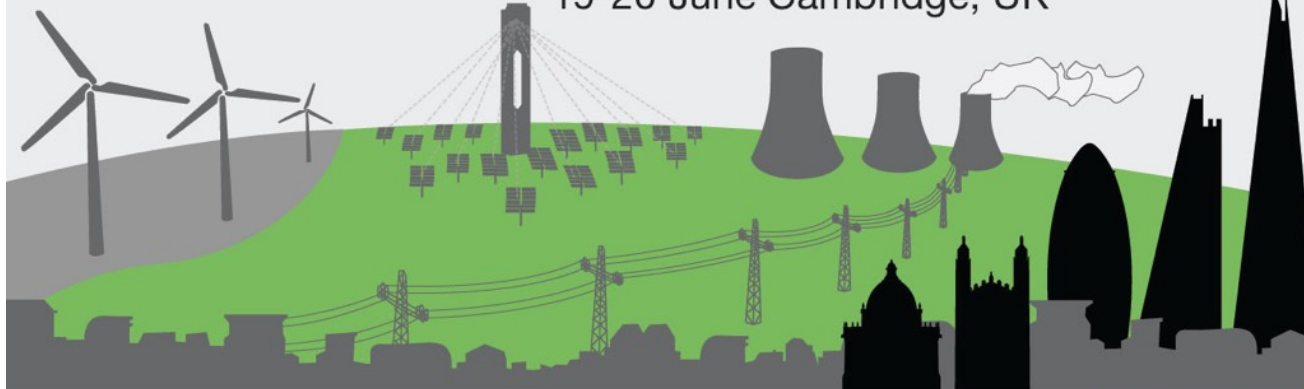


Smart Grids Cleanpower 2017 19-20 June Cambridge, UK



8th SMART GRIDS & CLEANPOWER 2017 CONFERENCE JUNE 19-20

Session I Introduction led by **Gavin Jones** 9.30-11.00am

09:30 Introduction - Dr **Justin Hayward**

09:35 **Gavin Jones** - Trends & Drivers | Overview of smart grids landscape

09:50 Briefing on Energy Trilemma - **Dr Derek Pedley**, Independent carbon management expert, formerly with ESKTN and Oxford U

10:10 Using Information to Innovate and Disrupt - **Andrew Strong**, Head of industrial innovation - **Cambridge Consultants**

10:25 Overview key current, near term & future storage technologies - **Prof Andy Cruden, ESA**

10:40 **Discussion panel with chair**

11.00am - 11.30am **Networking break and coffees**

Session II Technology led by Erwin Frank-Schultz, Executive IT Architect, Utilities and Infrastructure Technical Leader, **IBM and ARM** 11.30-12.45pm

11:30 DSM & Big Data Analytics, AI, Automation - **IBM**

11:40 Impact of 4 Technology Areas: Energy, Consumer, Operation, Information - **IBM**

12:00 Keynote: What is the Uber or AirBnB threat for the Energy Industry? - **IBM**

12:15 Energy blockchains and why you should care, JoJo Hubbard, COO-CoFounder, **Electron**

12:30 A Data Miner's Handbook, Dr Amyas Philips, Technical Director, **ARM**

12.45 - 13.45 **Lunch networking & showcases**



Session III Markets led by Jon Ferris, Head of Energy Markets, **UtilityWise** then Richard Druce, Associate Director, **NERA** 13.45-15.30pm

13:45 Enabling the Transactive Grid. How is the market structure changing, and what constraints does it place on transactive grid development? - Jon Ferris, Head of Energy Markets, **UtilityWise**

14:00 Key players and strategies: market structure & what still needs to change? - **UtilityWise**

14:15 How can consumers become more engaged with the market? - **UtilityWise**

14:30 Encouraging Markets to be Smart - **UtilityWise**

14:50 Market design to promote for flexibility in power systems - Richard Druce, **NERA**

15:10 Models of energy network regulation to promote smart grids - **NERA**

15:30-16:00 **Networking break and coffees**

Session IV Innovation led by **CIR & Imperial College**: Nick Coutts

16.00pm-17.30p.m. Challenges of innovation in grids and power

16:00 Funding Opportunities by **Innovate UK**, Harsh Pershad, Lead Technologist - Energy (Generation & Supply)

16:15 Energy leadership, innovation & entrepreneurship, Nick Coutts

16:30 The value & management of innovation - Nick Coutts

16:45 Case: Distributed Energy Storage and aggregation models for grid services - Simon Daniel CEO,

Moixa Energy

17:00-17:30 **Discussion led by Gavin Jones, summary & close**

Introduction (Gavin Jones, Smart Grids Consultant)

We have heard a great many presentations from a lot of speakers and a great deal of very interesting discussions both in the panel sessions and at lunch and coffee. We've heard about the structure and "energy trilemma" issues with the market as well as the roles of National Grid, regulator and government. We've heard about the challenges of smart grids around automation.

The key points of a wide ranging couple of days were: how much progress and how much has changed over the last 12 months complemented with the need for continued change moving forward. There was a general wish for more clarity on policy and regulatory frameworks, and of course the impact of Brexit, where the ending of EU research and investment funding was already being felt. For instance the BEIS future generation mix scenarios looked completely implausible with the current state of progress on new nuclear, which highlighted the need for other solutions.

There were a number of speakers who felt there needed to be market changes particularly to handle the challenges of flexibility and reliability with renewable generation, as well as the problems of funding the grid with more embedded generation both in front and behind the meter. As a key part of the solution to managing the future energy demands cost effectively, there was also wide support for opening up the DSR market to provide opportunities for more to take part, both as providers and users, and a lot of interest in the potential use of blockchain as part of the technical solution, for this and other energy related areas.

Storage was also another common topic, particularly battery storage both in where it can, and is, being used and where the challenges still are, and a mixed view on the potential of vehicle to grid, with both strong proponents and detractors.

There was a lot of discussion on the opportunities and challenges that Internet of Things brought to the energy industry, and also the practical structures already in place to help new applications be created in a secure and reliable manner, as well as the barriers to getting innovative ideas working at scale in the market.

So all in all a lot happening and a lot of confidence that there will be much to talk about next year too. It was a pleasant, excellent two days of conferencing and much fun too. -GJ



Gavin Jones; Trends & Drivers

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Derek Pedley; Energy Trilemma

- 4 year payback for Italy reducing bills and theft
- 31 million devices rolled out

Andrew Strong; Information to invocate and disrupt

- Control issues to attain sustainable grid activity
- Use big data to change the grid
- Data analytics to predict complex situations i.e. the grid

Andrew Cruden; Storage technologies

- Bath Count, pumped hydro
- Vehicle to grid
- Want high discharge rate and high energy rate
- Isentropic thermal energy storage
- Magnetic energy storage

What are you looking for in the next 12 month?

- Cruden Demonstration programme of technologies
- Strong Grid monitoring and the change in energy flows increase in real time data
- Pedley More effort put in by the government in sustainability renewables and smart grids

Why side towards EV battery

- Cruden Good access given from EV giving consumer a revenue from their car

Issue of battery cycles being used for grid application

- Cruden Cycles are conservative estimates,

Erwin Frank-Schultz; The future of energy

- Trilemma is a pull but there is also a push
- The use of the national grid as a back up problem of who is paying for that?
- Remove the barriers to energy make it comfortable
- Hyper ledger block chain idea
- Tennet, sonnen,
- Issues if people staying with their careers for 2 years on projects that are to exists for 10 years.

Get Video of oil plajorm

Jo-Jo Blockchain & opportuniHes in the energy market

- National grid balancing of services June 2017

Amyas Philips; Data Miner's Handbook;

How will blockchain deal with credit risk?

- Not fully automated good for the middle term not long and short!

Take control of your own data if using Blockchain model

Jon Ferris; UtilityWise

- Not an issue of capacity but the rising costs down to balancing and flexibility
- Demand side is not always the answer but you can also look at the cost of use against cost of saving it



Richard Druce; NERA

- Regulation needs to adapt to nurture innovative thinking
- Harsh Pershad; Innovate UK
- Innovate gov agency led funding competitions

Simon Daniel; Moixa

- Changing software every 6 months
- Trying to keep their hardware relevant 10 years in time
- Barrier of consumer adaptation over technology
- Battery management of IOT

8th Smart Grids and Clean Power 2017 – DAY ONE – Jacqui Gilbert

Justin: Introduction

- SGCP17
- 4IR = “Fourth industrial revolution”
- Chart from PWC looks at number of industrial robots per manufacturing workers. Asia leading the market. This will impact lifestyle, employment, gdp etc.

Gavin Jones

- Article in utility week complaining on lack of certainty that is impacting investment and a future view

Slide 1: Moving to a green grid:

- Image showing a green grid vision. There has been a distinct move towards “Green” solutions over the last 10 years. Becoming increasingly apparent as you drive around countryside: storage, elec charging etc.
- Challenges outlined as per slide. Political recognition as per manifestos that indicate that market isn’t working as well as it should

Slide 2: What happened in the last 12 months?

- UK is at the top of the large industrial energy prices. A real challenge for the industry when paying e.g. 50% more than France and our other competitors
- Challenge of fuel poverty
- Brexit: currency impact, tariffs, supply issues (as outside of EU), we may not be able to import Uranium
- Nuclear plant in Cumbria looks very unlikely to go ahead. Was originally part of providing baseload for ongoing energy strategy.
- UK Govt Green Paper: Not policy yet, but hope that it will become policy
- Teresa May/Election: Unclear what this will mean for driving policy moving forward
- All major manufacturers now have electric vehicles in their fleet. Challenges for the grid re: charging
- Market failing – ex-civil servants suggest that privatisation of energy will be seen as abhorrent in the future.
- Hydrogen injection – making gas grid less carbon intensive by using hydrogen instead of natural gas. Can also use excess electricity (another means of using storage)
 - First bid for supply of energy without tariffs is positive sign. Has just occurred in Germany. Will mean renewables will come in much cheaper
 - Energy crisis: people were paid to use energy. Experts believe this will happen again this summer. It will impact investment.

Slide 3: What about the next 12 months?

- Brexit – borders, supply, Ireland policy (currently an all-Ireland strategy)
- Time of use tariffs are gaining momentum
- Potential that inquiries into energy costs will happen annually
- Movement generally that fewer people are paying for upkeep of the network. The impact of this is quite significant.
- Movement to separate out the SO from national grid. Labour party talking about nationalising network as their licenses come up for renewal. Highlighting very large profits of network companies



Dr Derek Pedley The Energy Trilemma

- Slide 1: Is it really a trilemma? In a trilemma you would have two goals pursued at the expense of the third. However we believe we can achieve all three, and this drives us (govt, BIS etc).
- Slide 2: World Energy Council is source of image. In UK we think of energy equity as just affordability not access (other than price restricting access) but in many other countries they lack access (even physical infrastructure).
- Slide 3: Oliver Wyman Energy Trilemma index
- Slide 4: Year of table is 2016. Doesn't take into account anything to do with Brexit nor any energy cost impact from currency changes. Denmark is #1 in energy security as they have no import dependence. Most countries in the top 10 are European (except NZ). A useful way of looking at the ranking
- Slide 5: Energy calculator (a well accepted tool that is being used): Example given: Denmark we can see the complex set of metrics that are being utilised. If we go to the UK, we can see import dependence is much higher than Denmark, but comparatively we can see that UK is reducing CO2 dependence quite well.
- Slide 6: Smart Grids addressing the energy trilemma. The items listed are ideas/suggestions of how we might meet the trilemma through the various aspects of the smart grid. Italy introduced 32million smart meters. It paid for itself in 4 years through reduced costs and reduced electricity theft. It may be expensive to start but savings are much greater.
- Slide 7: The UK Govt. are using funding programmes to fuel innovation.

Andrew Strong

How to structure ideas and move forward on the challenges presented.

- Slide 1 and 2: About Cambridge Consultants
- Slide 3: Energy industry trends. Huge control issues re: security of supply. Had first day since the industrial revolution of a ZERO coal use day.
- Slide 4: Model for innovation framework. It's a feedback loop. Left is a condition or market that we want to manage. Data collection, trend analysis. Process then thinks of hardware or software. Then links to service innovation. Then link back to consumer and then reiterate.
- Slide 5: Home Energy Management System example. "Provide comfort as a service". First step was to create prototype proposition merging in-home connected devices with cloud service. 30 Trialists last winter. Moving to larger scale trial this coming winter
- Slide 6: Analytics. Believes this approach could work well with the smart grid.
- Slide 7: Hardware example. Allows oil operators to assess economic viability and profitability of well and extend life time of the well itself.
- Slide 8: Parallels/Implications: Whilst technology development is exciting it can sometimes be cost prohibitive.



Professor Andy Cruden ESA

- Slide 1: Overview
- Slide 2: Top 4 are all battery connected grid systems. There's a race on to find solutions robust, reliable and lowcost. Reason there is such a range of technologies, there is still a race on what will be the preferred technology.
- Slide 3: Electric Vehicles. A significant part of car cost – we need to own and develop this. Set up a battery institute in the UK is in budget statement. Will also be able to be used on smart grid.
- Slide 4: New Technologies. We are always searching for the new best thing. Lithium sulfur and silicon are becoming commercially available. Lithium air is still in lab. Lithium has restrictions though due to cost and availability.
- Slide 5: Image of layer structure of Li-ion battery. Challenge is how can we get more energy in that very thin structure but keep very high charge/discharge rate
- Slide 6: V2G. Achieving battery storage with low capital cost as plugged in vehicles have been purchased by individual consumers.
- Slide 7: Energy Superstore. Covers diverse range of different technologies. Looks at economics and integration issues into grids, and manufacturing and skills. If interested go to URL on slide
- Slide 8: Recycling challenges. Lots of competing chemistries in the lithium ion cell. At the moment we aren't trying to recycle to get lithium, we are currently focussed on cobalt. We need to put recovery in place for these exotic materials.
- Slide 9: Isentropic. Company is in administration but their technology is being tested by University of Newcastle. Looks like an automotive engine, driven by an electric machine (a motor), Creates hot and cold gas. Technology still hasn't been proven.
- Slide 10: Superconducting. Super conducting will have its niche. Example is from the early 80s. Not a lot of energy but power rating was huge.
- Slide 11 and 12: benchmark size of batteries between two images shown. Very different technologies and applications. Expense limits application.
- Slide 13: Centre for doctoral training. Cover and train a number of PhD students (32 currently, growing to 55 students) across range of technologies. Lots of material from students available at link on slide. We need to be developing future research leaders in battery technologies.
- Slide 14: conclusions. Significant potential for dual-use of electric batteries. Need to aggregate system.

Discussion Panel for Session One

- What you are looking for in the next 12 months in this area

- looking forward to new battery institute.
- yes electric vehicles follow you through your energy consumption through the day. We need to see the industrial strategy in to action. Fear is that we might backtrack from climate commitments
- See more effort from government into renewable sector into energy sector. Concern that we aren't going to have enough focus on what we need to do to even achieve continued day to day management. Achieve 2008 Act.
- how do you control the energy system structure (sales, privatisation etc). How the grid fits in to this new eco. It's such a conservative industry.
- Challenges in short term: cycle time of batteries tend not to be that high. Are there economic challenges when you're using up their lifespan. Where do you see the technology going? When will lifespan of batteries be so long that it is no longer an issue.
- current lifespan (Nissan e.g.) is performing better/longer than anticipated. I expect it will have some impact on the lifetime. There is research that the longer you keep a battery active you can manage it's lifetime. New Technologies will have significant impact on lifetime.



- **Mentioned data analytics and aspect of control (centralised or decentralised). Reducing complexity of system – is this probable? Possible?**

– there's a lot to learn from other systems. Energy is very slow to have monitoring and active management. A distributed approach is definitely a good one. Hoping to see from smart metering industry. Interesting to see how it develops.

There are some legal issues around who owns the data from sensor devices (and thus the value that people can derive from the data). This has slowed projects.

SESSION II

Erwin Frank Schultz

1. 2x2 grid Technology disruption – Trilemma is a pull, but there is also a push.
NB: How it is changing our behaviour (energy companies need to stay astute to this).
Convergence of OT technology. Security used to be based on obscurity but that is no longer true.
Need to implement patching strategies etc.
2. Model shift - System used to be neat now is shifting into a multi-sided model.
3. Shifting into five marketplaces: **Grid Services** (energy still will have to be moved around); **Energy Exchange** (a whole marketplace around exchanging energy); **Home experience** (Big question is how much of a role will the current energy market have in that space. At the moment they have low brand permission (low NPS scores), internet content providers are moving into this space... however at the moment every energy company has a footprint into the home. Will be an uphill battle for energy companies, but no one knows who the winners might be – the inroads and grab a generation (e.g. the older generation via assisted living)); **Business and City Experience** (coming up with integrated local approaches to energy management); **Information Services** (whole marketplace to be built around energy services to energy)
4. Utility Key Imperatives.
5. DLT and Blockchain
6. Hyperledger –
7. Case Studies – Metering – microgrid data and the need to manage this.
8. Tennenet – is using blockchain. Is not using national grid at all.
9. Video – Oil platform - Maintenance of asset through increased technology/datainsights
10. Tradeoff between buying energy from network vs energy from neighbour. Electricity may be more expensive from neighbour but cheaper in distribution cost. Every asset will need to participate in the market.

JoJo Hubbard – Electron COO

1. Where are we going? (Ed. That is what we are asking you :) !)
2. What is blockchain – Technology that allows you to create a transaction/interaction platform. E.g bitcoin. Blockchain 2.0 is programmable value (money); blockchain 3.0 is big industry. It's not just about transactions but it is a new way to do business.
3. What could it mean for energy? Q: who owns the data, and insights on our own behaviour?
4. Collaboration is key. Will increase liquidity for sellers.
5. A collaborative approach. Instead of going straight to product, they are able to put value on the delivery component. (e.g. looking at price of product but not at packaging and posting).
6. Key benefits of the approach.



Dr Amyas Philips

1. The 3 win-wins.
 2. Where to start – Chart which deloitte developed. If already delivering services you need to find ways of improving, integrating, connecting products.
 3. A no-brainer – need to ensure integration achieves application.
 4. The problem – it is defined differently by everyone, which is part of the complexity.
 5. The parts of the problem – you create solutions through stacks
 6. Hot and Cold Running Data – There are different kinds of ways to use data trends. Sits on spectrum between real time data and data sets (not so useful for immediate control but needed to train data).
- Big Data Landscape – Discussed further...



Panel for Session 2 #SGCP17 Day 1

1. What like to see in next 12 months
 - a. Blockchain – is a collaboration technology. At the minute it feels like everyone is trying to solve it themselves. Government should step in and have round-table and discussion. Let's proactively set the direction.
 - b. IBM – Think we are doing a lot of things right directionally. National Grid FES are ok but a little timid. Need to accelerate from 12 months to 8 months. Ofgem is allowing centrica to play with Blockchain in cornwall. Just worried we are moving way too slowly
 - c. ARM – Fragmentation of market is problematic. Consolidation is ideal

2. On Blockchain – clearing system – bitcoin is delivered instantaneously and thus reduces credit risk. How could this work for energy.
 - a. IBM – Can't see any blockchain market solving distribution problem (Will still need SO to ensure security of supply). Don't think that anyone will build a nuclear power station on a completely fluid market. Risk is likely to be only 30min between transaction and supply. Was proposed as a provocative model, will need big societal changes and government levelling the playing fields. Believe we need to have an "uber moment" and completely change the way we operate, regardless of if we get there it's important to have as a comparative model. How does this make us think differently?
 - b. Blockchain – Buy community energy for generating and UK have back up supply. Need options and development of desire to build towards zero security model
 - c. Gavin Jones – NB: blockchain will not result in the scrapping of everything.

3. 2030 system benefits. What do you see as trigger points for consumers to adopt the distributed generation systems? And in that journey how does it co-exist alongside existing system.
 - a. Blockchain – Blockchain will need to outcompete other technologies. Or a hybrid model where blockchain does transaction and a central entity validating transaction. Data-ownership model – exciting – you own your data that you generate through transactions, and then can profit from it's use/sale
 - b. IBM – German example - Pay people to charge the battery with excess energy and pay them later to discharge the battery. Or could do auction and have aggregators but germany/Netherlands were focussed on disaggregation. Need to chip away and prove what works/fails and build more pervasive systems.
 - c. Dr Philips – not everyone can join the grid and become a participant. Question is how do you get there?

4. Market Power – something to do with Bitcoin and having multiple types
 - a. Reason for joining blockchain is to participate in the network. Believe initially will have ego individual blockchain coins, but market power will consolidate
Arm – it's opensource technology. Key is how do use it to create new business models. Example: Telecomms has become dumb pipe to coontent developers.



Jon Ferris – Utility Wise

1. Every comment on article – demand isn't rising it's falling. DECC deleted word rising but comments remained. There is concern that DECC released an article stating our dependence on coal and gas is not for energy when it really is for electricity
2. Total demand from larger number of appliances is lower than it was before
3. Energy efficiency – benefits from policy to reduce demand
Bloomberg graph. Increasing miles per gallon resulted in a drop in horsepower. Efficiency doesn't have to come at a cost of performance. We can and are getting both and there is policy driving this.
4. Where is the market – We have a grid that's evolved from large scale power stations, most of us are connected to a distribution network, and industry connected at high voltage and consumers at low power. The market for wholesale energy is on a transmissions network. Green energy options growing. Incentivising batteries and decentralised energy generation
5. First part dominated by coal, nuclear, gas.... Changed in 2011 with growth of green energy. Below the line is growth of distributed generation.
6. What drives prices? Usually has been led by gas. Has been flat and mellow by large. Futures market is derived from much of the short-term market. Is becoming more volatile
Model marginal cost – in 2007 was non-existent. In 2008 prices spiked. Today – a lot more plants that will operate at negative prices. Inflexible generation from solar wind and nuclear. We don't need coal or gas on hot days – so wholesale prices turn negative. That impacts investment decisions for the future.
7. The highest demand 7 dec 2010 – at the time of nuclear, coal gas generation. Price followed demand (morning peak load etc). In 2015 – picture is very different. The peak of demand was more than 10GW ph. Much less coal and gas running, much greater diversity of sources – thus barely a spike in price worth noting. At start of day it fell to zero. In 2016, similar demand but coal and dropped off system. Increased call on storage. Prices spiked.
8. Look at feb 2017 – Wind outstripped coal. Level of demand is no longer an indicator of price. Two weeks later – wind was windy through morning but died off in evening. No spike in morning. Evening high spike
9. Solar – 10 may 2017. Day dip between morning and evening peak fell because of solar generation. Is not most efficient way of using our generation – turning on generators as demanded
10. Wednesday 17 May – Didn't get spike in the morning as plant had been running all day. The flexibility available was so low that caused a spike in prices. A very different wholesale market dynamics than a few years ago.
11. P305 - This change is deliberate. Graph – huge spikes in prices after coal taken off network
12. Balancing costs – costs will increase
13. Capacity market – trend – high in winter, lower in summer but overall declining. In capacity market we are subsidising embedded generation. How surprised people are that we settle on a halfhourly basis
14. Role of retailers – information and how it is shared will change the market. Not sure that there are any natural monopolies anymore. The role of the retailer is going to be prescriptive as brokering, billing and facilitating balancing. This impacts retailer power tariff structure shifting towards a time of use (ToU) structure. Retail needs to be looking at risk reflective pricing that reflects strains on system. Current market structure doesn't achieve this.
15. Demand side changing the market – With coal and gas being pushed off system, owning generation is a burden. To overcome this look to aggregate generation.
16. Shift from fixed procurement to more flexible procurement
17. Is demand response the answer? Most consumers won't switch suppliers to save 20p on their bill. The issue is less about cost and more about perception of control – the just in time industry.
18. Future green buildings – research is out of Denmark. There is a point where saving heat is more expensive than supplying heat.
19. Storage – Good paper from Bloomberg that came out last week that talks about limits of storage.
20. Network charging – Look at how grid is structured and charged. Ofgem is looking at one small aspect of it but it is not a holistic review as demanded by the market.
21. Access vs Use – recognise problem that value of grid is way higher when batteries run out and distributed generation is low... but who should pay for the network when there is an excess of supply.
22. Do network companies actually have a monopoly today? Not in 20 years as OFGEM CEO said.



Richard Druce – Associate Director, NERA

1. Electricity as a product is generally well defined.
2. What we have seen recently is rapidly declining value seen from generation investors through the energy market.

Very complete slides – please refer to the slides in the original CIR Strategy weblink to this document.

Questions:

- What are you looking forward to over the next 12 months
 1. – Energy policy being interrupted by two elections and Brexit – been waiting a long time for clear strategy and policy
 2. – One thing that irritates about the direction of energy policy is constant creep of low risk plan which eventually is doomed to fail. Need to demonstrate imagination and improve efficiency, not just doll out pet project of the day.
- Barriers to measurement. Equivalent organisation to (? Couldn't hear – smart grid?)
 - o Richard - Not obviously – The thing about smart grid technology it's not immediately obvious about how much you need and where. Creating market structure to signal where that stuff is needed is fundamental.
 - o The value is not in the asset, but in the data layer.
 - o Data could be the one homogenised framework.
- Access to data – looking like you'll get granular information because it is effectively there on the meter but the question is whether it has actually been taken off your meter.
- Issue is not GDPR - would allow network to use data for network purposes. They haven't got the right to use data for something else.
- At the moment they are not able to get the data with out individuals permission under current UK laws. Only allowed to get it if aggregated. But often there's just one user at the end and so you can't aggregate the data.
- We are increasingly gas fuelled – at the moment how gas works its very different from electricity – there is a challenge in getting to a future with integration between gas and electrical.
- Idea of inserting hydrogen into gas grid – re: electrification of heating. But it looks like there is the opportunity to do it, despite significant practical hurdles to overcome.
- Enough Supply generation will that change with electrification of transport and heat?
 - o Yes – gas plants running at 50% of capacity... coal plants weren't running...ideally want to generate as little as needed to meet demand.



7th Smart Grids & Cleanpower 2016

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