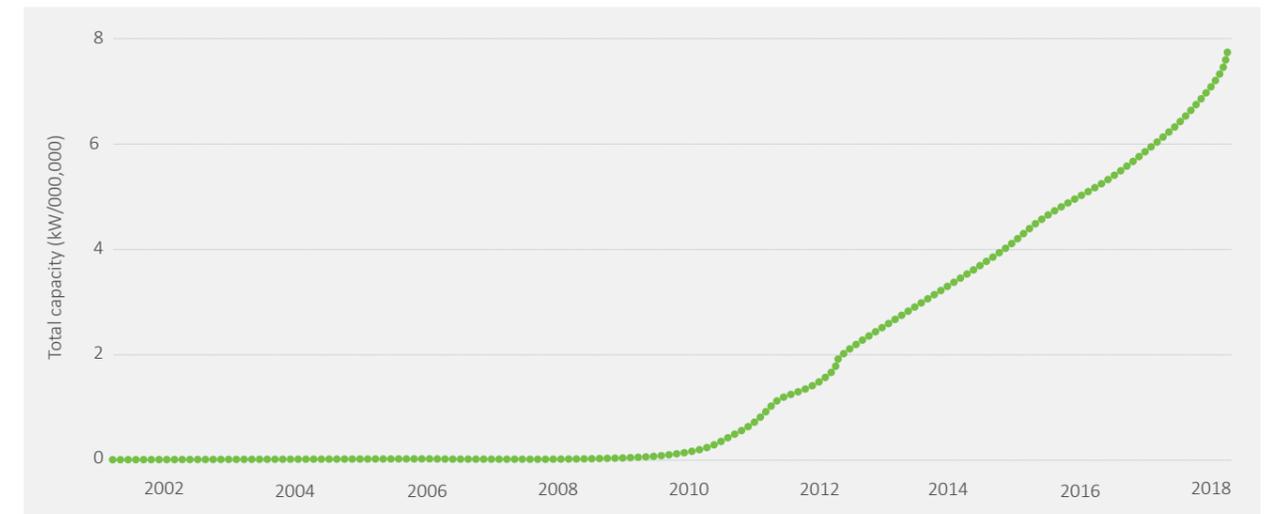
Figure 2: Number of connected appliances to grow significantly (B)



2.3.2 Solar PV

Australia leads the world in household solar PV penetration. When measured on the basis of systems generating less than 10kw, (8) 16.5 per cent of households across the country now rely on solar energy for much of their electricity needs. (9) Uptake differs from state to state. This is due to differences in solar feed-in tariffs, energy consumption charges and the number of sunshine hours in various locations. Including industrial and business-scale systems to the mix, Australia still sits high on the list globally. As of March 2018, there were more than 1.84 million PV installations in Australia, with a combined capacity of 7.8 gigawatts. (10)

Figure 3: Australian PV installations since April 2001 (C)



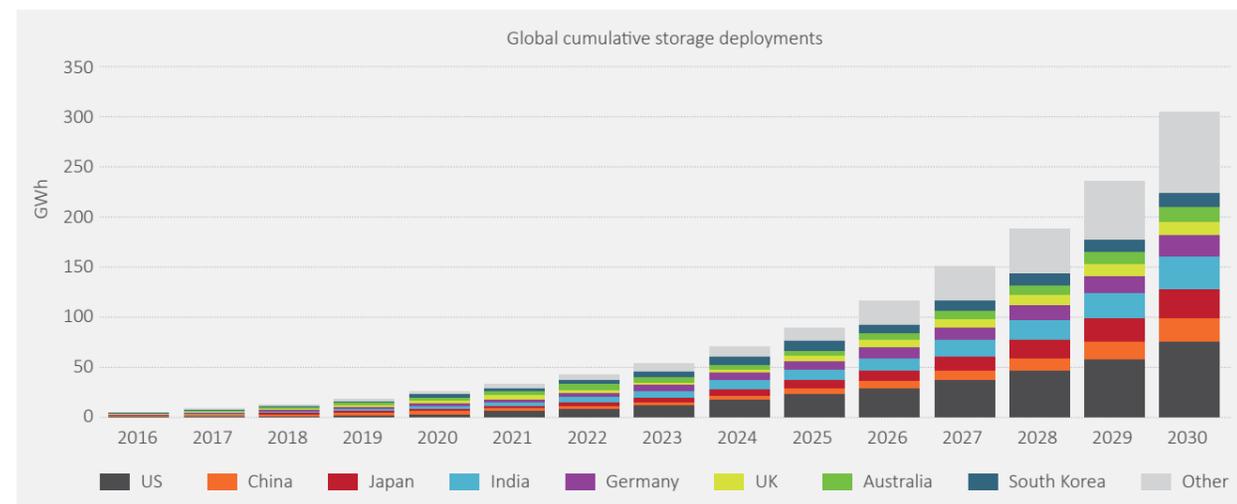
Moving away from the grid and becoming less dependent on traditional energy companies rated as the second biggest motivator (82%).

According to the Energy Consumers Association's report, *Residential PV: Customer experiences and future developments*, financial considerations are clearly Figure the primary driver – with 92 per cent saying they installed solar to reduce energy bills – but a **desire to move away from the grid and become less dependent on traditional energy companies rated as the second biggest motivator (82 per cent)**. Solar feed-in tariffs (80 per cent) and government grants (74 per cent) were also cited as key factors, with protecting the environment ranking fifth at 72 per cent. (11) No doubt, the 'feel good' factor underpins much of these statistics too.

2.3.3 Battery storage

Predictions around the biggest game changer of them all – battery storage – are being revised almost daily. With the global storage market predicted to double no less than SIX times by 2030, rising to a level of 125 gigawatts (or 305 gigawatt hours), utility-scale and grid edge batteries are crucial to full decarbonisation. ⁽¹²⁾ Battery storage will also have the most significant effect on the way we engage with and manage energy at all levels in society.

Figure 4: Global storage market to double six times by 2030 ^(D)

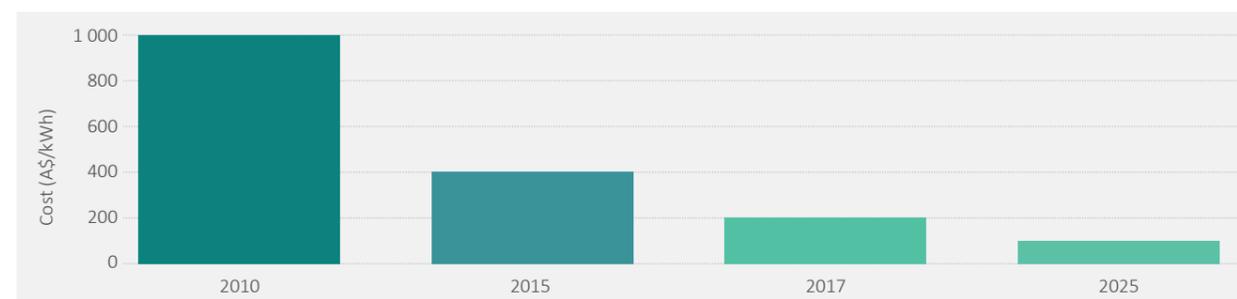


The global energy storage market is predicted to double SIX times by 2030.

An estimated \$US103 billion will be invested across the Americas, Asia Pacific, Europe, Middle East and Africa. Eight countries will lead the market with 70 per cent of capacity installed in the US, China, Japan, India, Germany, UK, Australia and South Korea.

Home battery storage is growing quickly in Australia too. The Climate Council of Australia released a report in February 2018 estimating that the market tripled in 2017, with more than 20,000 new installations. Three-quarters (74 per cent) of people polled across Australia expect household batteries to be commonplace in the next decade. With further dramatic price drops predicted to 2025, this looks increasingly likely. ⁽¹³⁾

Figure 5: The falling cost of lithium-ion batteries ^(E)

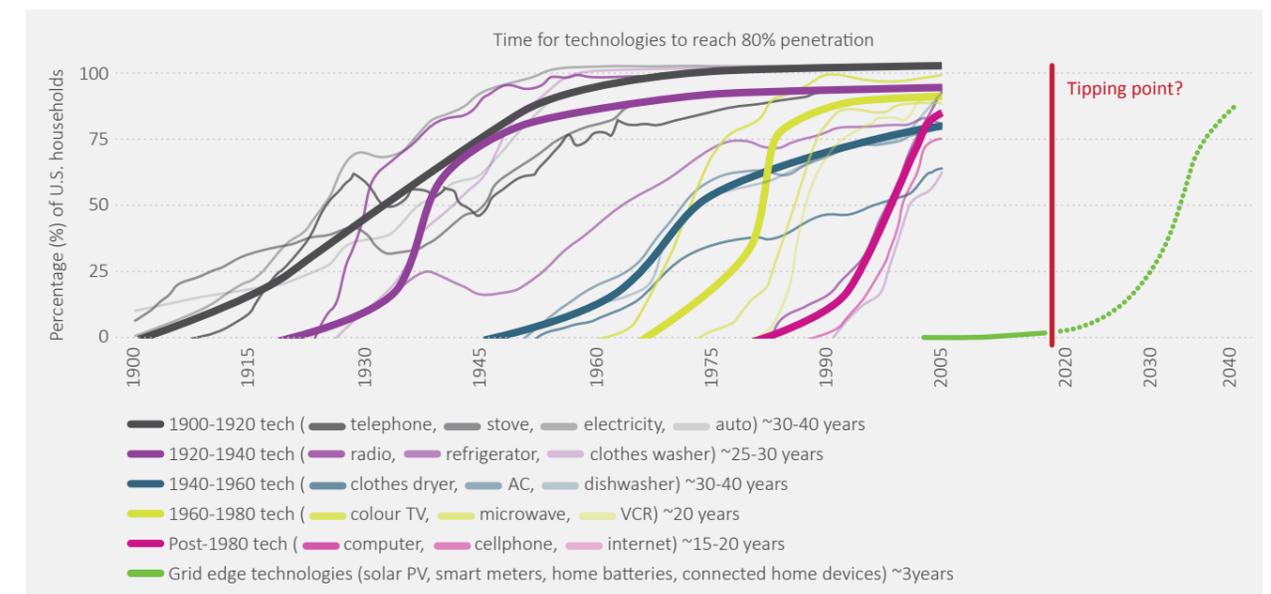


2.4 The Grid Edge – Tipping point

For energy companies, the Grid Edge is where the real opportunity lies.

Defining any consumer-facing technology that influences the grid, Grid Edge encapsulates the idea that energy control and distribution is now being driven from many parts of the grid rather than one central location. This concept is also described as ‘behind the meter’ or decentralisation. Whichever term you prefer, it’s clear in recent predictions from expert industry watchers such as Bain and Co that the tipping point for uptake of grid edge technology, when interest in these technologies will truly begin to accelerate towards 80 per cent penetration, will occur in the next three years. ⁽¹⁴⁾

Figure 6: Grid edge technologies are likely to follow an adoption S-curve similar to other innovative products ^(F)



As consumers increasingly turn away from centralised electricity supply via the existing grid to renewables supported by battery storage, it is services associated with the grid edge, rather than the commoditised supply of traditional, coal-fired electricity, that will both secure existing profits and open new revenue streams for energy companies.

3.0 CONSUMER ENERGY RESEARCH

3.1 Introduction

As the energy market itself transforms, we at Landis+Gyr wanted to know how much consumers understood about this transformation and to what extent they believed it was affecting their lives. So we commissioned Essential Research to talk to Australians in March 2018 about the way they are using technology to better manage energy use. The survey included more than 1,000 people, with focus groups in Melbourne and Sydney. These included some people who had smart meters and others who did not. Some were engaged with the topic of energy usage and others were not. In both states, our focus groups included two sub-groups:

- + Engaged group – energy consumers that stated they were highly interested in their energy use and management.
- + Disengaged group – energy consumers that stated they were not very engaged at all in their own energy use and management.

We discovered that many people are ready to take on greater responsibility as active energy consumers regardless of their experiences to date – they're just not sure how to go about it.

- + **68%** of Australians believe energy companies should supply more information to help them better understand and control their energy use
- + **69%** want to know more about what they could do with their smart meter
- + **88%** expect to receive an alert when energy usage suggests they have a faulty home appliance

With rising energy prices and more extreme weather events, energy consumption now carries a value-based and values-based proposition for many consumers.

While technology has made significant advances, there is a growing gap between possibility and action when it comes to consumers reducing their bills and energy footprint. Bridging that gap has emerged as a critical challenge as the national energy market looks to manage prices, supply and sustainability.

If the industry gets this wrong, smart meters will be a missed opportunity for the energy sector. Getting it right will help consumers become more active energy citizens.



3.2 Consumers want to get smarter

Energy consumers know they need to get smarter about home energy use. They are acutely aware that energy costs have gone up and will continue to rise, while energy supply has emerged as an issue, especially during hot summer months. There is also widespread understanding that the Australian energy market is in transition, throwing some doubt over future energy cost and supply.

Energy prices consistently rate as a top cost of living factor. The cost of living itself rates as the number one political issue, according to the April 24, 2018 *Essential Report* investigation on the subject.^(#)

We found the same concerns in the focus groups for this specific piece of research.



In Australia we've been very fortunate but... we're only starting to see the beginning of huge price increases. And it will become a problem, I think, for a lot of people, if they actually start adding up what they're paying outside of their mortgage.

Source: Melbourne engaged group

[#] <http://www.essentialvision.com.au/important-issues-5>

3.3 Information is power

The quantitative research shows that 68 per cent of energy consumers want energy companies to help them better understand and control their energy use.

Q Do you agree or disagree with the following statements – those who say that they know what household activities have the most impact on their bill (no=837)

	Completely applies	Generally applies	Total applies	Generally doesn't apply	Doesn't apply at all	Total does not apply	Unsure
I believe energy companies should supply me with more information to help me better understand and control my energy use	26%	42%	68%	22%	4%	27%	4%
I feel I have no control over my energy use	11%	27%	38%	34%	2%	60%	2%

Energy consumers feel that if they had relevant and usable information about energy use, then they would have the best opportunity to modify behaviour and get control over their energy costs.

As one focus group participant put it:



Education always leads to empowerment and ownership of your behaviour and what you're doing at home. So knowledge is power.

Source: Melbourne disengaged group

Consumers are currently finding information about energy use from a variety of sources, primarily their energy bill. While some feel their bills provide sufficient information, the research shows others need and want more detailed information.



I wouldn't have a clue. They could write anything on the bloody bill and I wouldn't know.

Source: Sydney disengaged group

The majority of consumers are currently receiving comparisons with other households on their energy bill. This is regarded as interesting information but not critical to behaviour change. There is demand for greater customisation. As one focus group participant put it, bills are “just a snapshot” of energy use.



If they specifically tailored your bill to break it into blocks ... lighting, heating, fan, this is your usage. Information like that's good because then you can make a conscientious decision 'what am I going to do?'

Source: Melbourne disengaged group

3.4 Sparking deeper engagement

Participants were also excited about some of the more complex ways that data could provide them with insights into energy use:

- + Regular appliance-specific energy consumption information.
- + Fault detection when an appliance is using energy inefficiently.

It is technically possible to provide this sort of data, but it is not readily available to most households.



If you found that the information that they gave you showed that this particular item is pulling all your juice, you'd say, 'is this item that I've got, actually worth having or should I replace it?'

Source: Melbourne disengaged group

The quantitative research reflects the findings of the focus groups in this regard.

Q How useful would it be for your electricity provider to give you information on the following?

	Very useful	Fairly useful	Total useful	Not that useful	Not useful at all	Total not useful
Alerts when your energy usage suggests you may have a faulty appliance	53%	35%	88%	8%	4%	12%
The amount of energy you, specifically, have used for particular appliances (eg, air conditioning, pool pump, dishwashers, etc)	47%	38%	85%	11%	4%	15%
Recommendations on how to reduce your energy use, based on the way you actually use energy	44%	41%	85%	11%	5%	16%
Time of use tariff information (eg, how much energy you've used during peak and off-peak energy/pricing periods)	41%	41%	82%	14%	5%	19%
Comparisons with other households like yours	27%	42%	69%	23%	7%	30%

In short, the majority of respondents want more of everything. They receive more information on other aspects of their life like banking and personal health but energy companies are yet to provide the same user experience.



I'm quite interested in having an app I could check regularly about how much energy we've used this month on what. I am at a stage when I want to start being more conscious about how we use electricity.

Source: Sydney engaged group

3.5 Technology is key

When people were taken through all the possible uses of smart meters, their potential to make energy use more efficient was well appreciated. Accessing detailed and personal information online or via a mobile app – with alerts sent by text or email – was one of the most appealing features.

Regardless of whether they had a smart meter, actively used the information it provided or knew what a smart meter was prior to the research, participants could see a variety of benefits.

These included:

- + Receiving information about power outages.
- + Real-time information about energy use.
- + No more meter-reading visits.

One participant in the engaged Melbourne group liked the way her smart meter allowed her to set energy use goals.



You've got a smart meter, you download an app and it actually logs you into your usage and it tells you how much you're using. You can set targets so that if you want to make sure you don't go over a certain amount, it tells you when you're getting close to it.

Source: Melbourne engaged group

Those who were renting or living in shared accommodation recognised that a smart meter would give them essential information when discussing faulty appliances or unusually high bills with a landlord or housemate.



Sometimes it's really hard to get a hold of our landlords and get them to do anything, so if we had concrete evidence that it was actually a fault they should deal with, that would help. We've had situations in the past where we had a bad TV connection, and they were like, 'maybe you've done something to the power point'. If we just had concrete information, then I think it would be easier to get them to deal with it.

Source: Melbourne disengaged group

3.6 Improved energy literacy

While there was enthusiasm among engaged smart meter users in Melbourne about what the technology could do for them, education is clearly still needed. This was reinforced in the quantitative survey, which identified demand for greater understanding of how smart meters power smart energy decisions.

Q How strongly do you agree or disagree with the following statements about digital or smart meters?

	Strongly agree	Somewhat agree	Total agree	Somewhat disagree	Strongly disagree	Total disagree	Unsure
I would like to know more about what I could do with a smart meter	26%	43%	69%	11%	6%	17%	14%
I think smart meters could be used more effectively in reducing my power bills	15%	40%	55%	11%	6%	17%	29%
I don't feel I have the skills or knowledge to get the most out of a smart meter	14%	34%	48%	22%	11%	33%	20%
I have a good understanding of what smart meters do now and could do in the future	11%	30%	41%	27%	13%	40%	20%

In fact, 69 per cent would like know more about what they could do with smart meters. Less than half felt they had the skills or knowledge to get the most out of a smart meter.



3.7 Trust in data privacy

Consumers are very cynical about the behaviour of corporations and the consumer benefits that flow from technological change. Corporate trust is low, particularly around the handling of consumer data.

Consumers are suspicious about whether new technologies are put in place to benefit them, suspecting that cost cutting, marketing and greater insight into their behaviour are bigger drivers. The longer energy companies hold off on offering the real benefits of smart meter data to customers, the further away they will be from forging truly loyal and lasting relationships with them.

Although some in the qualitative research were relaxed about energy providers knowing about the detail or their household energy use, others were highly concerned. The distinction is really about the perceived balance between benefits and costs – participants in the qualitative research wanted to know that there were clear benefits for them in the data being shared, before being prepared to accept the perceived costs or risks (eg, in terms of reduced privacy).



It just sounds like all the information goes to them and it doesn't necessarily sound like any's going back to us. Just giving [the energy company] more information, more power at the end of the day.

Source: Sydney disengaged group

Two vital prerequisites to a successful roll-out are ensuring consumers understand what smart meters can do for them and that they know what safeguards are in place.

	Strongly agree
I am comfortable with the data being collected and used as long as there are clear limits on how the data is used (eg, requiring that it can only be shared with individual records anonymised) and as long as there are clear benefits to ordinary household consumers	58%
I am uncomfortable with the data being collected and used even if there are clear limits and clear benefits to ordinary household consumers.	19%
Unsure	23%

The key requirement for building trust is honesty about how data will be used and how this information will contribute to broader consumer-interest decisions.

3.8 Engaged energy citizens

Many consumers do not really engage with their energy bills or usage beyond knowing how much they have spent. This contributes to competition between companies being driven almost entirely by price. As much as retailers have tried to differentiate on service, for most consumers the decision is all about getting the cheapest deal. Part of this is driven by a feeling of helplessness or inevitability, where consumers believe that any adjustments to energy use will have limited impact on their bill.

Smart meters have the potential to quickly and easily show consumers what they could do to use energy more efficiently by highlighting major contributors to their bill. The ability to identify potential faults has significant appeal because participants recognise these are often unknown and contribute significantly to energy bills. Being able to quantify how much energy is used by specific appliances will help them make more informed choices.

For example:

- + Knowing how much an old fridge is costing allows consumers to make a replacement calculation.
- + Numerous participants reported washing dishes by hand because they thought it was more efficient but a smart meter would show otherwise.

Most smart meter services tested in the quantitative research have similar appeal – they allow consumers to make more informed choices about energy use. This means consumers will pay more attention to bills because the information they contain will be more actionable.

There is also potential for smart meter information to become a real differentiator between retailers. Numerous respondents said a retailer offering the sorts of information discussed in these groups would be significantly more appealing than one that did not. Some even said they would be prepared to choose a retailer offering those services even if they were a little more expensive.

3.9 In conclusion

- + Consumers recognise that energy transition is upon them – they are embracing renewables and seeing the long-term potential of batteries.
- + Most regard power as a transaction and all too often find themselves playing the part of aggrieved customer.
- + It is also clear that some are taking initial steps to becoming more active consumers – seeking out information about the way they use and produce energy.
- + Digital technology including smart meters has an important role to play in increasing consumer awareness and helping them make more informed decisions.

Armed with this information there is a pathway for consumers to become even more active players – not just consumers but energy citizens who appreciate the shared value of minimising environmental impact.

4.0 THE CONSUMER EXPERIENCE

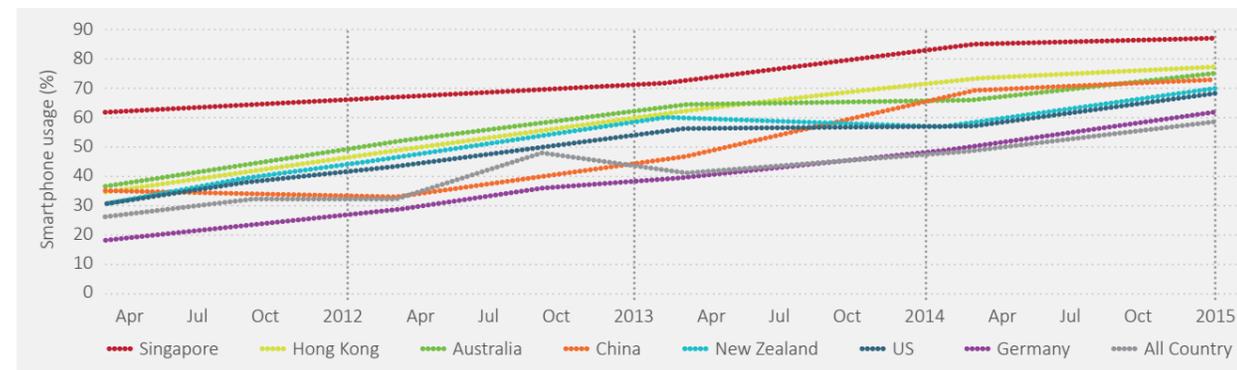
4.1 Mobility is the great accelerator

Digitalisation across a range of industries is significantly influencing consumer behaviour and the 'experience' customers expect to have with respect to the services that companies provide. It is mobile technologies that have, and will continue to have, a multiplier effect on this. The rise of smartphones have forever altered the consumer experience, significantly disrupting the relationship that companies have with customers. The Institute of Electrical and Electronic Engineers (IEEE) paper – *5G: Personal Mobile Internet Beyond: What Cellular Did to Telephony* – charts the technological tipping points that brought about major changes in user behaviour.

Cellular technology for example, took more than 20 years to gain popularity. When it happened, this shift was driven by the ability to call people instead of places. ⁽¹⁵⁾ Once mobile phone sizes and prices shrank to a compelling level, an essential new lifestyle accessory was born. When internet access was added, the game changed again.

Little more than a decade since the smartphone was commercially launched, this lifestyle accessory has become an essential personal assistant. Statista estimates more than one-third (34.7 per cent) of the world's population owns a smartphone. ⁽¹⁶⁾ Adoption varies from country to country, as does the scale of behaviour change for daily tasks like shopping, banking, travelling and staying healthy.

Figure 7: Global Smartphone Ownership ^(G)



Australia is at the forefront of smartphone adoption. *Deloitte's Mobile Consumer Survey 2017* estimates 88 per cent of Australians have one. These consumers checked their phones 560 million times a day collectively or more than 35 times each on average. ⁽¹⁷⁾

Changing smartphone usage is also very revealing:

- + **Mobile working** – 67 per cent use their smartphones for work, blurring the lines between personal and professional lives.
- + **Connected devices** – There was double-digit growth in the number of connected devices from fitness bands (15 per cent increase) to home security systems (73 per cent increase). Where almost half (48 per cent) of those surveyed in 2016 had yet to purchase any connected device, this reduced to less than one third (29 per cent) in 2017.
- + **IoT** – The Australian home IoT market is expected to be worth \$4.7 billion by 2021, up from \$377 million in 2016. ⁽¹⁸⁾

4.2 Machine learning is everywhere

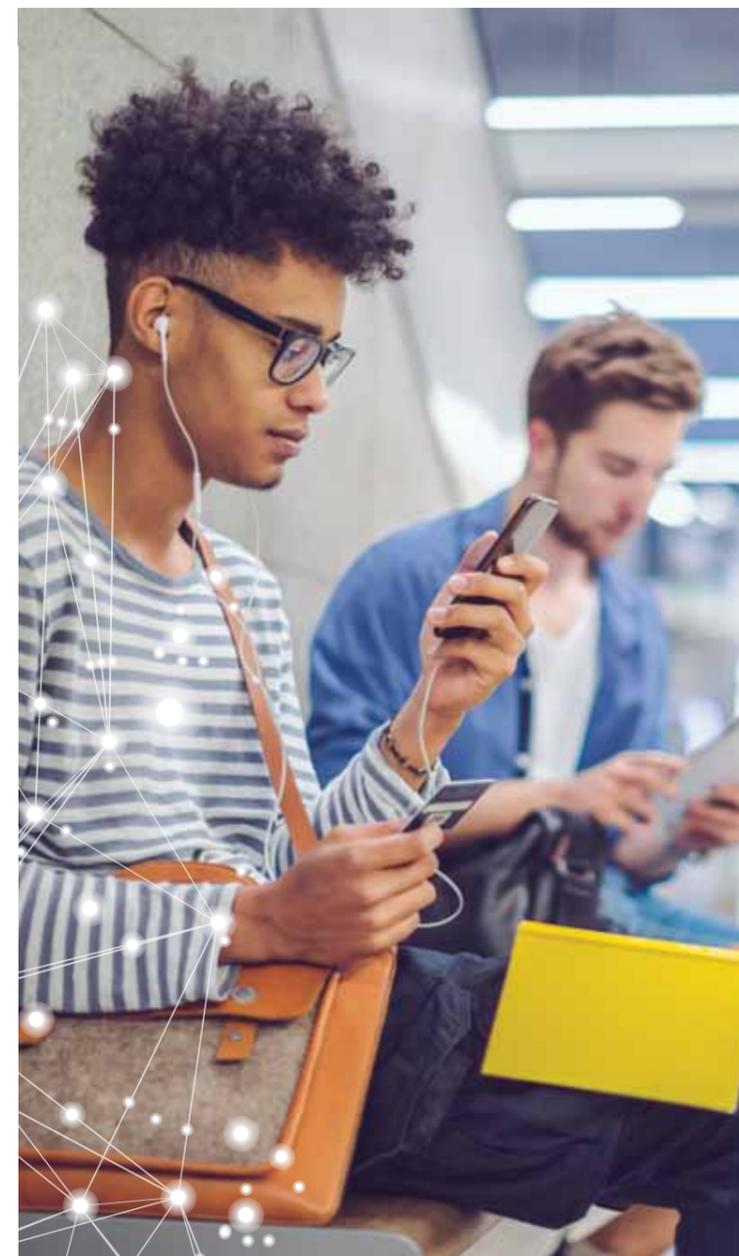
Machine learning is also becoming a normal part of daily life. Current popular uses include photo recognition to tag people, predictive text, voice assistants and apps that make location-based suggestions based on personal preferences. ⁽¹⁹⁾ Predictive text is the most popular machine learning function, with 39 per cent of all smartphone owners using it. Route suggestions are the most commonly used location-based service, with nearly one-third of respondents being aware of it. ⁽²⁰⁾

4.3 Virtual personal assistants

Voice-based virtual personal assistants such as Amazon's Alexa, Apple's HomePod and Google Home are now available in Australia. By applying a voice to the instructions consumers are used to getting from their smartphones, another barrier to use is being dissolved. These are likely to accelerate the take-up of connected home devices, bringing the truly connected home much closer to reality.

The entry of these devices fulfils a prediction made by the IEEE only a few years back:

We need to reach a state where we will seamlessly connect to the right individuals at the right time and through the right means. As a consequence, an individual driving should never be enticed to physically pick up a phone to answer a phone call or text. The context should be known and the best method of communication should be chosen based on the context of the users. ⁽²¹⁾



5.0 DATA ANALYSIS AND ACTION

4.4 An evolving energy industry

As the form and context of information exchange continues to evolve, the IEEE says the level of sophistication in the curation and personalisation of this information must also increase:

We believe this is where the next paradigm shift in mobile communications may lie. Instead of the consumers going to the internet, the internet will come to them, and in fact we will become nodes on the internet. We will become both the source of valuable information and the sink for highly personalised information and content. ⁽²²⁾

Although energy companies are yet to fully realise the benefits of the mobile internet on consumer engagement, the relatively small number of management tools on offer are being taken up voraciously, with 71 per cent of customers wanting SMS billing reminders. ⁽²³⁾ Two-thirds (67 per cent) would use online portals to report energy leaks or outages, ⁽²⁴⁾ while 55 per cent are interested in accessing real-time energy usage information and energy saving tips from their supplier. ⁽²⁵⁾ This positively impacts customer satisfaction with 67 per cent of consumers using digital channels stating that they are satisfied with their energy provider. ⁽²⁶⁾

Smart retailers understand that the most successful customer relationship experience focuses on each and every interaction across the full journey:

Across retail, banking, travel, home services, and other industries, companies are designing and refining journeys to attract shoppers and keep them, creating customised experiences so finely tuned that once consumers get on the path, they are irresistibly and permanently engaged. ⁽²⁷⁾

Currently, energy consumers are primarily focused on the monthly or quarterly electricity bill, making this the best starting point for personalised, two-way consumer engagement. The opportunities inherent in adoption of the mobile internet are clear. In the development of our innovation roadmap, Landis+Gyr has focused on the nexus between the reliability, accuracy and cost efficiency of smart meter data and the level of personalisation made possible by algorithms and machine learning, as well as the power of the mobile internet – both in its current form as a hand held device and its near future incarnation via devices such as Alexa. This will help our customers better serve their customers and create new revenue streams.

5.1 What to do with data

Data collection is now ubiquitous. This inevitably leads to consumer concerns about privacy and security. From an industry perspective, concern focuses on the sheer scale of storage required to house data securely as well as the need for cost-effective models for analysing and acting on it.

Given the small amount of product differentiation currently available to consumers, they are yet to experience the true benefits of energy data collection. As such, much engagement opportunity is being wasted.

The solution to consumer engagement for retailers, and peak capacity issues for distributors, can be found in what we actually choose to do with data.

5.2 Demand response

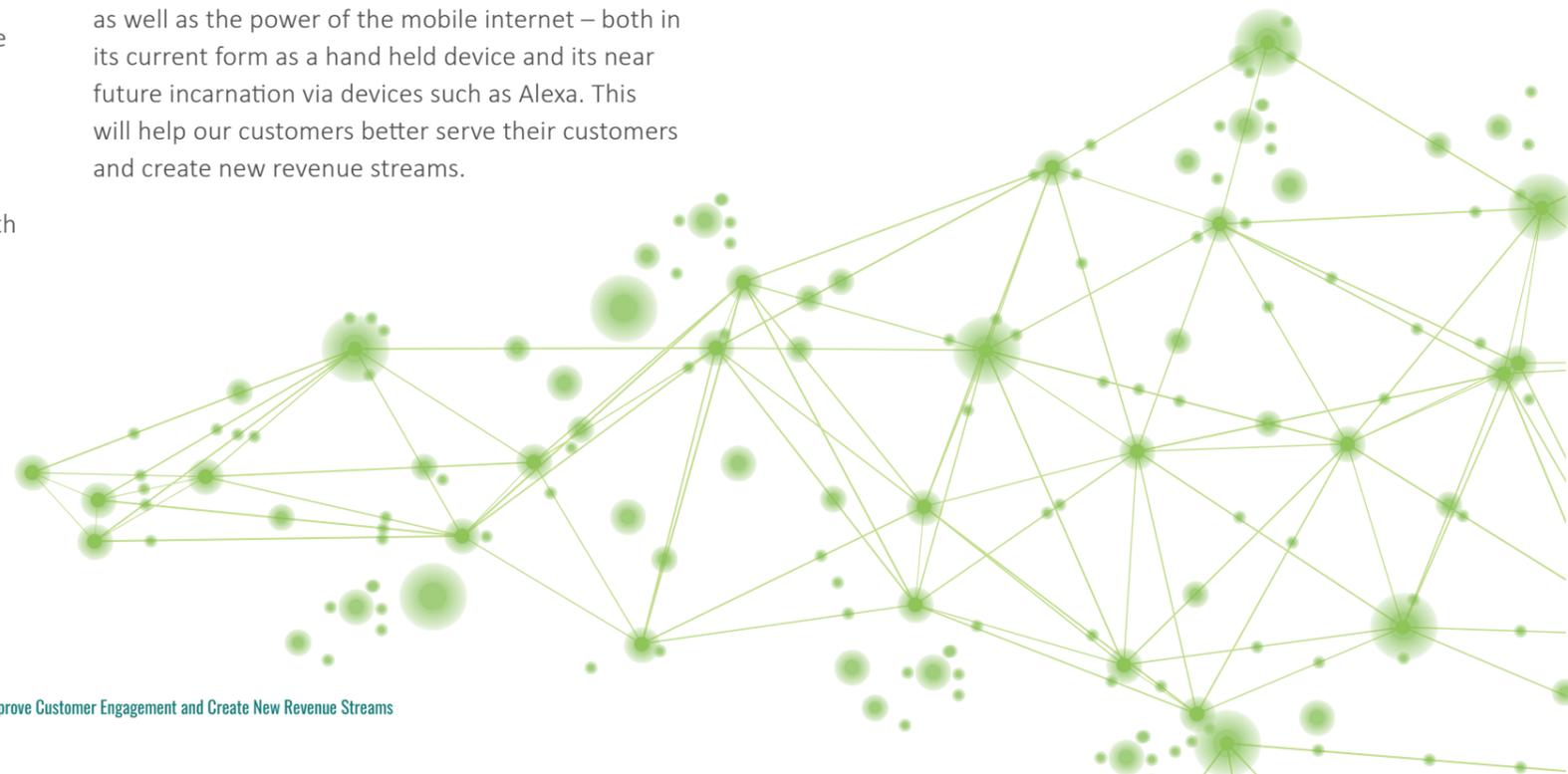
It is now well recognised that demand response mechanisms have benefits for consumers and the grid. If successfully implemented, such programs reduce electricity consumption and emissions while better managing peak demand. In so doing, system resilience would also be most cost effectively enhanced. Just as importantly, consumers would be empowered to take control of consumption and reduce their bills.

Demand response generally refers to reductions in electricity demand in two ways – first by reducing consumption in absolute terms, sometimes referred to as conservation and second by reducing demand at peak times by shifting significant usage to another time period.

As an example, swimming pool pump energy consumption represents the ultimate in discretionary loads. Australia's 1.4 million residential swimming pools represent an aggregate load of 3,700 megawatts, roughly twice the installed capacity of the frequently discussed Liddell power station. Residential pools typically account for 40 per cent of relevant household consumption and aggregate to about 10 per cent of total domestic electricity consumption.

In theory, if all pool installations were upgraded to the most efficient equipment available, this would reduce power consumption by the equivalent of a coal-fired power station like Liddell. Consumer savings would also flow from the avoidance of extra costly infrastructure to better manage such loads, avoiding costs being passed onto consumers in price rises. Finally, the environment would benefit from lower emissions and consumer engagement would increase.

Demand response programs are currently promoted as a means of forestalling blackouts rather than giving consumers an opportunity to take control of consumption, generation and storage to reduce electricity bills. It would be better to promote the benefits of lower bills and increased convenience.



5.3 Disaggregation and fault anomaly

As our consumer research clearly identifies, customer expectations are shifting to focus on the more granular, personalised user information that data provides.

Particularly in regions where smartphones have reached a significant level of penetration – Australia and Asia being prime examples – we are starting to see the emergence of consumer offerings that feature up to the minute, electronic energy bills via mobile devices, with increasingly sophisticated disaggregated, or appliance level, consumption information to follow.

CASE STUDY 1: Mojo gives Australian consumers the intelligence to reduce energy consumption and costs

Australian energy retailer Mojo Power promotes its pricing model as uniquely competitive:



You pay the same price to power your home that we expect to pay for the electricity we deliver to you. That's 0 per cent mark-up electricity usage rates, with no padded profits on top. ^(†)

Mojo's differentiation strategy focuses almost exclusively on smart meters and the power of data. It offers customers anytime, online access to electricity bills via a completely paperless service, displaying consumption in half hourly and full-day increments. Mobility is central to this strategy with a highly popular mobile app available for download via the Mojo website.

Consumption information includes 'real-time' feedback from smart meters based on half-hourly reads, where consumption is shown in dollar terms with disaggregated solar stream readings. Mojo also offers cash incentives for load reduction and annual cost breakdowns of how much the customer has saved using solar over traditional grid power.

[†] <https://www.mojopower.com.au/our-rates>

CASE STUDY 2: Tenaga National Berhad's (TNB) mobile bill app

Launched in March 2018, TNB's mobile smartphone app allows customers to view their account information, pay bills and monitor their power consumption trends, with consumption information dating back six months. With levels of technical sophistication to be rolled out in stages, the energy company states that the app is being offered ahead of a significant smart meter roll-out, to ensure the benefits of smart meters can be properly passed on to customers. It has been downloaded 30,000 times in one month.

In the words of TNB's Senior General Manager (Customer Service) Ir. Kamaliah Abdul Kadir Kamaliah:



Once the smart meter is implemented nationwide, the device will allow customers' to manage their daily usage and help them save their electricity bills.

A total of 1.5 million smart meters will be changed across the country in phases by December 2020. This will allow consumers to check their bills on a daily basis. This is a good initiative by TNB.^(°)

CASE STUDY 3: Engie launches customer app that offers fault anomaly

Global energy company provider Engie recently announced a consumer offering as part of its Think Energy business featuring disaggregation and fault anomaly. Working in partnership with predictive analytics provider, Grid4C, Think Energy is offering advanced machine learning insights through a branded app. This gives customers the ability to optimise smart thermostat efficiency settings and see the real-time impact on energy bills. They also receive inefficiency and fault alerts for home appliances.

The specific capabilities of the system include the ability to:

- + Optimise smart thermostat settings and simulate how changes will impact the customer's forecasted energy bill.
- + Alert customers when there are inefficiencies or faults with major home appliances.
- + Predict and diagnose heating, ventilation and air-conditioning faults.
- + Present customers with energy use and costs on a monthly, daily or hourly basis.
- + Alert customers when deviations from their usage patterns are detected.

[°] <https://www.nst.com.my/news/nation/2018/04/354783/mytnb-app-benefits-consumers>



6.0 WELCOME TO THE EDGE

6.1 Smart meters are the backbone

Consumers have become the dominant driver of technology innovation in the energy industry, pulling focus away from centralised distribution and management. They are influencing energy use, control and production at the grid edge. Landis+Gyr is committed to helping energy companies build stronger customer relationships and generate new revenue streams.

Disaggregation is a vital component of control at the grid edge. There is great value in consumers understanding how much energy is being used by domestic systems and home appliances. Digitally enabled disaggregation is the best way to offer this control with real-time accuracy while ensuring the least amount of physical disruption to the consumer.

Smart meters are the backbone of this transformation. They are the most efficient and cost-effective way to measure energy use in real-time. Smart meter technology also has a clear advantage over all other ways of measuring disaggregated energy use with respect to customer experience.

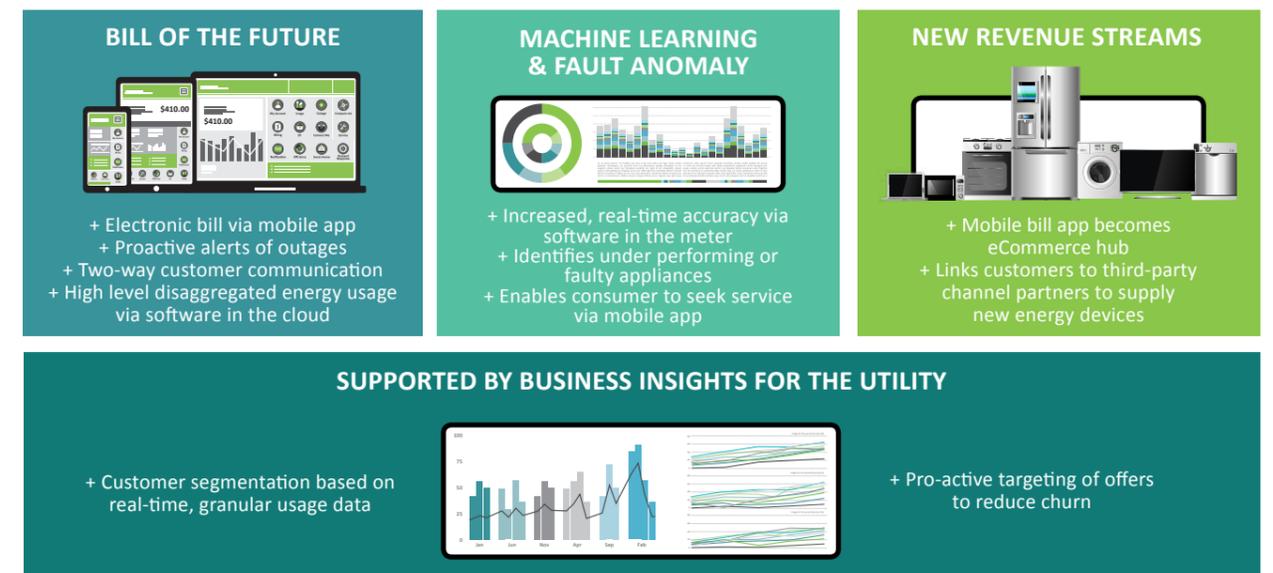
6.2 Consumer Engagement Platform

The Landis+Gyr Consumer Engagement Platform combines smart metering data with the power of analytics and machine learning to offer disaggregated energy measurement. The level of sophistication can be scaled up over time as consumer interest grows.

By providing advanced software capabilities to an energy company's electronic bill interface, we help create a permanent platform for all customer engagement. We call this our 'Bill of the Future'.

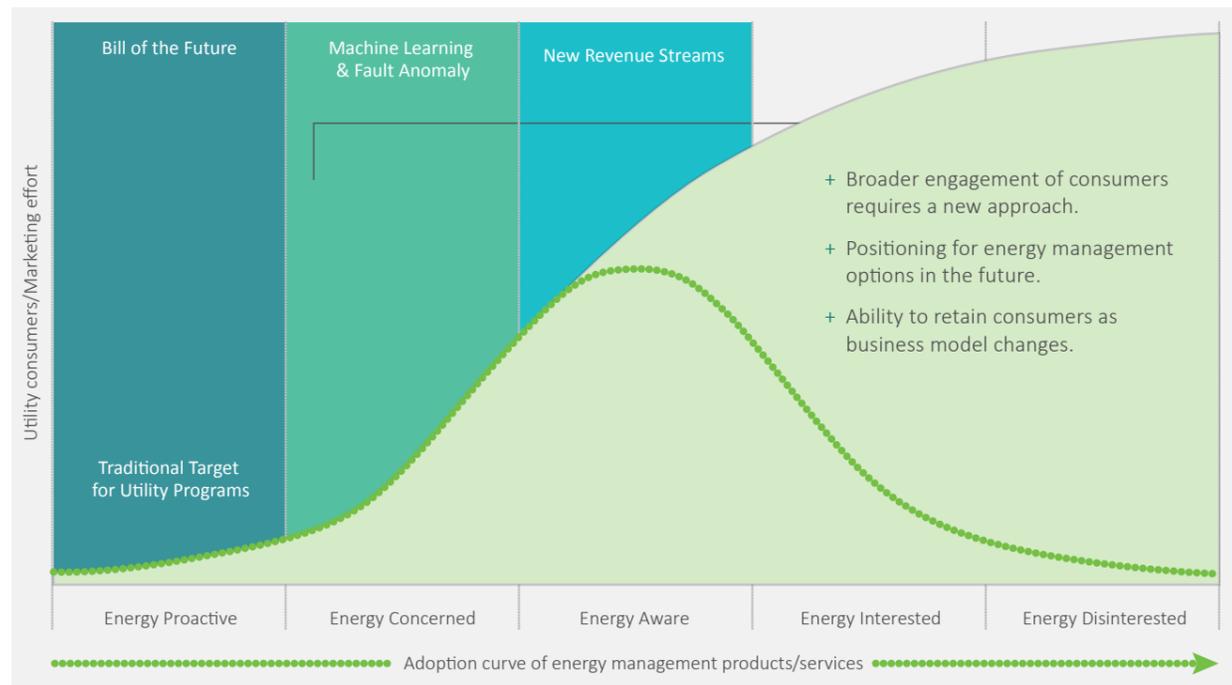
Ultimately capable of becoming the centre of control for customers to manage their energy use, the Bill of the Future enables customers to view current and historical energy bills, pay bills online and set budget goals. Dynamic graphical elements help customers better understand their energy consumption, measuring current energy rates and making historical comparisons. Current and planned outage information is also communicated and a two-way communications channel allows customers to report outages directly via their mobile device.

Figure 8: Consumer Engagement Platform



The Consumer Engagement Platform is designed to mirror the steps consumers have been proven to go through in their journey from passive to active energy managers.

Figure 9: Consumer engagement journey

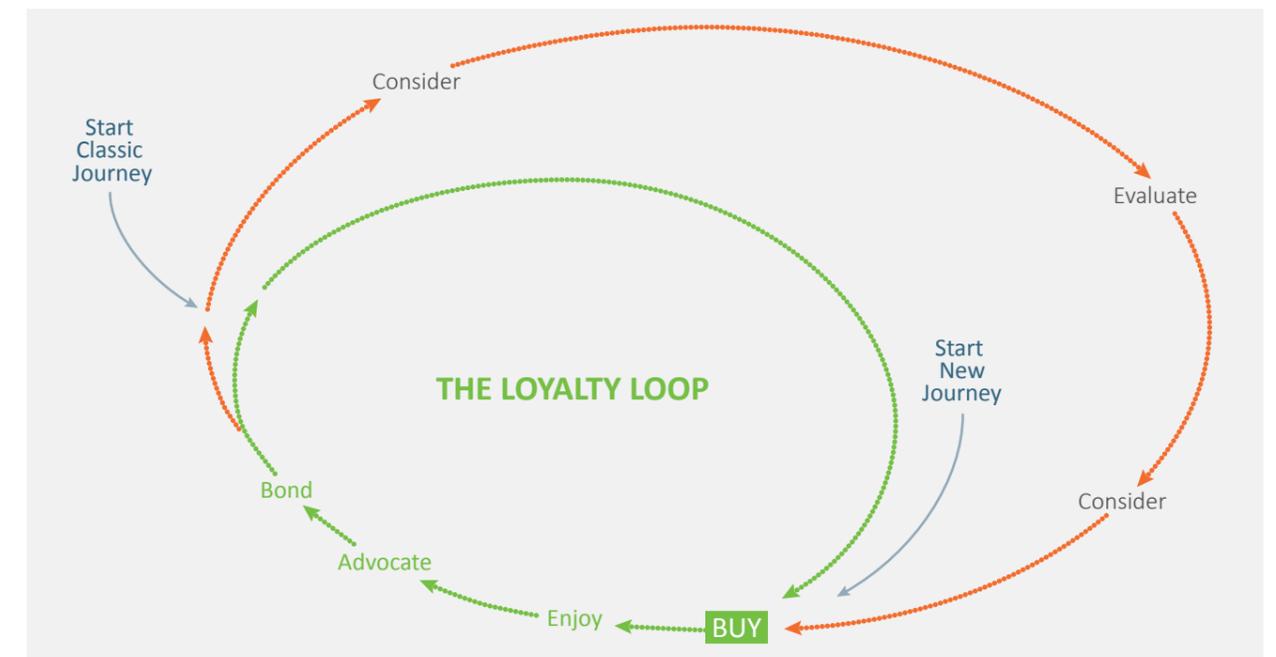


The second phase of consumer engagement is pivotal to deepening the relationship between energy users and energy companies. Smart technology combines metering data with the power of analytics and machine learning to predict current usage and future trends. The source of appliance faults can be identified showing future costs if the fault isn't fixed. This allows consumers to seek a service or product replacement to avoid unnecessary charges. For example, should a fault be detected in a home hot water system, normal usage figures can be compared to the extra energy used as a result of the fault. This can then be extrapolated out over a six or 12-month period so the consumer understands how much extra it would cost them over time if they do not fix the appliance.

6.3 New revenue streams

Finally, the consumer engagement platform is designed to create a dedicated, two-way channel to support customer loyalty into the future. Based on the idea of the 'Loyalty Loop' ⁽²⁸⁾ this channel effectivity creates a new customer journey that shortens or entirely eliminates the 'evaluation' step a customer traditionally takes when they are buying new energy appliances.

Figure 10: Streamlining the decision journey ^(H)



Using fault anomaly as the trigger, energy companies can offer replacement appliances via the same channel (the electronic bill), effectively delivering customers directly into the loyalty loop and keeping them there.

Ultimately, all consumer-facing energy technology can be offered this way – the potential for the successful transformation of traditional energy company business models to better suit digitalisation via this customer-driven channel is clear. Negating the need for more expensive advertising channels or door-to-door sales models (which are also physically invasive and therefore not conducive to a positive customer experience), this vital engagement platform exists within, and is facilitated by, the digitalised energy system itself.

For the energy company, a deeper level of customer segmentation is possible too. Segmentation can be determined via specific energy devices and consumption behaviours to predict if an energy user will respond positively to specific market offerings. This in turn moves churn analysis from reactive to proactive.

6.4 Grid Edge Solution Phase 1

How to easily and cost effectively supply this information to customers is key, as is the need to minimise home disruption as much as possible. Landis+Gyr's Grid Edge Solution suite has been modelled around these important considerations. By combining software in the cloud with our smart meter hardware and ubiquitous, network agnostic communications technology, the first level of this disaggregation includes a range of large home appliances and systems – including solar PV panels, pool pumps, hot water, heating, cooling and electric vehicle charging – to a high degree of accuracy. This level of service is the most cost-effective way for a retailer to provide entry-level disaggregated readings, while being the least physically intrusive to the customer.

Crucially, customers who sign up for this service will receive alerts to inform them of possible faults with the bigger ticket items in their home. This information is specific to their household and their particular energy usage, allowing them to take meaningful action.

Figure 11: Grid Edge Solution Phase 1



With 50 billion devices set to be connected to the internet by 2020, and prices in solar and storage predicted to drop dramatically in the next three years, this is a great way for energy companies to establish a strong foundation for deeper relationships with their customers.

Landis+Gyr can offer these services to retailers right now, so a foundation can be set without the need for investment in the whole roadmap. From the perspective of the journey retailers must take customers on to strengthen engagement over time, as the energy industry continues to evolve, this entry-level service ensures future innovation can be added when the customer is ready and willing to take the next steps.

6.5 Application programming interface

Application programming interfaces, or APIs, are one such field of innovation central to Landis+Gyr's Grid Edge Roadmap. Allowing disparate applications to communicate, APIs integrate applications from a range of different companies. APIs have been around for a while, but companies are only now starting to use them to create integrated, cross-company customer journeys.

In keeping with Landis+Gyr's Consumer Engagement Platform, API technology is a key feature of our Grid Edge Solution suite, where a range of new partner applications can be integrated over time so energy companies can continue to build a seamless customer journey.

6.6 Grid Edge Solution Phase 2 Roadmap

By adding API computing power to the meter, Landis+Gyr will ensure complex algorithms are processed using real-time local intelligence. Utilising our robust and mature radio frequency mesh communications technology, this power is further enhanced by innovation that provides a pathway to behind the meter systems such as solar PV.

Software housed in the meter will enhance accuracy and immediacy. Home energy usage can be optimised by co-ordinating heating, cooling, hot water heating, pool pumps and EV charging with both solar PV generation and battery storage to minimise the electricity bill in real-time, even with complex tariffs.

In response to a key issue uncovered in our consumer engagement research, this level of disaggregated accuracy also applies to a second level of home appliances, in addition to the bigger ticket items for which disaggregated readings were available in Phase 1. This means consumers will now be able to understand how much energy their oven and fridge are using, for example.

Figure 12: Grid Edge Solution Phase 2 Roadmap



6.7 Fault anomaly is crucial

With fault anomaly now also available at this level of disaggregation, retailers can establish and build new revenue streams by offering replacement appliances through third-party supply agreements.

Our Grid Edge Solution combines this internet of energy with IoT via the home area network to smart home devices like Amazon's Alexa and Google Nest. This means customers can be alerted to faults via voice activation in the home, as well as their mobile bill.

Massively scalable and robust, this 'in the meter' solution will reduce cost by eliminating technology duplication while minimising operation and support costs.

6.8 Distributed Energy Resources

The surging uptake of distributed energy resources, including residential battery storage, rooftop solar PV and demand response creates challenges and opportunities for the energy industry. DERs will play a central role in the decarbonisation of the energy system but, if left to grow organically, they will pose a threat to the safe, reliable and efficient supply of energy and much opportunity will be wasted.

DERs are capable of vastly improving network utilisation, while reducing costs and carbon emissions. Co-ordination across large fleets of DERs is critical to maintaining security, reliability and the efficient use of network assets. Landis+Gyr's Grid Edge Solution Roadmap will leverage smart meter data to provide services that can manage large DER fleets most cost effectively. Powerful and scalable, it will unlock the benefits crucial to an efficient, decarbonised energy system, without compromising safety or reliability.

6.9 Virtual Power Plants

Virtual Power Plants (VPPs), built through the aggregation of a coordinated fleet of DERs, will be important to unlocking the value of distributed energy. Key to successful VPPs will be the ability to orchestrate all resources in a reliable and timely manner to respond to energy system events as required. Reliable orchestration requires robust communication, measurement and control facilities through to each of the many resources comprising the VPP, but these facilities must come at a cost that does not compromise the VPP business case.

The technology used in Landis+Gyr's Grid Edge Solution builds on our 300 million + base of smart devices installed globally. With tens of millions of devices needing to robustly communicate billing data every hour of every day at a low cost per device, our ability to bring this technology to distributed energy resources enables VPPs to provide comprehensive orchestration at a cost that stacks up.

6.10 Microgrids

Whether it is for the supply of energy to a remote town or the sharing of energy within an urban community, microgrids will play an important role in an efficient, low-carbon energy future. Like the traditional energy system, consumer demand is increasingly decentralising the microgrid. A significant proportion of energy generation is now coming from distributed energy resources, rather than centralised power plants. Called 'distributed microgrids' this trend also goes a long way to providing consumers with greater control of their energy source and costs.

In any microgrid, maintaining the supply/demand balance and selecting the energy source with the lowest cost of supply is essential. To maintain an efficient and secure operating model, all resources in the microgrid must be orchestrated, which becomes more complex in a distributed microgrid because of the large number of generation sources and multi-directional energy flows. Like a VPP, reliable orchestration in a microgrid requires robust communication, measurement and control facilities through to each of the many distributed resources powering it.

Landis+Gyr's Grid Edge Solution Roadmap integrates microgrid solutions, enabling the robust, scalable and low-cost orchestration of DERs to ensure operation and costs are optimised.

7.0 IN CONCLUSION

In Australia, research demonstrates consumers are looking for more information on how to better manage their energy usage and costs. Increasingly aware of smart meters, consumers want to know what's in it for them. Knowing what data can do in so many other parts of their lives – such as banking, travel, health and fitness – they expect appliance-level energy usage information.

As consumers drive the decarbonisation and decentralisation of the energy industry, effectively leading transformation at the Grid Edge, energy companies need to leverage edge technologies to remodel the entire value chain and provide consumers more choice and control.

The mode of digital transformation necessary will be determined by a range of consumer drivers:

- + Rising energy costs.
- + Increasingly price-competitive distributed energy resources and battery storage.
- + A connected device market that is growing exponentially.
- + The increasing reliance on mobile technologies and the transformational affect this has had on consumer behaviour.

In addition, with the production and measurement of energy being increasingly commoditised, energy businesses must focus more on services.

To ensure success, energy companies must act on this knowledge now. Grid Edge technology innovation is key.

Transmission, distribution and retail businesses all have a vital role to play in transformation at the edge. Our Grid Edge Solution suite caters to their different but complimentary needs.

From the perspective of grid management, the suite enables cost-effective integration of large scale distributed energy resources and the efficacy of demand management as a central tool in managing peak load without excessive investment in new physical infrastructure.

The changes that consumers expect need to start happening now.

Landis+Gyr's Grid Edge Solution caters to the needs of consumers as they evolve, moving them from passive to increasingly active and engaged consumers.

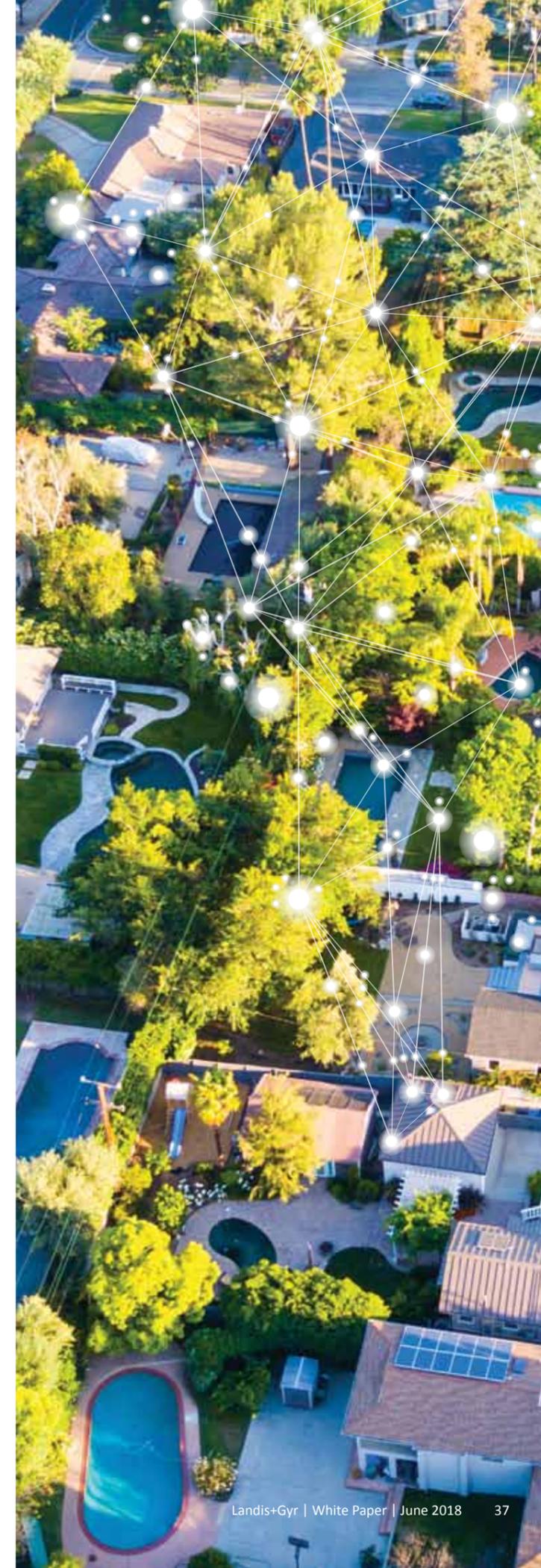
Beginning with software in the cloud, combined with smart meter data, analytics and machine learning, the solution applies a level of intelligence to energy bills that allows disaggregated energy readings for major home appliances and personalised fault alerts. Transforming the old, quarterly bill into a 'Bill of the Future', the Grid Edge Solution creates a platform for active, two-way, personalised engagement between energy companies and customers.

Phase 1 enables energy companies to increase positive customer engagement now, and also provides a cost-effective and scalable foundation for future innovation as market transformation continues.

Central to our Roadmap, Landis+Gyr's Application Programming Interface will integrate our Bill of the Future capabilities with a range of world-leading partner innovations **in the meter**, enabling energy usage to be optimised in real-time to offer consumers cost saving options, even with complex tariffs. Disaggregation and fault anomaly will be achieved down to a second level of home appliances, such as fridges, smart TVs and ovens and ultimately, the 'Internet of Energy' will be combined with IoT via the home area network to smart home devices like Amazon's Alexa and Google Nest. Robust and scalable remote monitoring and control of distributed energy resources will also be possible, enabling the operation of virtual power plants and demand response services.

History shows that when traditional, consumer-facing business models are disrupted by new technologies, product and solution innovation must focus on building new revenue streams. This innovation must be informed by the way consumers are expected to behave in the future, not how they behaved in the past.

The insights provided in this paper will go some way to helping the energy industry better understand evolving consumer needs and the innovative Grid Edge technologies available to meet them. We are committed to helping our customers successfully navigate energy market disruption and are ready to take the first, vital steps now.



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9.0 ABOUT THE AUTHORS

Monique Spanbrook

Monique Spanbrook is the General Manager of Marketing, Communications and Customer Experience for Asia Pacific at Landis+Gyr. Working with product and sales, a key focus is her development of customer experience propositions that enable energy companies to better serve their customers – the end consumer. Central to this is the understanding that the dramatic changes the energy industry is undergoing have a similarly profound effect on energy consumers and the level of service and control they expect in an increasingly digitalised economy. This requires fundamentally new ways of thinking about what customers want and need.

With 20+ years' experience in consumer, enterprise and corporate level communications and marketing, Monique has held senior management positions for Telstra Enterprise and Government's thought leadership program and their Corporate Brand divisions respectively. Adept at B2B, B2C and B2B2C channels to market, a particular area of expertise is her ability to take complex technical solutions deployed in a wide range of industry verticals (energy and resources, education, health, media and entertainment, supply chain and logistics, and retail) and translate them into clear and effective solution, program and campaign initiatives. Technology specialities include cloud computing (IaaS and SaaS), machine-to-machine monitoring, smart metering, data analytics, network (media, telecommunications, energy) and mobility.

Previously, as a creative director and executive producer, she worked extensively across Asia, Australia and New Zealand for numerous major brands and blue chip companies, including the 'big 4' banks, CLSA Capital Partners, Australian Consolidated Press, St George Bank, Audi, The Royal Bank of Scotland, Fairfax, PBL, Toyota, Alcatel, Mercedes Benz, BMW, The United Nations, The Department of Finance, The Garvan Institute, Schering Plough, Qantas, Nortel, and AAPT.

Monique holds a Bachelor of Arts degree in English from the University of Western Australia (UWA) and a Diploma in Performing Arts from the Australian Academy of Performing Arts (WAAPA).

Jack Dangar

Jack Dangar is the Product Manager, New Energy Solutions for Australia, New Zealand and South East Asia. Overseeing Landis+Gyr's Grid Edge solutions, areas of focus include distributed energy resource fleet management, and the increasingly important analytics portfolio, which provides next-level consumer engagement and grid insights across Australia, New Zealand and South East Asia.

Jack has more than nine years' experience in the electricity supply industry, specialising in innovation and emerging technologies. He has a broad range of expertise, from analytics and distribution network engineering, to strategy development, and has been instrumental in helping the industry extract value from new energy technologies.

Prior to his current role, Jack was a Senior Analyst at Australian consulting firm Energeia. Here, he built ground-breaking models to assist utilities in the development of tariff structures that incentivise positive consumer behaviours around solar PV and energy storage.

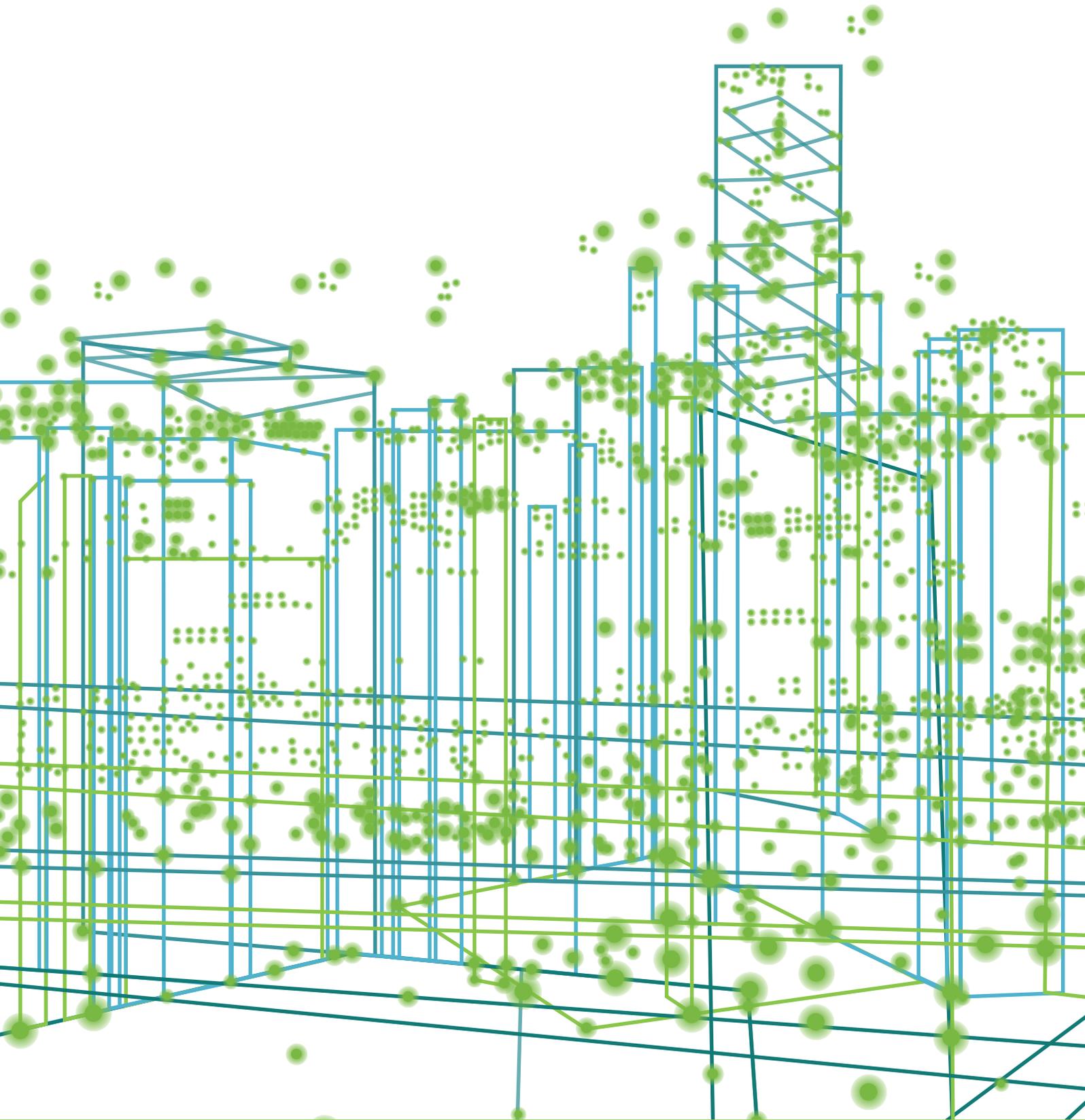
Jack also played a vital role in the development of regulatory submissions for electricity networks.

Beginning his career at Ausgrid, where he held various roles over six years, Jack has worked on some of the most innovative energy technology projects in Australia. Leading the electric vehicle trial that was part of the landmark *Smart Grid, Smart City* program at Energy Australia, Jack developed a load information system for distribution transformers and trialled next-generation protection technologies.

He also held SCADA, network planning and in-field roles, providing an excellent foundation of knowledge about the building and operation of electricity networks.

Jack holds a Bachelor of Engineering (Hons) in Electrical Engineering from the University of NSW (UNSW).

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