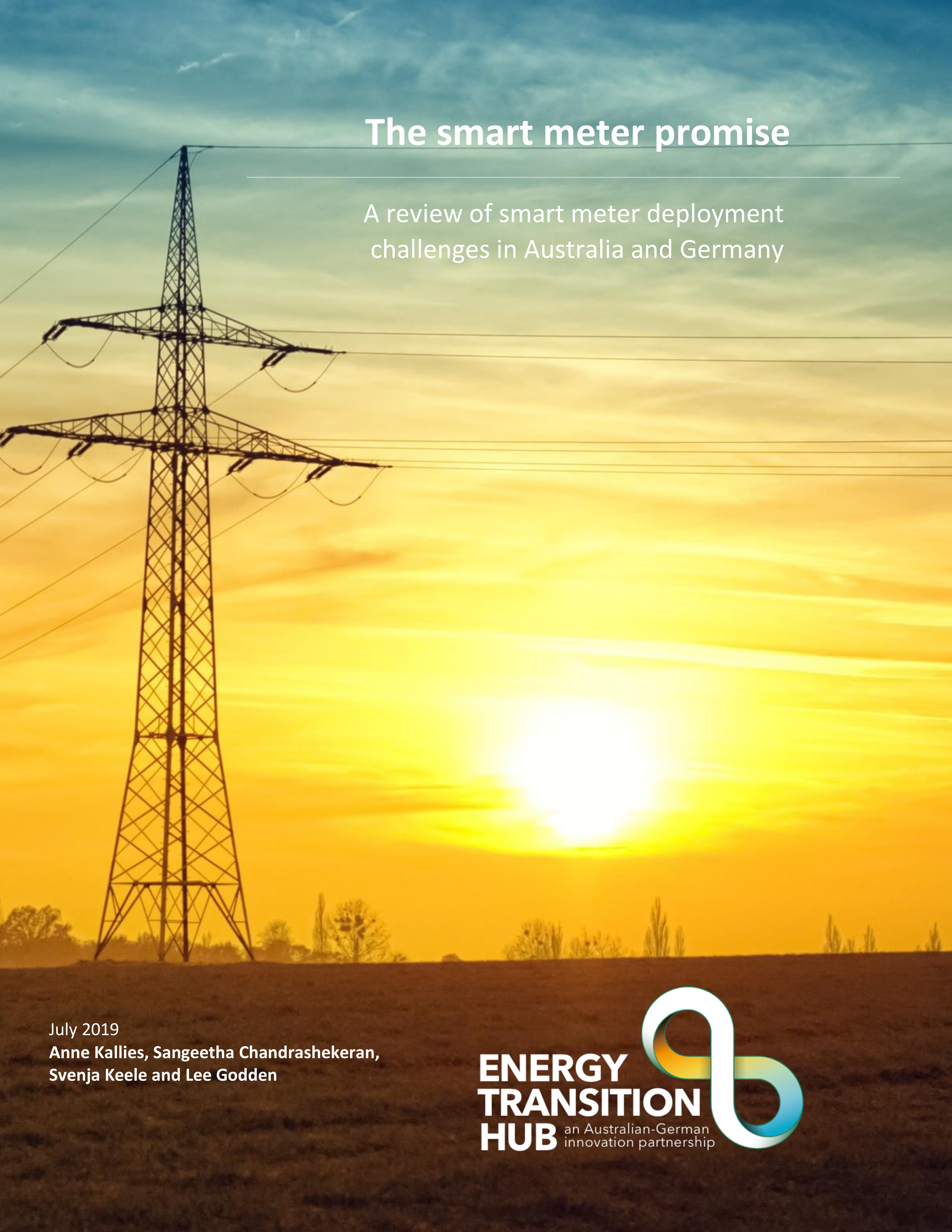

The smart meter promise

A review of smart meter deployment challenges in Australia and Germany

July 2019

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ENERGY TRANSITION HUB an Australian-German innovation partnership

Acknowledgements

The Australian-German Energy Transition Hub is supported by the Commonwealth through the Department of Foreign Affairs and Trade.

Prior publications

This report draws from analysis that the authors have previously published in the following papers:

Chandrashekeran, S., Dufty, G. and Gill M. (2018) *Smart-er Metering Policy: Getting the framework right for a customer-focused smart meter rollout*, University of Melbourne: Victoria.

Godden, L. and Kallies, A. (2018) 'Smart Infrastructure: Innovative Energy Technology, Climate Mitigation and Consumer Protection' in Zillman, D., Godden, L., Paddock, L & Roggenkamp, M. (eds) *Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions*, OUP: Oxford

Citation

Please cite this document as: Kallies A., Chandrashekeran S., Keele S. and Godden L. (2019) *The Smart Meter Promise: A Review of Smart Meter Deployment Challenges in Australia and Germany*, Report for the Australian-German Energy Transition Hub, University of Melbourne: Victoria.

Contents

Executive summary

Energy transition, energy security and energy affordability are critical and highly contested policy issues in both Australia and Germany, as elsewhere. Small consumers are being enrolled in a new wave of energy governance, shaped around promises of customer choice, lower prices and demand side management.

New energy governance is seen to hinge on the collation and utilisation of high resolution and timely energy consumption data, collected by a new generation of so-called 'smart meters'. Both technology and data are claimed to catalyse a raft of economic and system-wide benefits including: increasing innovation and competition in the energy marketplace, shifting energy consumption patterns to highest value uses, making more efficient use of existing infrastructure and delaying expensive investments in additional energy system capacity, and improving the efficiency and accuracy of energy markets.

But how are benefits and risks being passed on to consumers?

We compared three smart meter rollouts, two in Australia and one in Germany, with regards to their underlying objectives, rollout models and data access and security regimes. Our preliminary study found that the *distribution* of benefits and risks varies widely across different levels of the system – from individual households to retailers to distribution businesses or to the wider network. Who benefits from smart metering depends heavily on the interplay of infrastructure, regulatory arrangements and industry structure.

The *nature* of the benefits and risks are also changing. The explosion of consumer data enabled through the integration of information technologies across multiple daily activities – from electricity consumption to banking to telecommunications – has the potential to empower consumers but the risks need careful oversight to ensure protection of consumer privacy. Smart meters are representative of wider regulatory trends to situate the consumer as a central pivot of information but simultaneously to address the attendant risks by predicating regulatory intervention on the premise of consumer protection.

In turn, we need to find meaningful ways to reduce energy prices and expand new energy services like solar power and electric vehicles, and smart metering can help deliver these benefits. However, robust governance and monitoring regimes are crucial for the social acceptance of new technology. Further research and practical experience with the deployment models and data protection regimes of large-scale smart meter rollouts are necessary to assess whether the right balance is being achieved between innovation, competition and data security.

1. Introduction

Advanced metering infrastructure, often called 'smart meters', is being rolled out in multiple jurisdictions worldwide. Early adopters to pilot the technology in the early 2000s included the Nordic countries, Italy and New Zealand, while parts of Australia, Canada, the USA, the UK and Spain developed their own programs in the late 2000s. Despite its claimed 'game-changing' potential, however, smart metering has proved slow to deliver its projected outcomes at scale and has encountered numerous difficulties overcoming technical, regulatory, economic and public trust barriers.

In this paper, we draw from experiences in Australia and Germany to show the difficulties in materialising the benefits of smart meters evenly and to highlight the significant costs and new vulnerabilities borne by consumers. We focus mainly on small consumers. While smart meters have been available to large electricity consumers in many jurisdictions, smart meter coverage is low amongst residential customers and small businesses. The flow of benefits for this segment is complex and contingent. Consumers have highly variable energy consumption patterns and differentiated capacities and motivations to actively engage with the technologies and markets to access the benefits. At the same time, data privacy and security have become important considerations for energy consumers.

Three case studies from Australia and Germany are used to suggest that the bold future-oriented claims of smart metering need to be set against accounts of current deployments and the complex institutional factors that shape consumer costs, benefits and risks. This paper is intended to identify and discuss a range of emerging issues facing policymakers, regulators, market actors and consumers in the deployment of smart meters. It identifies potential areas of future research to contribute to ongoing dialogue between researchers in Australia and Germany, as well as inform the public and other stakeholders.

2. The smart meter promise

The electricity sector is transforming at a global scale and many bold claims are being made about the central role and transformative potential of smart meters. Developments in the energy market and new generation technologies (including the penetration of information technologies into the energy sector) hold the promise of the emergence of an administratively and physically decentralised, consumer-oriented energy system radically different to the centralised supply system of the last century. Smart meters, it is said, can create empowered consumers actively participating in the electricity sector to generate individual and collective, system-wide benefits.

It is important to ground these claims in evidence about actual smart meter deployments and examine the extent to which smart meters are delivering tangible consumer benefits that outweigh the associated costs and risks to individuals. Smart meters[1] generally have two features. The first is the ability to record energy use with a high degree of granularity. Smart meters typically measure electricity consumption in 30-minute intervals and send consumption measurements daily; in the near future, Australian smart meters will enable access to consumer energy data with a granularity of 5 minutes (Chandrashekeran et al., 2018). Smart meters can also be set to measure consumption of particular equipment on site (e.g. air conditioning). The second shared feature is that they allow two-way communication between the consumer (e.g. household) and the data manager. This requires access to sophisticated communications technology and infrastructure. This feature means meters can be read remotely and that smart meters can deliver a suite of added services to consumers such as in-home control devices to reduce costs during peak pricing periods and enable new energy management technologies like batteries and photovoltaics (Burger et al., 2013; Leiva et al., 2016; Parag and Sovacool, 2016).

Some smart meters are 'smarter' than others. There is no such thing as a standard smart meter. The functionality of smart meters is typically defined in a specification that outlines what services the meter supports. Higher levels of service typically mean a greater range of benefits but also a higher per-unit price. They also have different communication capabilities. Smart meter functionality influences what can be achieved in terms of improved bill management, energy management (e.g. remotely controlling appliances and disconnecting the residence), and smart grid management (e.g. that enable electricity market participants to interact with the meter) (AEMC, 2012).

Experiences so far have shown that successful introduction and use of smart meter capabilities by consumers is not just a question of enabling technology, it requires carefully considered policy settings. Multiple policy agendas seek to rationalise the rollout of advanced metering infrastructure (Figure 1)

[1] Smart meters represent a third generation of metering technology, following from accumulation and interval meters. While accumulation meters record energy consumption mechanically and must be read manually, interval meters record consumption electronically but are still read manually. Smart meters record electronically and can be read remotely.

(Buchanan et al., 2016; Darby, 2012; Gellert, 2015; Harvey, 2013; Jennings, 2013; McHenry, 2013). The introduction of advanced metering has been promoted variously as a climate change mitigation strategy, enhancing productivity or empowering consumers.

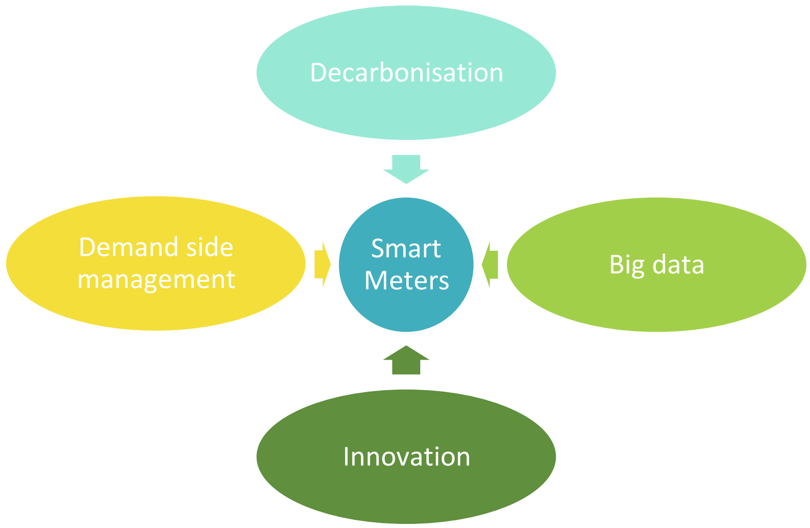

Figure 1. Converging policy agendas support smart meters

A *decarbonisation* agenda sees smart meters as an enabling technology for decentralised renewable energy, such as solar microgeneration. The rationale for smart metering is also based on the promise of better price signals, which will reallocate the costs of supply and promote *demand-side management* (for example incentivising consumers to defer energy use during peak periods) (Gelazanskas and Gamage, 2014; Godden and Kallies, 2018; Groothuis and McDanielmohr, 2014; Strbac, 2008).

More recently, the *big data* agenda sees smart meters as a technology that generates more granular, timely and cost-effective information about consumers, enabling more sophisticated market segmentation, which potentially enables a raft of tailored services targeted at households (Productivity Commission, 2017; see Kragh-Furbo and Walker, 2018). Closely related to this, the *innovation* agenda anticipates that smart metering – and in particular the data generated by this technology – will stimulate new products, services and business models in energy management (AEMC 2012).

Each of these policy agendas feature overlapping and sometimes divergent claimed benefits for different constituencies (Figure 2): consumers (small to large), industry, system operators, and energy users as a whole (Buchanan et al., 2016; Darby, 2012; Depuru et al., 2011; Hall and Foxon, 2014; Inderberg, 2015; Jennings, 2013; McHenry, 2013; McKenna et al., 2012; Sovacool et al., 2017; Strengers, 2010; Wilson et al., 2017).

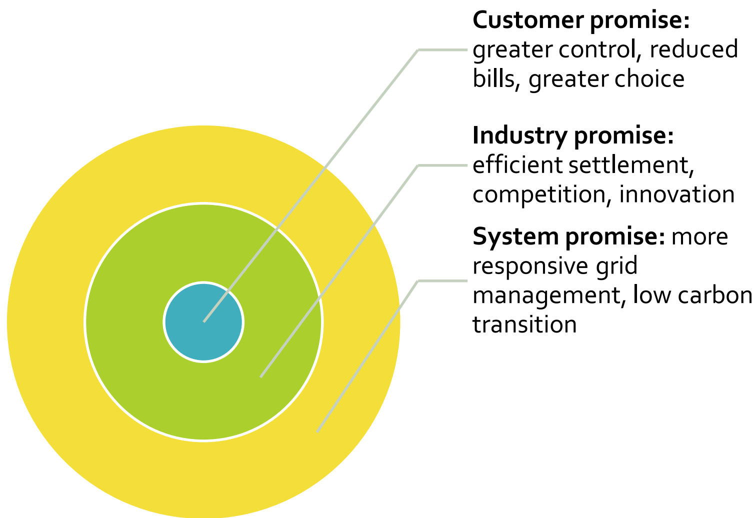

Figure 2. The promises of smart energy systems

Individual *consumers* are promised that smart meters will give them greater control over their electricity usage by providing timely and high-resolution information about their electricity consumption. In the context of rising energy costs for households, smart meters are expected to reduce electricity bills for customers by enabling time-of-use pricing and through avoided investment in grid upgrades brought about by reduced, deferred or attenuated demand patterns. Smart meters are also intended to give customers greater choice by introducing contestability to metering services and enabling third party providers to offer value-add products and services. Smart meter rollouts are part of reforms aimed at enhancing cost transparency in energy markets.

Industry benefits from smart meters are promised in the form of cost effectiveness and competition in metering and billing services, together with opportunities for innovation in energy management products and services. Smart meters are also said to facilitate more efficient and accurate settlement of electricity markets. At a *system* level, smart meters are expected to support the transition to low-carbon energy systems and to improve energy security by enabling more responsive management of the grid. These different promises have driven deployment models for smart meters in different ways, producing divergent distributions of associated benefits and risks.

3. Australian and German smart meter deployment models

A major issue for smart meter rollouts is how potential consumer benefits can be captured such that benefits outweigh the costs and risks. Australia and Germany are both deploying or starting to deploy smart meters at scale. Both countries are also grappling with introducing equitable and fair cost recovery models. Valuable lessons for future implementation in other jurisdictions can be drawn from the assessment of three smart meters rollout programs undertaken across the two countries.

Australia and Germany have liberalised electricity markets. In Australia, the National Electricity Market (NEM) governs electricity provision across the eastern and southern states of Queensland, New South Wales, Victoria, the Australian Capital Territory, Tasmania and South Australia. In most states, consumers are able to choose their electricity supply from amongst retail businesses, some of whom are vertically integrated with generation businesses. Similarly, electricity market reform in Germany allows consumers to choose their retailer. In the past, responsibilities for metering have been aggregated to distribution businesses under a logic that metering is a fixed part of the electricity network. However, smart meter introductions disrupt these expectations.

Case Study 1: State of Victoria: mandated distributor-led deployment

Australia's interest in smart meters can be traced back to early 2000s (KPMG, 2013; Lovell, 2017b) when the Council of Australian Governments (COAG) commissioned an Energy Market Review, (the *Parer Review*) which recommended the mandated rollout of interval meters to households and small business customers to increase demand-side participation in the newly formed NEM. Subsequent work at a national level between 2002 and 2006 supported the implementation of new metering arrangements: by this time, advancements in technology meant that smart meters were being considered instead of interval meters in order to secure a wider range of customer and network benefits. The sustained interest by Australia in advanced metering during the early 2000s was driven by growing concerns about the infrastructure costs of meeting peak load demands (Chandrashekeran et al., 2018; Godden and Kallies, 2018; Lovell, 2016). The ability of more sophisticated metering to support greenhouse gas reduction goals also became an increasingly important narrative justifying smart meter rollouts.

In 2007, COAG committed to a national mandated rollout of electricity smart meters in areas where benefits outweighed costs (NERA, 2008). Recognising that overall costs and benefits of advanced metering infrastructure were likely to vary by jurisdiction (especially by states/territories), a *National Smart*

Metering Cost Benefit Study was commissioned to evaluate where an economic case could be made to pilot smart meters (NERA, 2008). Meter functionality, cost recovery models, privacy concerns and the potential benefits to customers, distributors and retailers were all key issues under consideration. Cost-benefit analyses, principally conducted by external consultants, have been key accountability mechanisms for smart meter policy-making generally. Shortly thereafter, a *National Smart Meter Program* was announced to coordinate these pilots, which included the *Smart Grid Smart City* initiative and Victoria's *Advanced Metering Infrastructure Program*.

State-level support for smart meters in Victoria similarly has origins in the early 2000s. The Victorian Essential Services Commission published a ruling in 2004 supporting the mandatory rollout of new manually-read interval metering technology under the promise of increasing retail competition and achieving better economies of scale in the purchasing and rollout of meters. In 2005 the Victorian State Government commissioned a cost-benefit study for deploying advanced metering with two-way communications capabilities (CRA and Impaq Consulting, 2005). In 2006 the Government expanded the ESC ruling to approve the rollout of smart meters and in 2007 a technology pilot was conducted by the Victorian Government.

The Victorian *Advanced Metering Infrastructure Program* was implemented between 2009 and 2013 during which time 2.8 million meters were installed covering 93% of households and small businesses. Smart meters were installed by distribution businesses with customers charged upfront AUD760 for the meter (Victorian Auditor General's Office, 2015). The rollout caused a consumer backlash (Lovell, 2017a; Victorian Auditor General's Office, 2015). The state government mandated meter functionalities so that all customers received the same provision of services. Consumers were therefore not given a choice of metering providers, costs or timing nor in the entity collecting and managing their consumption data. Meters were installed on premises and cost recovery occurred via their retail bill. On the other hand, bundled meter and data services meant there were no perverse incentives to install multiple meters on premises, consumers were not expected to navigate complex meter functionality and price choices, and (in theory at least) there were savings from the economies-of-scale achieved by a single rollout (Chandrashekeran et al., 2018).

Two reports from Victoria's Auditor-General (in 2009 and 2015) were highly critical of the overall governance of the *Advanced Metering Infrastructure Program* and the poor delivery of promised benefits (particularly to consumers). In-home tools to access user-friendly information about electricity use are still not widely taken up, which has led to a failure to drive expected innovation and behaviour change. Time of use pricing, while technologically-enabled through the smart meter deployment, has proven politically highly-contentious based on concerns about inequitable impacts particularly for low-income and vulnerable households. The rollout lacked a comprehensive communications campaign to encourage consumers to capitalise on the benefits of their meters.

Nevertheless, Victoria now has near-universal provision of advanced metering infrastructure with sophisticated metering functionality, and work is continuing to deliver new initiatives to realise the value of the AMI Program, for example via the Victorian Government's investment in the Centre for New Technologies (C4NET) and the independent Victorian energy prices comparison website (Victoria Energy Compare).

Case Study 2: Australia's national electricity market: contestable retailer-led deployment

Declining electricity consumption and the public backlash of Victoria's mandated distributor-led smart meter rollout shifted regulatory sentiment from the early 2010s towards more market-oriented policies. Consumer choice within the electricity sector became the dominant framing for smart metering. Some parts of the industry and government began to support a new model where retailers, rather than distributors, would have responsibility for metering services and functions would be minimalist (Chandrashekeran et al., 2018). The experiences in Victoria were crucially important in shaping the design of the second case study – the NEM rollout.

A second, different approach to the introduction of smart meters in Australia has been adopted across the rest of the NEM[2] Following an extensive electricity market review in 2012, the *Power of Choice* review, responsibility for supplying customers with meters has been shifted to retailers. Between 2012 and 2018, the AEMC and others have pursued a package of new rules and reviews to implement the recommendations of the *Power of Choice* report.

The AEMC introduced *Competition in Metering* reforms as part of this package. The subsequent NEM rollout, which commenced on 1 December 2017, is designed to provide incentives for competition in metering services and ultimately aid innovation in energy services. All new and replacement meters within the NEM will now have to be 'smart meters' (AEMC, 2012). Responsibility for metering services has been shifted from distributors to retailers, who will be able to offer smart meters to customers of their choice. Customers can also request smart meters from their retailers.

Metering services have been unbundled into three new contestable roles: metering coordinator, metering provider and metering data provider. The new metering coordinator is responsible for metering services, including installation of meter infrastructure, and crucially, management and security of metering data (AEMC, 2015). The metering coordinator will generally be appointed by the retailer, who will negotiate fees to provide the meter and access the meter data. The metering coordinator appoints a metering provider to install, operate and maintain the meter as well as a metering data provider to collect, process

[2] The NEM governs electricity provision across the eastern and southern states of Queensland, New South Wales, Victoria, the Australian Capital Territory, Tasmania and South Australia.

and store metering data. All three roles can be provided for by a single entity or by several entities, but they all require separate accreditation and registration with AEMO (AEMC, 2015). In contrast to the Victorian rollout, under the national rollout arrangements, the retailer becomes the primary point of contact for the vast majority of customers seeking metering services. Consumers are still able to change retailers, although this creates potential problems around cost recovery.

The AEMC has set a minimum threshold of smart meter functionality for the national rollout, which is lower than the Victorian program. The AEMC has mandated six minimum services that all meters must support; these minimum services are different to those specified in the Victorian rollout. Analysis by Chandrashekeran et al (2018) shows a demonstrated lack of consumer benefits for a number of reasons: the minimum six services are predominantly focused on delivering retailer benefits including reducing retailers' operational costs; retailer incentives may conflict with primary consumer benefit ; at this stage, there is no guarantee of consumer benefits, e.g. easy access to billing data; distributor access to meter services offering consumer and societal benefits has also not been guaranteed.

The AEMC has argued that additional functionalities may be offered by retailers at a higher cost to consumers who will be willing to negotiate and pay for higher functionality where they see value in doing so. They argue consumers may also choose to engage with third-party providers for value-added energy products and services if the meter supports these. Compared to the state-wide distributor-led rollout in Victoria, which was able to claim economies of scale, the national retailer-led rollout is slower and has higher per meter installation costs. It is as yet unclear how these higher costs are being passed on to consumers. The lack of scale will also delay universal deployment of smart meters with some estimates suggesting the full transition to smart meters could take over 30 years (Chandrashekeran et al., 2018).

Case Study 3: Germany's energy transition: staggered distributor-led deployment

Germany also has experience with smart meters and, similar to Australia, it has initially prioritised advanced metering for large consumers and for generators as well as for new buildings. For all other consumers, smart meters were to be introduced once 'technically possible' and 'economically justifiable'. [3]

Germany is now committed to a gradual smart meter rollout to all consumers, subject to a cost-benefit analysis embedded in legislation (Godden and Kallies, 2018). The smart meter rollout in Germany is driven by European Union-level legislation. The EU directive *2009/72/EC on common rules for an internal European electricity market* sets expectations for all EU member states to install Smart Meters for at least 80% of consumers by 2020, if an economic cost-benefit-analysis is assessed positively (Godden and Kallies, 2018 at Annex I). The German government commissioned consultancy Ernst & Young to

[3] S 21 b of the Energy Industry Act 2011 (repealed).

undertake a comprehensive cost-benefit analysis in 2013. The analysis ultimately concluded that for the majority of households the potential energy savings would not outweigh the costs of installing smart meters. Instead, Germany committed to a staggered rollout that connected expected benefits with the costs of the installation and operation of the smart meter system.

Germany has introduced a *Smart Metering Act* (2016) (*Messstellenbetriebsgesetz*) that integrated existing and new metering requirements. The Act is implementing the metering requirements of the EU and lays the groundwork for a new phase in *Energiewende*, the country's energy transition plan (Moss and Gailing, 2016). The digitalisation of the energy transition aims to support better integration of intermittent renewable resources into the electricity market, but also anticipates opportunities for more targeted tariff offers and smart home applications (Federal Ministry for Economic Affairs and Energy, 2015). Ultimately, the legislator anticipates that the introduction of smart meters will lead to a reduction in energy use. The so called 'intelligent metering systems' ('intelligente Messsysteme') includes a modern meter collecting consumption data in real time as well as a smart-meter-gateway, which connects the meter to a communication system.

Like in Australia, metering is traditionally part of the distributor's role. The German rollout creates two new roles – that of the metering operator and that of the smart meter gateway administrator. While distribution network operators remain 'grundzuständig' (responsible in principle) for the operation and management of meters, they have to ensure the administrative unbundling of this function to allow future contestability.

The smart meter deployment to households is being implemented in a staggered fashion, with a mandated rollout to all consumers subject to electricity usage thresholds, maximum costs and particular technical capabilities for metering infrastructure being achieved. Germany's Smart Metering Act distinguishes between rollouts that are mandated, optional (for the operator, not the consumer)[4] and voluntary (negotiated between consumer and metering operator). Crucially, for both mandated and optional rollouts – the legislator provides that the annual costs of installation and management of the meter has to remain under particular thresholds.

A mandated rollout for consumers is currently only in place for those consumers with an annual electricity use over 10000 kWh (from 2017) and 6000 kWh (from 2020), as well as those that also generate renewable energy (for example with solar rooftop) or have a heat pump installed.[5] An average German family uses 3500-4000kWh annually (Ernst & Young, 2013, 20), which means that the vast majority of households are not yet included in the mandated rollout. These households may receive smart meters if the metering

[4] Optional smart meter deployment does not mean that the consumer has an option, but that the metering operator can decide to install a smart meter, even if not mandated. The consumer cannot refuse meter installation.

[5] Note that not all rooftop solar system will require installation of a smart meter, but only those systems with a capacity of over 7kW, see *Smart Metering Act 2016* (Germany) s29 (1) No2. Optional installment is possible for systems between 1-7kW, see *Smart Metering Act 2016* (Germany) s29 (2) No2.

operator chooses so, and if the operator is able to keep annual metering charges under a designated amount per year with costs determined by annual electricity use (Godden and Kallies, 2018:15-17). If the consumer chooses to get a smart meter installed, annual meter charges will be negotiated with the metering operator.

The rollout is currently delayed. This is partly due to cost thresholds, but also because smart meters and their communication systems have to be certified according to strict safety standards set by the Federal Office for Information Security. Only when three independent providers offer sufficiently certified systems in the market will there be a comprehensive mandated rollout. As of May 2019, only one provider has achieved the necessary certification.

Preliminary scoping of key issues: deployment models and consumer benefits

How smart meters are deployed in the different case studies has important implications for how expected consumer benefits emerge. Regulatory choices for rollout models create new roles, new institutional arrangements, and new requirements for consumer behaviour and engagement in the market. *Which* smart meters are installed similarly matters for the range of benefits accruing to customers, both directly and indirectly. Technical specifications shape the functions that smart meters offer and, when combined with unit and installation costs, create different incentives for customers, retailers or distributers to invest in advanced metering infrastructure and services. This discussion highlights three key issues arising from the deployment models selected and the realisation of benefits for electricity consumers. While not comprehensive, these are important areas warranting future research as smart meter rollouts progress in Germany, Australia and elsewhere. These include the **changing expectations on consumers**, the **use of cost-benefit analyses to justify deployment** and the **difficulty of ensuring the fair distribution** of burdens and benefits associated with smart meter introductions across the energy value chain.

Key issue 1: changing the consumer role in energy

Historically, responsibilities for metering services[6] have resided with distribution businesses under the logic that metering is a fixed part of the electricity network. In Australia and Germany, metering costs and assets were thus regulated and part of the distribution costs of a consumer bill. However, following a pervasive liberalising trend in the electricity market and the 'unbundling' of electricity services, responsibilities for smart meter installation, maintenance and data collection are now shifting. In contrast to the old interval meters, however, smart meters can be seen to sit at the interface of distribution and retail. Innovation at the so called 'distribution edge' is a feature of transition efforts around the world (eg, Paddock and San Martano,

[6] Services associated with metering include the installation and maintenance of the infrastructure, reading of the meters, storage and reconciliation of the consumption data.

2018). Smart metering is part of and facilitator of many of these innovations. Gui and MacGill (2019) show that only a minority of consumers is equipped to make rational investment decisions in this new and challenging area.

All three case studies delineate responsibilities for smart meter deployment, operation and data management in a different way. In Victoria, these responsibilities continue to sit with the distributor, whereas the rest of Australia has seen a shift to retailers. In Germany, metering installation remains the responsibility of the distributor while metering operations can be transferred to third parties. The ease and clarity of potential interaction between the different entities involved – retailers, distributors and (potentially) metering operators – and the consumer, can become a central issue in smart meter deployment. Denying consumers the right to refuse a smart meter installation, which both the Victorian and German case studies share, seems to carry a risk of generating opposition to mandatory deployment. On the other hand, expecting consumers to actively engage with a metering upgrade seems to misunderstand its lack of appeal as a commodity purchase. Experience with the Victorian smart meter rollout shows that consumers are slow to engage with the capabilities of smart meters. Introducing competitive metering services alone will not lead to better outcomes – consumer education will be key to realising benefits (Victorian Auditor General's Office, 2015).

Overall, smart meters are part of a general shift in the role of the consumer in the energy sector. Whereas consumers were previously considered passive participants in the sector, with transitions to 'smart' energy consumers are envisioned as pro-active, often also producing renewable energy (prosumers). Further research will show whether these expectations can be achieved.

Key issue 2: the influence of cost-benefit analyses

All three case studies raise issues of how the promise of consumer benefits requires certain preconditions, and for a consumer perspective to be a primary, not secondary, focus of policies. Cost-benefits analyses were a feature in the history of both Victorian and German smart meter rollouts. The case studies show that cost-benefit analyses can be used selectively to marginalise or highlight consumer benefits. Cost-benefit analyses are a key decision-making tool, providing a threshold for technology deployment.

The national Australian cost-benefit analysis undertaken in 2007, which informed early Australian smart meter pilot projects, found that consumer benefits were highest with a distributor-led model with the majority of benefits coming from avoided meter costs and business efficiency benefits e.g. avoided meter reading costs (NERA, 2008). Benefits from a retailer-led rollout were projected to be much lower. For consumers specifically, expected benefits derived from lower bills, which hinged on the uptake and implementation of new tariff offerings – offerings that we are yet to see widely in retail and that are only emerging in the network pricing. Consumer benefits also varied based on consumption patterns and flexibility. Most importantly, consumer risk was identified particularly due to the increased ease of disconnecting customers in distress.

Ultimately, Victoria relied on a separate cost-benefit analysis that produced a more positive result in support of the rollout. This was later found by the Auditor-General to have grossly underestimated implementation risks and over-estimated potential benefits (Victorian Auditor General's Office, 2009, 2015).

By contrast, in Germany, a less optimistic cost-benefit analysis has constrained the rollout at the household scale. The German legislator has used the report to calculate the potential benefits that a smart meter installation can provide to a single household and set cost ceilings that reflect this differential. Additional systems-level savings through avoidance of network and generation investment are foreshadowed in the underlying cost-benefit analysis. Unlike the Victorian and German rollout, the NEM rollout was not based on a cost-benefit analysis. This aligns with the underlying premise of consumer empowerment – in other words, the market will work out when the benefits of a smart meter installation outweigh the costs.

Overall, the case studies show that the way potential benefits of smart meters are framed influences how they are measured and evaluated; and ultimately the manner in which the balance between prospective benefits and costs of the technology are conceived in policy decisions. Future rollouts should be aware of the impact that such implicit assumptions can have on the forecast cost and benefits of smart meter deployment. There is a potential to link research on smart meter rollout experiences to the substantive literature on the use and critique of cost-benefit analyses as a public policy tool that has become entrenched in industrial economies as a means to assess environmental policy (Livermore, Glusman and Moyan 2013, 2). The comparative analysis of smart meter deployment in Australia and Germany similarly has ramifications for research on policy transfer and policy learnings (Dunlop et. al. 2018): as vital aspects of any effective energy transition.

Key issue 3: ensuring benefit flows

The different foci of cost-benefit analyses and their very different recommendations illustrate the challenge of distinguishing between, and valuing differentially, collective or system level benefits versus those that accrue to individual households based on their patterns of behavior and choices. This points to a further key issue – that the costs and benefits of the smart meter rollout may be disaggregated and occur in different parts of the value chain - and not necessarily to the same market participants. For Victoria it has been identified that the smart meter rollout has primarily benefitted distributors and retailers, whereas only a relatively small proportion of consumers realised benefits such as energy cost reductions based on information obtained through smart meters (VAG, 2015). In considering the policy rationales for the introduction of smart meters it is important to distinguish between the realisation of individual consumer benefits and collective social benefits such as lowering peak energy demand. Moreover, a simplistic equation of cost and benefit for energy consumers underestimates the systemic inequalities already at play in energy markets.

Accordingly, there is a growing recognition that the electricity market needs to become more consumer-oriented. This means creating opportunities for consumers to make informed choices about the way they use electricity based on their assessment of the value they derive from services. For customers, it is not the meter per se that is attractive – it is the services that metering enables, e.g. real time interface, battery storage etc. Metering can enable greater customer participation in the energy market and control over energy bills by enabling these new products and services that consumers want, such as tariff choices that can lower bills (Chandrashekeran et al., 2018). However, realising these individual benefits will require considerable change in consumer behavior and facilitative regulatory interventions (ACCC 2018; 2019).

Individual benefits, such as lower tariffs, are dependent on consumers' own decisions to change consumption patterns and/or take up new retail offers, such as flexible pricing. This still relies on the actions of a number of industry and government players to create enabling conditions for consumers to make individually beneficial decisions and provide supporting infrastructure e.g. the existence of flexible pricing options (Chandrashekeran et al., 2018:30) and the transparency of information as to those choices (ACCC 2018).

Individual benefits can be traced back to the specific consumer and manifest in measurable outcomes such as the ability to switch energy retailer more quickly and more certainly. Systemic benefits, such as improved network efficiencies, through improved outage response and avoided network augmentation, will only be passed on to consumers if there are mechanisms in place requiring such a flow through. There needs to be a clear mechanism by which benefits to other parties, such as retailers and networks, are translated into consumer benefits. Simply assuming that a retailer benefit will be translated into lower costs for consumers is insufficient. There must be evidence that these savings are being passed on to individual consumers over time (Chandrashekeran et al., 2018:31).

The German and Victorian rollouts share a focus on the system and industry promises, rather than the consumer empowerment promise. The NEM-rollout, on the other hand, emphasised consumer choice. The main argument for a retailer-led rollout seems to be that the installation of smart meters benefits consumers by lowering costs for both electricity retailers and electricity distributors. It is assumed that retailers' efficiency gains will be passed on to consumers through lower electricity costs. This, in turn, assumes that competition is functioning effectively in the retail market; an assumption not supported by recent analyses by the national consumer watchdog (ACCC, 2018).

Social or collective benefits cannot be so easily individualised and are hard to quantify. These may include promoting system security and reliability, and facilitating a transition towards a more decentralised low-carbon grid. These benefits tend to require a critical mass of meters to be installed before they can be realised (e.g. improved management of the network). Scale efficiencies that enable coverage across geographic area are important elements in the realisation of these benefits (Chandrashekeran et al., 2018:31).

4. Australian and German consumer access regimes: potential risks

One of the central constraints to be recognised is that the rollout of smart meters does not ensure customers can access their energy data on a regular basis. That facility requires the creation of consumer data access regimes. In this section we consider the consumer risks surrounding emerging data access regimes and the need for improved data protection frameworks.

Consumer data protection frameworks are ongoing areas of concern for both regulators and consumer groups, as well as for individual citizen-consumers (Bruening, 2015; Cunningham, 2017; Diaz, 2013; Gellert, 2015; Harvey, 2013; Hoenkamp, 2011; King and Jessen, 2014; McLean, 2015; Quinn, 2010; Schwartz, 2003). Until recently, energy data collected from a standard accumulation or interval meter would reveal little about a consumer's life. This has changed with the capabilities of smart meters, which can provide a fine-grained picture of a household's daily activities (Balough, 2011; Gellert, 2015; Papakonstantinou and Kloza, 2015). Energy data is now a valuable commodity (Productivity Commission, 2017; Schwartz, 2003).

Access to smart meter data by consumers and third parties is central to achieving the 'promises' of meter deployment. Yet, this access comes with a range of risks. Any smart meter regulatory regime will require the protection of consumer privacy and consumer data. This encompasses limits on data sharing, disclosure of privacy practices, the ability to opt out and data security requirements (Forbush, 2011, Véliz & Grunewald, 2018).

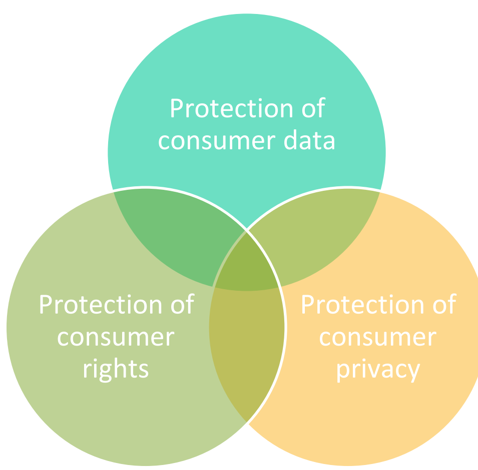

Figure 3. Three inter-related dimensions of smart meter consumer protection

Broadly speaking, there are three inter-related regulatory frameworks that are applicable to smart meter data and consumer protection (Figure 3): *protection of consumer data,* which governs who has the right to access consumer data, how consumer consent can be provided, and who is liable for data breaches; *protection of consumer privacy*, which defines privacy in this context and establishes how privacy is protected and by whom; and the more general *protection of consumer rights* in relation to the purchasing of products and services.

Case studies 1&2: Australia's data access and consumer protection regime

In Australia, electricity consumer protection arises from multi-level regulatory arrangements (Eisen, 2013; Godden and Kallies, 2018; Harvey, 2013; King and Jessen, 2014). General protection regimes include privacy legislation at state and federal levels and consumer protection laws, including Privacy Principles. These Principles provide rules for collection, use and disclosure, data quality and security, and access to data. In particular, they set out that 'secondary use' of data beyond its initial purpose requires consumer consent. Beyond these general rules, Australia has a specialised regime of data access and protection in the NEM regulatory framework. Australia is also focussing on providing sector specific data access regimes that seek to give consumers 'more access to and control over their data' (ACCC 2019, 8).

The National Electricity Rules together with electricity sector licence conditions contain an energy sector-specific data access regime. The Rules provide that a range of market participants such as distribution network operators, the electricity market operator (AEMO) and retailers have access to consumer electricity data. These entities only have access 'for a purpose that is permitted under the Rules'.[7] Consumer consent is not required for these entities to access smart meter data, as they need the metering data to fulfil their functions of managing network congestion, settling bills and operating the system. Additionally, the rules provide that consumers, or a third-party service provider acting on their behalf and with their consent, can access smart meter data.

The access regime has been considered to not deliver sufficient consumer benefits. Two high profile reports published in 2017, the *Finkel Review* and a review by the Productivity Commission on *Data Availability and Use*, found considerable barriers for consumers to access and use their electricity data (Finkel et al., 2017; Productivity Commission, 2017).

A new Consumer Data Right, specifically addressing the emergence and risks of big data across the banking, energy and telecommunications sectors, is currently under development (Australian Government Treasury, 2018). Framework legislation is at bill stage, with sector specific regimes, including electricity, to be developed subsequently. For electricity, there are plans to create a platform of raw energy use data that third parties can access subject to accreditation processes and consumer consent. The Australian Competition & Consumer Commission has consulted on different data access models to enable safe

[7] NER, Rule 7.15.4

energy data sharing between consumers, data holders and potential third parties seeking access to provide services. However, clear parameters for data collection, access, storage and deletion and consumer consent are to be developed 'at a later stage' (ACCC 2019:24). There are questions about how this landscape of complex small transactions will be effectively regulated. The ACCC is flagging the risk of pooling sensitive data, which may be exacerbated if the data sharing model provides for centralised consumer energy data storage and single point of failure.

While still at a draft stage, the Consumer Data Right legislation has created Privacy Safeguards, which will be more onerous than the general Australian Privacy Principles. Beyond these safeguards, electricity sector-specific privacy safeguards may be designed. Beyond the Consumer Data Right, there are currently several processes underway that may impact the future governance of consumer energy data in Australia. These include plans for a new Data Sharing and Release Bill addressing data held by government as well as an enquiry around digital platforms undertaken by the ACCC. The interactions between these existing and emergent regimes are unclear and potentially confusing to consumers (see also CPRC, 2019), and will need to be carefully assessed as they mature.

Case study 3: Germany's data access and consumer protection regime

Similar to Australia, in Germany data access and privacy protection is provided for through sector-specific and more general data protection legislation. Unlike in Australia, however, German electricity data protection and privacy are regulated at a federal level. Additionally, European Union law has been a crucial driver for both energy and privacy legal reforms. There is an implied constitutional right for informational self-determination,[8] which drives strong data privacy protections in Germany.

The German access rules for smart meter data are similar to Australian laws and regulations. The *Smart Metering Act 2016* provides that certain entities such as the distribution network operators, metering coordinators and retailers have access to smart meter data. Beyond this defined range of participants, the consumer can provide consent to allow other parties to access. Consent is defined in the *Federal Data Protection Act 2018* and has to be requested in an intelligible and easily accessible form, using clear and plain language. Whether consent has been given appropriately will be assessed in each individual case.

The *Smart Metering Act* has been described by the German government to provide 'privacy by design' (Federal Ministry for Economic Affairs and Energy, 2015). Design elements of the Act include technical prescriptions for data transmission and handling, general encryption of all data, de-personalisation as far as possible, and strict certification requirements for meter operators. Beyond this, the *Federal Data Protection Act* applies as well as the European Union's General Data Protection Regulation (GDPR),

[8] Recht zu Informationellen Selbstbestimmung, derived from Articles 2 and 1 of the German Basic Law.

where the *Data Protection Act* has not provided an otherwise more specific provision. The GDPR applies to companies and organisations that process the personal data of EU residents or that have an establishment in the EU, or offer goods and services in the EU (Art 3 GDPR). It prescribes a data protection regime, including express rights to delete data in particular circumstances and including requirements about what constitutes prior and informed consent.

A range of issues have been raised in regard to the German protection regime. There is doubt as to whether the German government has overreached its ability to adapt the requirements of the GDPR to national law. The specific protection regime in the *Smart Metering Act* and its strict requirements have so far not been achieved, thereby delaying the smart meter rollout (Deloitte, 2018). On the other hand, some commentators are concerned that it is unclear how the privacy of all household members can be sufficiently protected.[9] A recent report on the state of the digitalisation of the energy transition finds that data protection and security are important to consumers (FMEAE 2018:63). The danger of data misuse is the main reason consumers refuse the installation of smart meters. The report concedes that while the majority of households support the rollout of smart meters, the actual acceptance of the digitalisation of the energy transition will be apparent only when practical experiences with rollouts have been gathered.

Preliminary scoping of key issues: data access and consumer protection

Evidence indicates that consumers want control over how their data is collected and shared, yet they feel powerless when it comes to big data (Consumer Policy Research Centre 2018). Data sharing navigates a difficult balancing act with, on the one hand, high potential for consumer empowerment and a range of individual and societal benefits, and on the other hand, the need to protect consumers from data abuse.

For energy data in particular, a major difficulty lies in its ‘abstract and invisible’ nature (Véliz & Grunewald 2018:702), making it difficult for consumers to fully comprehend the potential privacy impact of energy data collection and sharing. It is crucial that we develop a universal regulatory framework for access to energy data that is simple and safe for all consumers. Research in this, and other areas of big data use, is in its infancy. This study can draw on some early insights of the consumer experience in Victoria’s roll out, but ultimately, research informed by practical experience is required to assess how well protection frameworks work. Key areas of regulatory concern that have been addressed in different forms in all three case studies and raised by literature are highlighted here.

[9] see for example V Lüdemann, M Ortmann, and P Pokrant, ‘Datenschutz beim Smart Metering— Das geplante Messstellenbetriebsgesetz (MsbG) auf dem Prüfstand’ (2016) 3/ 2016 Recht der Datenverarbeitung 125.

Key issue 1: informed consent

As noted, many potential smart meter benefits rely on consumers actively accessing their energy data or providing access to third parties providing services. How consumers can give informed consent to share their energy data remains an elusive question. Australia's Consumer Data Right discussion recognises this problem but has not yet fully developed what genuine informed consent means in this context. The European Union's General Data Protection Regulation requires that consumer consent is explicit, confined to a specific purpose, easy to understand, freely given, and easily withdrawn. Pre-ticked consent boxes are not permitted under these rules. Similar rules have been developed by the ACCC for the Consumer Data Right (ACCC, CDR rules outline 2019. 7.10). Future research should test consumers' comprehension and their effective capacity to consent to sharing very abstract and technical data.

Key issue 2: pooling data and combining datasets

Access regimes as outlined in the case studies show that a range of actors already have access to consumer energy data in order to settle bills, manage networks or operate the energy system. Beyond those entities, additional access for third parties acting on behalf of consumers plays an increasingly important role.

Due to unbundling, regulators are faced with an increasing number of actors having access to increasingly fine-grained and sophisticated datasets. Data pooling in a platform or combining datasets across sectors generate new risks of unauthorised data access or abuse. This has the potential to be particularly negative for vulnerable consumers. We need to ensure that open access does not increase risks for vulnerable groups. The concern is that valuable datasets can be combined, such as credit ratings (banking), spatial location (telecommunications), and household activity (energy). There are numerous implications of this, not least of which is charging vulnerable consumers deemed 'less desirable' higher prices and limiting the products and services on offer.

The three case studies focus on the danger of unauthorised access to data, with Germany highlighting data security and the ACCC considering how to minimise single points of access to data sets. Ensuring the fair and equitable use of energy data, however, is not yet a focus of discussion. Careful monitoring of smart meter rollouts will be required to ensure data availability does not unduly disadvantage vulnerable consumers.

Key issue 3: equitable access and consumer education

Finally, the way in which data is provided to consumers or service providers on their behalf needs to be in a readily accessible, comparable and readable format (Chandrashekeran et al., 2018). It is not enough that consumer access rights exist; consumers must be actively encouraged to use them (Chandrashekeran 2018). This involves a wide-ranging, effective and ongoing consumer education campaign. While there are highly active energy "prosumers" who generate and sell their own power and actively monitor and manage their energy use, most households do not fall into this category. Most customers need information and encouragement to take up opportunities arising out of smart meter data. This will require better communication by governments, retailers, networks, consumers and community organisations as an integral part of the smart meter rollout. Even with the help of the tools and campaigns described above, there are those who may still miss out on the benefits – such as, for example, vulnerable consumers who engage with smart meters but end up making poor choices through a lack of financial or digital literacy (Chandrashekeran 2018). This poses questions of the best way in which all consumers can be empowered to benefit from smart meter introductions.

5. Summary of key issues

Table 1 presents a summary of common consumer benefit promises of smart meter deployments, and list key issues with securing these benefits. The table can provide a useful reminder to decision-makers and regulators and serve as a future research agenda.

Table 1. Summary of key issues

Smart meter promise	**Potential consumer benefits**	**Key issues for securing these benefits**
Better information	Access to more detailed and timely data about what you use and when plus associated costs More accurate billing Easier for consumers to shop around for retail offers that better suit lifestyle and budget	Meaningful data access requires a common and easily comparable format which is not yet guaranteed. Consumers must be engaged with the electricity market to secure benefits of additional information, yet engagement on energy is notoriously low, disadvantaging less-engaged customers. Higher resolution data, unbundled metering services and remote communications generate new data privacy risks that must be managed.
Lower costs	Network charges that better reflect the cost of supplying electricity at the time you use it Cost reflective tariffs likely to lower bills for majority of consumers, including low-income or hardship customers, as they provide greater rewards for reducing peak demand Lower future network costs as a result of reductions in peak demand, which are passed on to all consumers	Cost savings for distributors and retailers would need to be passed on to customers, which is difficult to monitor. Cost reflective pricing would need some level of regulation to protect customers and energy usage not easily displaced to off-peak periods. The potential for split costs and benefits of smart meter installation, or the costs of accelerated meter turnover, means consumers may be worse off. By contrast, paying for more expensive meters without commensurate benefits may leave consumers worse off. Cost savings may be closely tied to the ability to access and use energy data, which may disproportionately advantage retailers or more engaged customers.
Better network service	Potential for quicker and lower cost response to power interruptions	How can social/collective benefits from more efficient network management be realised?

Smart meter promise	**Potential consumer benefits**	**Key issues for securing these benefits**
	Potential for lower network costs flowing from more efficient operation of, and investment in, poles and wires	Cost savings for distributors and retailers would need to be passed on to customers, which is difficult to monitor.
Better retail service	Retailers will be able to offer more innovative pricing, service and product options Faster process to switch retailers Potential bill savings due to remote meter reads and more efficient retail services More flexibility for people who want more frequent bills	Can retail offers be meaningfully compared? Are these services available in a distributor led rollout?

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