Storage Business Models: Lessons for Electricity from Cloud Data, Frozen Food and Natural Gas

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ABSTRACT

The aim of this paper is to evaluate different well-established non-electric storage markets (cloud data, frozen food and natural gas) in order to identify relevant lessons for electrical energy storage (EES) connected to electricity distribution networks. The case studies that have been evaluated are Google Drive (cloud storage), Oakland International (frozen food storage) and Centrica Storage (gas storage). A specific business model methodology has been selected for comparing the different business model components across these sectors. The methodology (following Johnson et al., 2008) refers to key interconnected components: customer value proposition, the revenue formula, key resources and key processes. The evaluation of the three case studies suggests that well-developed business models already exist in growing and mature storage markets. Regulation plays also an important role across the different storage markets and business model components, however its importance varies depending on the type of market. Innovation in storage business models is also observed (technological and contractual) which should also be facilitated in EES. Innovation helps move storage markets towards more sustainable business models.

Keywords: Electrical energy storage, Gas storage, Frozen food storage, Cloud storage

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1. INTRODUCTION

Electrical energy storage (EES), along with interconnection and flexibility in demand, is among the innovations that can support the transition to a non-fossil fuel energy system based on renewables. In the UK, the 'Smart Power Revolution' facilitated by these innovations has been estimated to save customers up to £8 billion a year by 2030 (NIC, 2016). Driven by the climate change targets set by the European Commission (40% and 80-95% cut in GHG by 2030 and 2050 respectively, compared to 1990 levels) and its individual member states, it is expected that intermittent generation such as wind and solar will increase substantially in the EU. EES storage can help to balance supply and demand, integrate less controllable power sources and decarbonise the energy market (and hence other sectors). The quick implementation of EES (in months rather than years for conventional generation and network investments) and the cost reduction of storage technologies will also contribute to its expansion. Between 2010 and 2016, electric vehicle (EV) battery pack prices have fallen around 80%, from US$ 1,000/kWh to US$ 227/kWh, with prices expected

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to be below US$ 190/kWh by 2020 (McKinsey, 2017). The downward trend has also led to recent announcements of large-scale storage projects, such as those in Australia[1] and Chile.[2]

EES has a multiproduct nature and may offer different revenue streams to those that operate or own the facility. The potential welfare gains from storage can be influenced by the type of ownership arrangement (Sioshansi, 2010; Schill and Kemfert, 2011). Integrated solutions (e.g. storage plus distributed energy resources—DER) help to mitigate the variability of intermittent generation (Mount et al., 2012), can enhance the reliability of distribution and transmission networks (Mountain and Carstairs, 2018) and may represent a potential game changer in places with high household PV penetration (Macgill and Smith, 2017). In general, the size of the revenue streams depends on different factors such as the place where the facility is located (at a generator, on the transmission or distribution system or at the end-customer), the type of service provided (ancillary services, investment deferral, arbitrage), the type of arrangement (individual storage units or integrated solutions with DER), the storage technology (which determines the type of service to be provided under different technical specifications), the market and regulatory context (which may or not encourage its deployment) etc. Even though there are powerful forces promoting EES, there are some barriers that may prevent its full deployment. Among these are regulatory barriers (around the classification of EES, the charging methodology, connection rules, ownership and unbundling rules and regulatory revenue compensation), market barriers (EES and related products as new market participants in existing wholesale and ancillary services markets, EES services provided across multiple classifications) and technological barriers (high capital costs, few technologies at the commercialisation level, lack of modelling capabilities, lack of smart technologies for real time dispatch) (see Sioshansi et al., 2012; Bhatnagar et al., 2013; Anaya and Pollitt, 2015; IRENA, 2015; BEIS and OFGEM, 2016; Pollitt and Ruz, 2016; Sidhu et al., 2018).

The implementation of well-designed regulatory frameworks and established business models for EES is still a work in progress. The lack of a defined asset class for EES and the failure to properly value its unique attributes, characteristics and benefits represent a barrier to its participation in organised wholesale electricity markets (FERC, 2016, p.24). The European Commission is working on a proposal to define energy storage and related rules regarding its ownership. However, its asset classification (as generation or consumption) along with the issue of double charging (as a generator and as a load), has not been addressed yet (EC, 2017). In Great Britain, the Office of Gas and Electricity Markets (OFGEM) is also evaluating specific changes to the current residual and balancing services use of system (BSUoS) charging methodology for storage (OFGEM, 2017a) and changes to the current electricity distribution licence related to storage ownership (OFGEM, 2017c). Based on this, new proposals (driven by industry) have emerged for changing the current method for charging storage for using the system.[3] In the USA, there are initiatives that aim to reduce barriers to the integration of electricity storage resources (and its participation in the wholesale market) and to set a more appropriate cost recovery mechanism, FERC (2017). At the state level, there are also different initiatives that are being promoted such as California's Energy Storage and Distributed Energy Resources (ESDER, phase 1 and 2) (CAISO, 2016, 2017).

The aim of this study is to explore well-established non-electric storage markets such as natural gas, cloud data and frozen food storage to identify some key lessons applicable to EES

1. See: http://reneweconomy.com.au/sa-100mw-battery-storage-tender-won-by-tesla-and-neoen-65874/
2. See: http://www.power-eng.com/articles/2017/03/solarreserve-to-build-450-mw-solar-facility-with-storage-in-chile.html
3. See: https://www.nationalgrid.com/uk/electricity/codes/connection-and-use-system-code/modifications/removal-bsuos-charges-energy

operated by electricity distribution companies.[4] The selection of the non-electric storage markets covered in this paper has been made to illustrate alternative storage markets with respect to degree of maturity (different stage of their life cycles) and business models, while still being relevant to electricity. After selecting the storage sectors, we looked for company cases which were well documented and/or willing to participate in our research. We decided to select only one case per type of storage market for a better and deeper discussion. Section 2 discusses the life cycle stage of each market and provides additional details about the selection of case studies and EES.

In contrast to the current literature in EES that concentrates on technical aspects and cost benefit analysis (Sioshansi, 2010; Schill and Kemfert, 2011; Shcherbakova et al., 2014; Newbery, 2016; Sidhu et al, 2018), and the identification of EES business models but without looking at other industries (Pollitt and Ruz, 2016; Lombardi and Schwabe, 2017); this study explores the opportunities that EES owners/operators have for capturing the value of storage by (1) identifying properly the job to be done (the storage products offered to customers), (2) the way to monetise them (that defines the value to the storage firm) and (3) the resources needed to make this possible (assets, partnerships, storage capacity allocation mechanisms, among others). A look at different non-electric storage markets provides valuable insights on the way in which the different components of business models are interacting and capturing value for both customers and storage firms. The business models' discussion across the different markets is based on the method proposed by Johnson et al. (2008). The authors identify four interconnected components: the customer value proposition, the revenue formula, key resources and key processes. Further details are given in Section 3.

The rest of this paper is structured as follows. Section two describes the life cycle associated with the three non-electric storage markets and EES. Section three explains the business model methodology. Section four explores the three non-electric storage markets and their respective business model components. Section five compares and analyses the three cases based on the methodology proposed and identifies key lessons for EES. Section six sets out our conclusions.

2. LIFE CYCLE OF EES AND NON-ELECTRIC STORAGE MARKETS

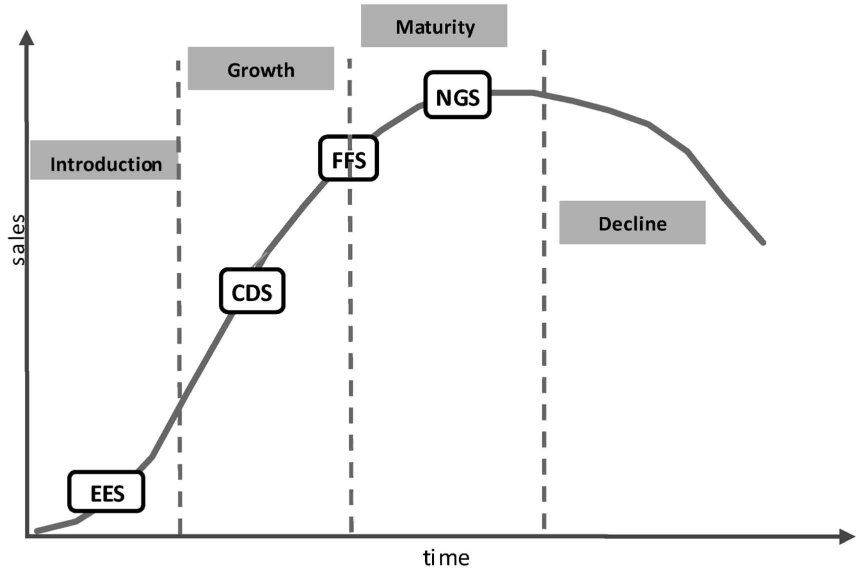
Studies that define the product life cycle (PLC) have their origins in the 1960s (Levitt, 1965; Cox, 1967). The original concept identified four independent stages associated with the PLC (introduction, growth, maturity and decline)[5] and the well-known bell-shaped curve with sales volume (on the y axis) and time (on the x axis). [6] It was developed under the marketing arena first (M-PLC) but its use has been extended to other fields. Different criticisms of the four-stage PLC have also emerged over time. Among them are those related to the sequential framework of the stages, their length and issues with the definition of the product (Dhalla and Yuspeh, 1976). The limited value of the PLC in forecasting (across the four stages) is discussed by Day (1981) and Grantham (1997), while Lambkin and Day (1989) discuss the shortcomings of the PLC model and the need for a more comprehensive approach that includes both demand and supply-side factors in

4. We have focused on EES operated by electricity distribution companies (EES in distribution) because currently this is a less developed type of grid connected storage, with significant potential for expansion.

5. *Introduction* stage refers to the phase where the product is brought to the market, sales are low and growth is low. This is the moment where demand has to be created. *Growth* stage (also called Take-off Stage) represents the phase where the market expands quickly due to an increase on customer demand. *Maturity* stage is the phase when demand levels off and grows for the most part, competition become more intense and more effective. *Decline* stage reflects the moment where demand of the product starts to reduce and sales follow a downward trend (Levitt, 1965).

6. Variations of the initial four-stage proposal involved additional stages such as development/pioneering (before introduction) and saturation (in between maturity and decline).

Figure 1: Life cycle of EES and other non-electric storage markets



Notes: EES: Electrical Energy Storage; CDS: Cloud Data Storage; FFS: Frozen Food Storage; NGS: Natural Gas Storage.
Source: Levitt (1965), adapted.

the process of market evolution. In spite of these criticisms, the concept is still well accepted in the literature of PLC within and beyond the marketing field. In their study of the 115 product life cycle articles (over the period 1950-2009), Cao and Folan (2012) identify 77 articles that discuss the traditional product life cycle model (M-PLC), 37 articles that follow a later product life cycle model (E-PLC)[7] and one that discusses both.

The selection of non-electric markets that are in different stages of their respective life cycles allows us to capture the different operating approaches across their business models' components. Figure 1 depicts the different life cycle stages associated with each of the different non-electric storage case studies and EES.

We have classified EES in distribution as an emerging market (Introduction stage). Even though energy storage has been around for decades (i.e. pumped hydroelectric storage), it is the new EES application that places this market in the introduction stage. The downward trend of battery prices is also triggering the development of this market. EES in distribution is currently being introduced in a few jurisdictions with relevant initiatives linked to trials (e.g. the Smarter Network Storage and Customer-Led Network Revolution projects in Great Britain; the Horizon Power pilot project in Australia). The demand for EES in distribution is being created but as already mentioned in the preceding section there are still some barriers that may limit its move to the growth stage.

We have placed *cloud data storage* in the second stage (growth stage). Demand for cloud data storage (or cloud storage, for short) is being adopted by different types of data users (from individuals to big enterprises) and is increasing due to the upward trend of the amount of data generated, advancing technologies (e.g. artificial intelligence, machine learning)[8] and the development

7. E-PLC (Engineering PLC) refers to emerging PLC theories that go beyond marketing and examine the real and complete life of the product (from product conception to decommissioning).

8. According to IBM the increase in data generated and these two capabilities enable the data " to be quicker collected, processes and analysed…". See: https://www.ibm.com/blogs/cloud-computing/2018/02/23/ibm-storage-cloud-future/

of key capabilities (e.g. software-defined storage)[9] that favour more flexible and scalable data storage solutions. The growth of the internet[10] has also contributed to the deployment of cloud storage which is reflected by the move from the traditional data centers to cloud data centers[11] allowing cost reduction (due to shared resources). However, one of the main concerns is still related to security issues.[12] This study explores data cloud storage associated with Software as a Service (SaaS) which denotes the most basic form of cloud service (or cloud computing) model. Our case study of cloud storage is Google Drive.

This study places *frozen food storage* between the growth and maturity stage. This is a well-established market that will continue expanding due to the high demand for frozen food which accounts for one the biggest sectors in the food industry (Sun, 2012). Some of the drivers of this upward trend are its convenience (i.e. cooking time saving), its lack of seasonal dependency and its preservation of nutrient contents (Li et al., 2017; Berry et al., 2008). Frozen food also helps to reduce food waste which represents a high cost to society (WRAP, 2015). The preference for frozen food is attracting more competitors in refrigerated warehouse capacity. New cold storage additions in emerging economies have driven the increase in cold storage capacity worldwide (IARW, 2014). Freezing has been around for centuries (i.e. ice houses), but technology (in freezing and food processing) and the deployment of cold storage infrastructure (in warehouses, supermarkets, households) have made frozen food more accessible. Even though, there are still some concerns about other food processing technologies (e.g. food irradiation (see Maherani et al., 2016)). In the UK, the frozen food storage market is dominated by third party logistics firms, followed by retailers and producers (BFFF, 2010). The case study that we present from this market is Oakland International, a third-party logistics firm that operates in the UK and Ireland.

Gas storage is in the third stage (maturity stage) with a well-established market containing many competitors (including liquefied natural gas (LNG) imports). Originally natural gas storage units operated as part of vertical-integrated gas firms and later on were owned and controlled by gas pipeline companies especially in the USA (Dahl and Matson, 1998) and also by energy firms that specialised in stored gas (i.e. former BG Storage in the UK). However new rules in the gas market (e.g. FERC Order 636 in the USA,[13] the European Gas Directive,[14] Undertakings in the UK) mandated the use of the storage gas facilities on an open-access basis. The non-discriminatory access has expanded the use of gas storage units (originally limited to backup inventory and seasonal supply sources) in arbitrage and financial instruments and the offering of more flexible services (i.e. virtual gas storage). Currently, natural gas storage plays an important role in (1) security of supply especially in those countries that rely on natural gas such as the USA, the UK and China (IEA, 2018), (2) in customers' bill reduction (by protecting customers from price spikes) and (3) the deferral/

9. Software-defined storage helps to handle the issues with traditional storage systems by separating the storage control operations (software) from the storage devices (hardware), Darabseh et al., 2015.

10. By December 2016 the number of internet users were around 45.8% of the world population while in 2006 this number represented only 17.5% of the total population (World Bank Data, see: https://data.worldbank.org/indicator/IT.NET.USER.ZS?year_high_desc=false

11. By 2021 public cloud data centers will dominate the storage market representing 73% of the total storage capacity in data centers (CISCO, 2018).

12. Based on Cybersecurity Ventures (2016) predictions, cybercrime will grow to US$6 trillion annually (up from US$400 billion annually in early 2015) and global spending in cybersecurity products and services to will be over US$ 1 trillion from 2017 to 2021.

13. See: https://www.ferc.gov/legal/maj-ord-reg/land-docs/restruct.asp

14. See: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0094:0136:EN:PDF

avoidance of network investment (EUA, 2016). By 2040 natural gas could provide a quarter of global energy demand and if so its use will rise by 45% (IEA, 2017).

In spite of the size and significance of natural gas in the global energy system, the gas storage market looks challenging due to a reduction in storage capacity utilisation[15] and a decline in seasonal spreads (EC, 2015) and short term price volatility.[16] Our case study is Centrica Storage, a gas storage firm that operated Rough, which until recently was the largest seasonal storage facility in the UK.

Summing up, the three non-electric storage markets have seen progress in technology and innovation (e.g. internet penetration and key capabilities, freezing technologies and food processing, virtual services for gas storage) and supportive regulation (e.g. frozen food safety standards, data security regulation, open-access rules for gas storage facilities) allowing their respective deployment. Even though EES in distribution is still in the introduction stage, we see progress in the technology and in its regulation. Investment in battery storage technologies are helping to reduce capital costs (i.e. batteries) and different lines of innovation are observed such as its use in distribution, new market participants and new commercial arrangements. Trials that will help to determine the technical and commercial viability of EES in distribution are also observed and are mostly supported by energy regulatory authorities. The regulatory framework for EES operated by electricity distribution companies is still evolving (EC, 2017; OFGEM, 2017c).

3. BUSINESS MODEL METHODOLOGY

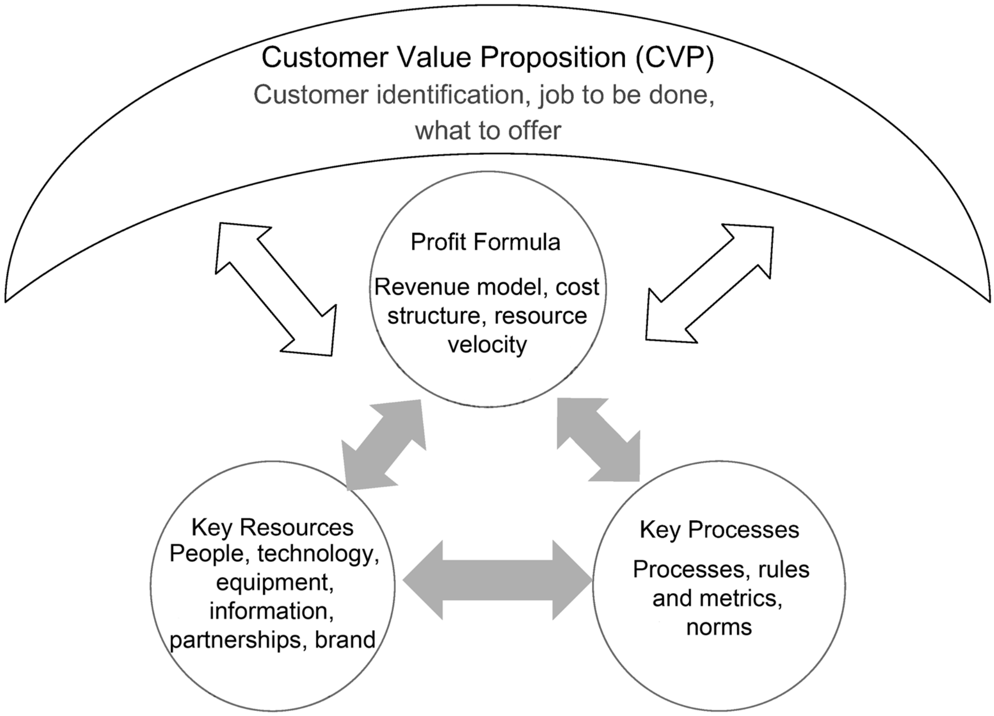
The definition of business models is still a work in progress. Business models have no clear place within economic theory or business studies, rather they are seen as an interdisciplinary topic, and as a conceptual model of a business rather than financial (Teece, 2010). According to Zott et al. (2011), the lack of a clear definition of business models does not mean that there is no convergence of perspectives in the business model literature. Based on an evaluation of 103 business model studies, Zott et al. (2011) find that 37% do not define the concept of business models at all, 44% define business models by identifying key components, and 19% refer to business model definitions proposed by other scholars. A common theme across many studies is that business models are about the delivery of value to customers and firms (Magretta, 2002; Johnson et al., 2008; Teece, 2010; Gassmann et al., 2014; Rayna and Striukova, 2016). This value can be in the form of services or products that fit customers' needs where customers are willing to pay for getting the job done and firms are able to internalise and transform this payment into profits. Our business model methodology is based on Johnson et al. (2008), who identify four interlocking business model elements: the customer value proposition (CVP), the profit formula, key resources and key processes, see Figure 2.

CVP is about creating value with which to target customers that relates to the job to be done, understanding all its dimensions and the solution (offering) provided that fulfils the need. According to Johnson et al. (2008) precision is the most important attribute of a CVP, which reflects how perfectly the business model nails the customer job to be done. The profit formula defines how the companies generate value for themselves while providing value to customers. It takes into consideration the revenue model (pricing, purchase frequency, value added services), cost structure

15. Authors' own estimations from Gas infrastructure Europe (GIE) data base and Natural Gas in Underground Storage from U.S. Energy Information Administration.

16. Authors' own estimations from Henry Hub Natural Gas Spot Price. Data base from U.S. Energy Information Administration.

Figure 2: Business Model Components



Source: Johnson et al. (2008), adapted.

(cost allocation: direct/indirect costs, economies of scale), margin model (related to the desired profit level) and resource velocity (the use of resources over time).

Key resources and processes are needed to deliver the value to customers (CVP) and to the company (profit formula). It is the combination of both (resources/processes) that makes for successful realisation of the potential from the CVP and the profit formula.

4. DISCUSSION OF NON-ELECTRIC STORAGE INDUSTRIES AND CASE STUDIES

The following subsections discuss case studies covering the three different industries.

4.1 Cloud Data Storage: Google Drive Case Study

Customer Value Proposition

Google Drive, a cloud storage service, was released in April 2012 by Google. Google Drive is oriented to end-users only (allowing them to interact with their private storage and content). Google Drive provides cloud storage services for individuals and non-individuals under different plans and price options discussed below. Google Drive can be accessed from different systems such as MAC, iOS, Android. It also supports different kinds of files, including general files (archive, audio, image, text, video), Adobe files and Microsoft files. Google Drive has set specific storage limits that depend on the type of file.[17] Google Drive also offers a set of apps (many of them developed by

17. See: https://support.google.com/drive/answer/37603?hl=en&ref_topic=2375187

third parties) that can be used to create and modify files. Third party applications can be found in four primary marketplaces (Google Apps Marketplace, Chrome Web Store, Google Drive Add-Ons and mobile apps). Google Drive has over 800 million customers, supports more than 150 languages and has more than 2 trillion files stored (as of May 2017).[18] Among the companies that make use of Google Drive are The Weather Company, KAPLAN, HP, Jaguar, and Land Rover.

Profit Formula

Google Drive currently offers free cloud storage for individuals but limited to 15 GB. For additional storage capacity, there are different plans with a starting storage capacity of 100 GB (1.59 GBP/month) up to 30 TB (239.99 GBP/month).[19] Yearly discounted payments are also possible but are limited to two plans: 100 GB and 1 TB. Google Drive offers two plans for non-individuals (Google for Work): Group (best for teams) and Domain (best for companies). In both cases a monthly payment of US$10/user is required with unlimited cloud storage (or 1 TB/user if fewer than 5 users). Based on the selected plan, customers are offered specific features (e.g. data protection, productivity tools, administrative tools, support) which are more comprehensive for the most expensive storage plans. In terms of security Google Drive offers comprehensive data protection services, however some of the services (e.g. encryption, certifications and regulatory compliance programs) are limited to enterprises. Google Drive products are not isolated and usually linked to other products that can be offered by third parties, some of them chargeable. Google benefits due to economies of scale by offering cloud storage with pooled resources (*resource pooling*) that are shared across its different customers. This is also referred to as multi-tenancy.

Key Resources and Processes

This cloud storage service relies on the different data centers that are owned and operated by Google around the world, and that are mainly concentrated in America (9), following by Europe (4) and Asia (2). Sustainability is an important aspect of Google's data center operations. Google committed to reach 100% renewable energy for its global operations, including data centers and offices. Its strategy encompasses the use of long term Power Purchase Agreements (PPA) usually between 10 and 20 years and renewable energy purchases from utilities.[20] Google is the world's largest corporate buyer of renewable power (followed by Amazon, US Department of Defense, Microsoft, Facebook)[21] with 20 signed contracts with a total commitment over 2.6 GW (wind and solar energy) representing more than US$ 3.5 billion in infrastructure investment. In addition, Google's data centers are currently among the most efficient with a trailing twelve month (TTM) Power Usage Effectiveness (PUE)[22] of 1.12 across all its data centers.[23] In terms of data security, different services and products provided by Google (including cloud storage) might also be subject to audits and investigations for reliability and regulatory violations or criminal activity. This means that gov-

18. See: https://www.theverge.com/2017/5/17/15654454/android-reaches-2-billion-monthly-active-users
19. Prices as of July 2018.
20. See: https://environment.google/projects/ppa/
21. As of Nov. 2016. See: https://environment.google/projects/announcement-100/
22. PUE is a metric for measuring infrastructure energy efficiency for data centers. It was developed by The Green Grid Association (GGA, 2012). PUE is defined as follows: $PUE = \frac{Total\ Facility\ Energy}{IT\ Equipment\ Energy}$.
23. See: https://www.google.co.uk/about/datacenters/efficiency/internal/

ernment agencies investigating criminal activity, administrative agencies, courts and others, may request access to user data.

4.2 Frozen Food Storage: Oakland International Case Study

Customer Value Proposition

Oakland International (Oakland) is a multi-temperature supply chain firm that operates in the UK and the Republic of Ireland.[24] As a third party logistic operator (TPL), Oakland provides integrated supply chain solutions for frozen, chilled, ambient and related services that involve storage, tempering, picking, packing and distribution, to both retailers and producers. The company stores and distributes circa 1.2 million cases of food per week (9.6 million individual units), with around 3,500 different products delivered to 50 different destinations. Customers benefit from a "no minimum order" offer, full traceability, quick delivery (1D order, 2D delivery, D: day) and the option of consolidated pallets. The products are stored and distributed to different distribution centers from retailers (including the UK big 4 grocery retailers), discount retailers (e.g. Aldi, Lidl), convenience retailers (e.g. SPAR, Budgens), and others (wholesale, food service). Availability and quality are at the heart of its value customer proposition.

Profit Formula

Suppliers are charged based on the number of cases (including storage and transport) and vary depending on product complexity. The consolidation scheme applied by Oakland allows a supplier to be charged per case (instead of per pallet rate) if it shares space on the pallet with products from other suppliers that go to the same destination. Customers are invoiced weekly based on volumetric pricing regardless of destination but depending on the type of product and retailer. Oakland works closely with network partners that allow the company to provide an end-to-end supply chain solution (from factory/source to customer/retailer). Oakland does not own transport assets for distribution due to the high competition that exists in this market segment in comparison with cold warehouse facilities. The selection of transport partners is not linked to price but to the suitability of the solution. Retailers play an important role in the selection of the most suitable solution (around 40% of the transport services are from retailers). The remaining volume is handled by long-term transport partners. The practice of triangulating logistics allows Oakland to guarantee at least 93% utilisation of its transport fleet, saving small producers up to 90% in supply costs.

Key Resources and Processes

Oakland owns and operates its own and core warehouse with a 34,000 pallet capacity and has expanded to two additional sites (in Great Britain and Ireland). The average storage utilisation is 80% and it is influenced by the season (Christmas is the busiest). The warehouses have been designed with multi-temperature zones to accommodate different types of frozen food storage. These zones are monitored and controlled continually, offering customers the option of stock visibility, automatic report notifications and control of the whole picking process. Frozen food storage and distribution are audited and certified to British Retail Consortium (BRC) standards. Oakland has key

24. It has around 250 workers and a £20 million turnover with a 2025 group growth strategy of circa £180 million turnover (Oakland, 2016).

partnership agreements with transport partners that allow the company to reach around 120 retailers distribution centers (of these 58% belong to traditional retailers, 18% to convenience retailers and 14% to discount retailers). Oakland has fixed routes agreed with each partner for core destinations and anything unusual or infrequent is handled by a variety of small transport companies. Storage and distribution services are subject to short/medium term contracts, usually for less than one year.[25] In terms of food safety, there are regional (i.e. those from the European Commission) and international (i.e. Codex Alimentarius) regulations and standards associated with the processing and handling of frozen foods. Sustainability is also a top aspect for all the participants in the cold supply chain. Oakland has implemented different green initiatives that involve solar power generation (750 KW for reducing peak demand), voltage control, energy efficiency (refrigeration, lighting and heating), waste water treatment, electric car (for local mobility), among others. In terms of performance, Oakland has set a Service Level Agreement with suppliers at 99.5%.

4.3 Natural Gas Storage: Centrica Storage Case Study[26]

Customer Value Proposition

Rough, Centrica's gas storage facility, injected gas in summer and withdraws it in winter and stored gas on behalf of utilities, gas traders and gas producers. The maximum working as volume held in the Rough was 135.6 billion cubic feet which is approximately 41.1 TWh (Centrica, 2017). Rough offered three main products, S Store (physical storage), C Store in the day ahead/within day market and V Store which is the virtual product. In C Store and V Store gas was delivered to the National Balancing Point (NBP) and no entry capacity was required to be purchased at the National Transport System at Easington. A firm and a flat injection was allowed only in V storage gas with no specific requirements regarding maintenance, while in C Store variable injection rights were allowed with specific injection and withdrawal maintenance requirements, among others. Storage was usually commercialised under a bundled unit (known as storage bundled unit—SBU[27]) that comprises three separated activities: injection, storing and delivering. Centrica Storage also offered additional storage services (unbundled capacity where available) such as unbundled space, unbundled injection and withdrawal, and gas in storage. The unused capacity (injection, withdrawal, space) was available through different supplementary interruptible products (interruptible and Use it or Lose it—UIOLI—services) using different mechanisms with a specific ranking of interruption (first in interrupted last). The unused capacity could be traded among users using the online management system, StorIT.

Profit Formula

The offer of a bundled product enables the gas storage firm to ensure a more efficient use of its capacities reducing the chance of underutilisation (Le Fevre, 2013). In contrast to the majority

25. Contractual arrangements differ through the cold chain and are sensitive to supply and demand. According to Nomad Foods, the largest frozen food manufacturer in Western Europe with a market share of 11.7% (FFT, 2016), the selection of cold warehouses is more complex than the selection of refrigerated transport. In the selection of cold warehouses Nomad Food uses tendering for long term contracts (5-15 years). However in the selection of refrigerated transport the length of contract is lower (2-5 years). A combination of both services is also possible.

26. The decision to include Centrica Storage in this study was made before the firm announced the termination of its storage business.

27. Each SBU comprises: 1 kWh/d deliverability, 66.593407 kWh of space, and 0.351648 kWh/day injectability.

of gas storage companies that operate in Europe, Rough was not subject to mandatory allocation. Instead auction based approaches and bilateral agreements were used to allocate capacity for a mix of products. Centrica Storage suggested[28] that bilateral contracts cater to customer needs more than auctions. It also suggested that newer seasonal gas storage contracts tend to be "virtual guaranteed contracts" that allow for full optimisation of the contract by the customer. Centrica Storage stated that these new contracts allowed customers to capture more value due to the option of optimising their injection/withdrawal nominations against market prices rather than to inject or withdraw as early and quickly as possible (in order not to lose their injection/withdrawal rights), if these rights depend on the overall stock of all customers.

There are some concerns that relate to the value of gas storage which is not captured under the current regulatory framework. According to EUA (2016) there are societal benefits such as the contribution to security of supply that gas storage firms can offer but that are not reflected in the revenue streams, suggesting the need for direct subsidies to top up revenues. This is also in line with Centrica Storage that stated that the UK market doesn't pay for the "insurance value" of gas storage in contrast with other European countries subject to different sorts of regulation that incentivise the provision of gas storage for security of supply. Gas Infrastructure Europe (GIE, 2017) states that the value of flexibility and storage services from green and natural gases need to be reflected in a new regulatory framework for gas storage.

Key Resources and Processes

Centrica Storage operated and owns the Rough gas storage facility, as the long-range gas storage facility in the UK. The storage facility is composed of the Rough reservoir, offshore installations (47/3B and 47/8A) and the onshore terminal in Easington. The Easington terminal received gas as a liquid from 47/3B, then the gas was dried, filtered, metered and delivered into the National Grid Transmission System (NTS). Rough is subject to specific European regulation for gas storage (Directive 2009/73/EC, EC Regulation 715/2009, REMIT[29]) and other national specific rules such as those established by the UK's Competition and Market Authority (CMA) and OFGEM. Specific Undertakings have been set over time which involved rules regarding third party access, transactions related to Minimum Rough Capacity[30] and Additional Space,[31] unbundling (legal, financial and physical separation), data transparency, among others. Capacity could be allocated using two different resources: competitive mechanisms and via bilateral agreements.

Due to technical problems identified in March 2015, Centrica Storage has reduced its operation in the last years. The number of SBUs sold for 2016/2017 decreased to 340 million (in comparison to 455 million in 2015/2016). As a result of the limited operation in the first half of 2016, followed by the cessation of injection and withdrawal operation during the second half of 2016 and low price volatility, gross revenues were 40% lower in 2016 than in 2015 (Centrica, 2017). The storage facilities were at the end of their design life and were failing testing and the cost to fix the problem was very expensive, then it was not possible to return to normal operation. As a result, Centrica Storage announced the termination of associated storage contracts effective from 1 October 2017.[32]

28. Personal communication.

29. EU Regulation on Energy Market Integrity and Transparency.

30. Means 455 million SBUs.

31. Space into which gas can be injected over and above the Minimum Rough Capacity and that cannot be less than 1534 GWh.

32. The Competition and Market Authority's (CMA's) decision to terminate the Rough Undertakings was made in December 2017. See: http://www.centrica-sl.co.uk/news/centrica-and-csl-welcome-cma%E2%80%99s-decision-termi-

5. BUSINESS MODEL COMPARISON AND LESSONS FOR EES

This section discusses some key lessons for EES based on our three case studies. A summary of the main business model components associated with the cases and EES is provided in Annex 1.

5.1 Customer Value Proposition involves the target customers and the product/services to be offered in order to get the job done. Depending on the type of market we observed that:

(1) **Some products are more sensitive to regulation regardless of their life cycle stage.** Gas storage is a relatively mature market that involves the provision of storage products to utility gas companies. Regulation (of third party access, capacity allocation, congestion management) plays an important role especially if the gas storage firm has market power. On the other hand, cloud storage is a growing market where regulation does not have much of a role in the type of storage products offered by Google Drive but does have some impact on issues related to data protection and cybersecurity (at national/cross borders).

EES is an emerging market where regulation plays an important role in the identification of the products to be offered. There is a need to define and classify EES and to identify the kind of products that can be offered (by whom and for whom). There is a lack of harmonisation in the rules (or no rules at all) that mandate the deployment of EES. In Europe, there is generally a lack of definition of energy storage and sub categories such as EES (in contrast with gas storage) among EU member states—with some few exceptions such as Italy[33] *and Germany (BDEW, 2014, p.2). Rules regarding appropriate and harmonised grid charge methodologies (even in hydro power storage) are still a work in progress (EASE, 2017). There are some recent initiatives that try to address this concern, such as the EU energy package of November 2016 entitled "Clean Energy for all European" (see EC, 2017) and the UK's Smart Systems and Flexibility Plan (OFGEM, 2017b). Outside Europe, California is among the pioneers in the development of EES facilities supported by an early definition and a new classification of energy storage as Non-Generator Resources (NGR). The NGR model is the principal means by which energy storage resources participate in the California market (CAISO, 2016, p. 2).*

(2) **Customers have the option to select from a range of products and end-to-end solutions in the form of bundled products.** In frozen food storage Oakland usually offers an all-in-one price that involves picking, storage and distribution. In gas storage a similar approach is observed by the offering of SBUs. The offer of bundled products allows customers to concentrate on their core business.

In terms of products, and in contrast with gas storage which offers limited products concentrated only on gas storage (injection, storage, withdrawal), EES can offer multiple products (e.g. energy storage, frequency regulation, peak load shaving, voltage control etc.) that can be offered at the same time to multiple players (e.g. the system operator, the local distribution network operator and energy suppliers). The value proposition of EES depends on where the facility is deployed on the electricity grid (transmission, distribution

nate-rough-undertakings

33. See: Decision 574/2014/R/EEL, p. 17. http://www.arcaitalia.it/wp-content/uploads/2015/01/Delibera-574-14.pdf

or behind the meter). The deeper within the distribution grid the location the more products/services to be offered (Fitzgerald et al., 2015, p. 18). There is not a harmonised list (and names) of the products/services than EES can provide. This can vary among countries which at the same time are subject to different regulatory environments and market design conditions. A comprehensive list of EES products under the current British context can be found in Sidhu et al. (2018) where the main revenue streams of distributed EES (including the social ones) are estimated. Sioshansi et al. (2012), provides a comprehensive list of EES products applied to the American context. Similar to our three case studies, the offer of bundled products by EES operators/owners such as distribution utilities may be an option. For instance, depending on the allocation mechanism, customers (such as the ISOs) may require EES bundled products (Greve et al., 2018).

(3) **Some products are more flexible or offer quicker response than others.** In natural gas, virtual (V) storage offers more flexibility than C storage and this provides more flexibility than S Storage. According to Centrica Storage, newer gas storage contracts are based on the virtual gas option instead, which indicates that customers value more flexibility. Google Drive offers more storage capabilities (key features) to business/enterprises than to individual customers. In both cases the provision of flexibility may involve higher prices.

Based on the introduction of intermittent renewable resources into the electricity grid, new requirements for ancillary services (including unbundling) and appropriate participation models (currently design for traditional generators) would be expected. EES operators can benefit from their multiproduct nature and operational flexibility offering differentiated products (depending on the technology) that can respond faster in comparison with other ancillary service providers. In the UK, the Enhanced Frequency Response (EFR) is one example of the demand for frequency response products than can react faster in the light of the increase in intermittent renewable resources (i.e. wind, solar) in the generation mix (NGET, 2016). EFR is a very fast frequency response product which can be provided by EES, but not by conventional fossil fuel generators or pumped storage hydro. Some ISOs from the USA, such as ERCOT, are also proposing enhanced ancillary service schemes to respond to the growth of intermittent resources (Newell et al., 2015).

(4) **There are different levels of accessibility offered to users for contracting and management of their interaction with storage**. In Google Drive an internet connection is the only thing required to open an account and start storing, while in frozen food storage the process may involve negotiations between the customer and Oakland before selecting the storage product. In gas storage Centrica Storage facilitated an online management tool (StorIT) for trading gas storage products among users.

In the case of EES this relates to the way in which customers can get access/contract storage products. We believe that market based mechanisms and bilateral agreements will be the default instrument to allocate EES capacity. For instance, in California, Investor Owned Utilities (IOUs) that own and operate electricity distribution networks procure EES using e-bidding. Bidders are required to register as an "offeror", to filling out and submitting the online offer form and to upload supporting documents through the Request for Offers (RFO) website. Bidders are also required to send in electronic format all submitted materials on a flash disk to an Independent Evaluator. A similar practice is currently observed among transmission system operators (TSOs)/ independent system operators (ISOs) *in procuring ancillary services, balancing services, among others. The Internet of Things and digitalisation (i.e. smart software) will play an important role on the democratisation and accessibility of EES products.*

(5) **Disruptive or Sustaining (innovation)?[34] is present in some storage products**. For instance, this is the case of Google Drive, which used the internet as its main access tool for cloud storage supported by different system operations, business apps and with 150+ languages. With Google Drive, users are replacing private storage (PC hard disks, flash disks, mobiles phones, companies' data centers) with public cloud storage (global data centers). One more approach (which is more sustaining than disruptive) is observed in virtual gas storage that allows for full optimisation of the contract by the customer who is offered a contractual delivery point. The product is still gas storage but delivered in a different point with specific improvements (i.e. firm working gas volume, firm injection rate, firm withdrawal rate, no maintenance periods).

EES is an emerging market with regulatory issues and market challenges that is revolutionising the conventional way to procure more flexible grid support products (i.e. ancillary services) and to deal with the decarbonisation of the electricity sector. The disruptive component of EES is not the technology (i.e. lithium-ion batteries) which has been around us for years (i.e. in mobile phones/laptops batteries) but in its use/application at grid scale and in its multiproduct nature. The integration of EES is disrupting the electricity market by the introduction of new resources (products/services), the accommodation of new players that facilitate the trade of EES products (energy aggregators, DSOs), innovative arrangements (i.e. hybrid solutions) and the need for new business models that facilitate the EES integration. According to Gassmann et al. (2014, p. 1), new business models are often based on early weak signals: (1) trendsetters signal new customer requirements and (2) regulations are discussed broadly before they are eventually approved. Energy regulatory authorities should continue working on new or enhanced regulatory frameworks that help to unlock and capture the value of EES.

5.2 Profit Formula represents the way EES firms transform the customer opportunity to their own opportunity by monetising it. We observe that:

(1) **Firms' revenues are driven by the maximum use of the storage facility**. This is a key point especially for companies that are only focused on storage products, such as gas and frozen food storage firms. As we have seen this is a key driver of success in frozen food storage and a key issue undermining profitability in gas storage.

In contrast to the non-electric sectors that are part of this study, EES would not necessarily benefit most by maximising the physical use of the storage facility (like in gas storage or cold storage) but by the simultaneous exploitation of different revenue streams (based on the array of products it can offer) that maximise profits. EES can, for example, simultaneously defer network upgrade investments, offer frequency response, energy price arbitrage

34. Based on the definition given by Christensen et al. (2015), disruptive innovation describes the process that allows companies (usually initially smaller with few resources) offering services or products that challenge established incumbent businesses. In our example with Google Drive the disruptor would be cloud storage and the disruptee would be classic physical storage devices. On the other hand, sustaining innovation refers to improvements (i.e. incremental advances or major breakthroughs) that make products better in the eyes of existing customers.

and peak load shaving. Some products may be more profitable than others, some products may be mandatory (i.e. not subject to any compensation), some products may be mutually exclusive[35] *and some subject to different tendering terms (short term vs long term basis). However, if the storage facility is owned/operated by an electric utility some limitations may apply (due to regulation) when trying to capture the different revenue streams that EES can offer. Jurisdictions which place fewer arbitrary restrictions on the number of products EES can simultaneously offer will be those that offer a more conducive environment for EES business models to be successful.*

(2) **Storage firms benefit from the use of virtual and shared storage resources**. For instance, Google Drive offers cloud storage services to individuals, small/medium business and companies using pooled resources (*resource pooling*) that are shared with different customers. Server virtualization is also a good example of sharing resources (i.e. consolidation of server machines in one server that runs multiple virtual environments). A related approach is the case of Oakland and the option of pallet consolidation.

In the case of EES, a business opportunity that involves third party access is foreseen by owners/operators of EES who offer shared virtual storage. Similar to cloud storage, users can get a virtual space for charging/discharging energy according to their needs or other products that EES can bring. In this case, the storage facility would act as the cloud data center and the owner/operator of this facility would act as an aggregator. However the implementation of this kind of model at grid level looks challenging due to the nature of the product to be provided. In the EU, based on the latest EC Directive proposal on common rules for internal market in electricity EC (2017, Art. 36), distribution utilities would continue to be discouraged from owning or operating storage facilities with some specific exemptions (i.e. storage facilities with transparent tendering procedures that offer services that help distribution utilities to fulfil their operational obligations). From this, we see that at least in the EU, distribution utilities may have to develop different commercial and ownership arrangements in order to maximise the revenue streams that EES offers.

(3) **Opportunities for capturing value based on the life cycle of storage components differ between sectors.** In cloud storage data center equipment (composed of computing equipment such as servers and storage, among others) has an average lifetime of 3 years. In general, due to the advance in technology, ICT equipment is expected to have shorter life cycles because of the need to be updated more frequently. Smart phones and laptops/PCs are good examples. Cloud storage firms can capture an additional value in reducing the need to buy expensive private IT equipment (extending the lifetime of the private equipment that is used). A different picture is observed in natural gas storage with a life cycle over 20 years. In contrast to data center storage equipment, the option of replacing the gas storage equipment in the medium or short term is not economically viable.

EES owners can benefit from the option using second hand batteries. This is because EV applications are more demanding than grid-scale batteries. EVs require higher capacity limits (expressed in % of the initial capacity) in comparison with grid applications, 80%

35. In MISO, ISO-NE and NYISO markets electric storage is eligible to provide frequency regulation, however those that provide that service are explicitly prohibited from providing other services (ESA, 2016, p.7).

versus 40% respectively. This makes it possible to reuse EV batteries in grid applications (Hein et al. 2012). There is currently an emerging market for the second use battery. For instance, FreeWire Technologies, a company based in Virginia, is offering a portable EV charging service (called Mobi Charger, an all-in-one module) that allows customers to charge their EVs anytime using an array of second-life lithium batteries.[36] In Germany, large scale second use projects (for primary control power) that make use of retired EV batteries are also observed (i.e. 15 MW and 13 MW operated by Daimler, and 2 MW operated by Vattenfall/BMW/Bosh), GTAI (2018). The environment can also benefit with the use of second life batteries (cascade reuse) in terms of lower energy demand and CO2 emissions with lifetime net reductions between 15% and 70% (Richa et al., 2017).

(4) **Offer storage products with or without third party involvement.** We observe that storage products in the three case studies are offered directly by the companies without the need for third parties trading these products. However, some exceptions may apply. This is the case of Oakland when offering bundled products to their customers (suppliers). In this case, the distribution component needs to be contracted by long term transport partners, even though suppliers are charged by Oakland for storage and additional services that are part of the cold supply chain.

The involvement of third parties in the provision of EES products/services to be offered by the electric utilities (i.e. DSOs) is linked to the regulatory framework that rules this market. In the UK, electricity distribution utilities cannot trade directly any of the EES products such as ancillary services and energy in the wholesale market due to the unbundling/ownership rules applied to electricity distribution firms. A different approach is observed in California, where electric utilities are allowed to operate and own these facilities and also to procure EES products through competitive mechanisms (i.e. Energy Storage Request for Offers). Offerors can own/lease the project site and relevant structures or commit to purchase/acquire lease hold interest in the project site in order to participate (SCE, 2017, p. 40). In this case, electric utilities can own up to 50% of the total storage projects they are required to contract for regardless of the grid interconnection point. The primary purpose of the utility-owned storage facility is to support the distribution system (grid focused) however when the distribution function is not required, electric utilities are allowed to participate in the wholesale energy market via a Wholesale Distribution Access Tariff (WDAT).

5.3 Key Resources and Processes help to capture the value of storage for both the customers and also the companies that offer the different storage products. We observe that:

(1) **Ownership remains in the firms that provide the storage products**. The three companies that are part of this study own and operate their own storage facilities (public data centers, cold warehouse, gas storage reservoir). Google operates a more decentralised cloud storage platform with worldwide data centers locations, in comparison with Centrica Storage and Oakland.

EES can be deployed under multiple ownership models. The viability of the different ownership models would depend on the way EES assets are regulated. EES can be owned and operated by electric utilities, third parties (including energy suppliers, aggregators,

36. See: https://www.freewiretech.com/ev-charging/

independent power producers), or joint ownership between any of the above. Rules regarding EES ownership vary among jurisdictions. For instance, in many states of the USA (e.g. California, New York, Hawaii) electric utilities are allowed to own and operate EES facilities. In addition, different requirements may also apply depending on the business unit (i.e. distribution, transmission, generation) that would manage the storage facility (EPRI, 2016, pp.2-3). On the other hand, the current European regulatory framework limits the participation of transmission and distribution operators (TSOs and DSOs) in EES, however differences are observed among EU member states. Italy has opted to allow the TSO and DSOs to build and operate batteries under specific conditions. However this initiative has been limited to the implementation of both, energy-driven and power-driven pilot projects for EES using an input-based incentive mechanism (TERNA, 2016). In the UK OFGEM has recently reaffirmed the need for unbundling by suggesting that network companies should not operate or own storage and has proposed changes to the electricity distribution licence (OFGEM, 2017c), in line with the most recent EC Directive proposal (EC, 2017).

(2) Market mechanisms (including bilateral agreements) are common practice in allocating storage capacity. In gas storage we have bilateral agreements and auctions, while we only observe bilateral mechanisms in frozen food storage.

For EES we would expect a combination of both, bilateral contracts and competitive mechanisms (auctions, request for offers (RFOs)). Allowing market participation (via electric utilities or third parties) reinforces the EES business model. A good example of market-based mechanisms is the one applied in California by SCE through its RFO for energy storage. However in terms of the auction design there are some considerations to take into account. For instance, in contrast with gas storage or other RFOs that involve the purchase of renewable energy, the use of a reserve price, cost cap or reserve multiplier on any given service would not seem to be applicable in the allocation of storage capacity. This is explained by the fact it would be difficult to meaningfully regulate the price of any given service from a multiproduct EES facility.

(3) Key partnerships matter. The creation of strategic alliances is observed especially in cloud storage (i.e. Google Drive has key alliances with third-party developers to add specific functionalities) and frozen food storage (where long term transport partners make possible to offer bundled services).

Strategic alliances with energy suppliers, EES developers, the distribution network operator and even with generators might play an important role in the provision of cutting-edge EES solutions. Depending on the regulatory framework, key partnerships with third parties may be necessary to fully commercialise the wide range of products that EES offers. Strategic alliances with storage developers can help to optimise EES storage system operation and lead to a more cost-efficient EES technology.

(4) Cost-cutting, green and energy efficiency initiatives promoting decarbonisation are a common trend. We have observed initiatives that help to reduce the carbon footprint, promote green technologies and at the same reduce operational/capital costs. The installation of solar PV panels and use of EVs, along with other energy efficiency measures has been undertaken by Oakland. Google has purchased renewable electricity for use in their data centers.

The increase in intermittent renewable resources is driven by the transition to a low carbon economy supported by specific decarbonisation targets. There is a trade-off between decarbonisation and the cost of balancing the system (driven by the increase in variable and uncertain renewable energy). The implementation of hybrid solutions—where storage and intermittent generation are combined—can help to increase the share of renewable energy and also the value of EES and controllable load (Mount et al., 2012). These emerging participation models may represent a business opportunity for EES owners/operators. However, their implementation may also depend on the regulatory context. Some recent examples of large-scale hybrid initiatives are observed in Chile (Concentrated Solar Power+thermal storage, 450MW/5.8GWh) and Australia (battery storage+wind power, 100 MW/129 MWh). Depending on the technology, some hybrid solutions may be more economic than others. For example, the combination of solar PV with lithium-ion is seen as the cheapest solution for peaking services in Australia with a levelised cost of energy (LCOE) between AUS$100-340/ MWh (RepuTex, 2017, p. 8). Other initiatives involve peer-to peer electricity trading. This is the case of SolShare that installed the world's first peer-to-peer electricity trading platform[37]. Blockchain is gaining attention outside the financial sector and it is expected to have a broad application in the energy sector (Burger et al., 2016).

6. CONCLUSIONS

In this study we have explored how other non-electric storage sectors—natural gas, frozen food and cloud storage—are doing in terms of the provision of their respective storage products. A specific business model methodology allowed us to compare the way the different business model components interact and provide value to both the firms that deliver the storage products and their customers. Some key lessons have been identified by contrasting the business models related to these sectors with EES. We observe the existence of well-developed business models in growing and mature storage markets. Successful business models provide a value proposition to customers and can generate profits for the storage firms. All storage products are also sensitive to regulation, but the degree of sensitivity varies by storage type (gas and EES are the most sensitive among those we look at). Finding the optimal configuration of ownership of storage facilities is an important part of the business model. Restricting this arbitrarily may be not beneficial for the development of EES. There has been a lot of innovation in storage business models, especially in the use of technology and in contracting (market and bilateral), which should be facilitated in EES. The Internet of Things and digitalisation could play an important role in promoting the widespread adoption and accessibility of EES products.

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37. See: https://www.me-solshare.com/

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APPENDIX 1: BUSINESS MODEL COMPONENTS—A COMPARISON

Case Study	Customer Value Proposition	Profit Formula	Key Resources/Process
Google Drive	Cloud storage offered to individuals and non-individuals (small/medium business, enterprises) supporting over 150 languages	Different storage plans for individuals, business, enterprises	Worldwide data centres
	Provision of data storage services at lower prices (economy of scale) with worldwide access	Combination of one-time payment and free (basic storage: 15 GB)	Use of public cloud storage
	Customers more focused in their businesses (storage assets managed by Google instead)	Flat rate for teams/firms. Limited to 1 TB/user if fewer than 5 users	Key partnerships with third parties for developing of apps
	Integration with hundreds of business apps (Dropbox, Facebook, Twitter, Instagram)	Cloud data storage is linked to other Google products (apps), some of them chargeable	Audits and certifications for reliable cloud storage (only for non-individuals) and investigations for cybersecurity reasons
	Provision of key features depending on the type of customer	Multi-tenant approach for lowering costs	Use of renewable energy for its operation (through PPA)
	Accessibility from different browsers, devices and system operations supported (windows, Mac, Android, IPhone/IPad)	Product oriented only to end-users (a different product is offered to developers)	Use of metrics for measuring performance (PUE)
Oakland International	Frozen food storage services for retailers and producers	Retailers are charged based on number of cases	Own warehouse facilities for ambient, chilled and frozen food
	National coverage with quick delivery (1D order, 2D delivery)	Price per case vary depending on product complexity	Energy efficiency practices (refrigeration, lighting and heating), renewables (solar PV), electric cars.
	Product traceability, no minimum load	Frozen food storage services attached to other services of the cold supply chain provided by Oakland and key partners	Key partnerships with different players of the cold supply chain (including transport)
	Consolidated pallet for lowering costs (shared use)	End-to-end logistics favours less steps lower costs and better performance	Carbon footprint reductions driven by technologies and processes
	End-to-end solutions allows customers to focus on core activities	Use of triangulation logistics with important savings to customers	Regulation and audits for processing and handling frozen food
	Accessibility to main retailers		Metrics: 99.5% SLA
Centrica Gas	Provision of gas storage services to utilities, gas producers/traders	Maximum use of storage facilities by offering all in one service	Owns and operates the storage facility, no intermediaries
	Offer of bundled (SBU) and unbundled services (injection, withdrawal, space).	Bilateral agreements (over auctions) which allow to cater customers' needs better	Use of market-based mechanisms and bilateral agreements for allocating capacity
	Gas storage services to and from: in situ (Store S) and NPB (Store C, virtual)	In the case of auctions, a marginal cost reserve price is set	Online management system StorIT with tracking inventory and receive nominations (secondary market)
	Possibility of extending SBU by buying unbundled space. Customers are allowed to trade Gas in Store (GiS) free of charge with other SSC signatories	Storage SBU pricing based on fixed price or index price	Subject to specific allocation rules (Undertakings) for Minimum Rough Capacity and Additional Capacity

(continued)

APPENDIX 1: BUSINESS MODEL COMPONENTS—A COMPARISON *(continued)*

EES market	Multiproduct, with different kinds of products to be offered (energy storage, frequency regulation, peak load shaving, etc.)	Maximum revenues driven by the simultaneous exploitation of different revenues streams	EES can be deployed under multiple ownership models, which will depend on the way how EES assets are regulated
	Multicustomer, with different types of customers to be served (SO, energy suppliers, DNOs)	Virtual storage as an additional revenue stream	The use of market mechanisms reinforces the EES business model
	Offer of differentiated products with operational flexibility and faster response	Potential savings due to the use of second hand batteries	Strategic alliances with key partners for the provision of cutting edge EES solutions
	EES disruptive component based on its use/application at grid scale, its multiple nature, accommodation of new players and innovative arrangements	Revenue model may be subject to the requirement of third parties for the product commercialisation	Emerging participation models (hybrid systems: renewable generation+storage) subject to regulation