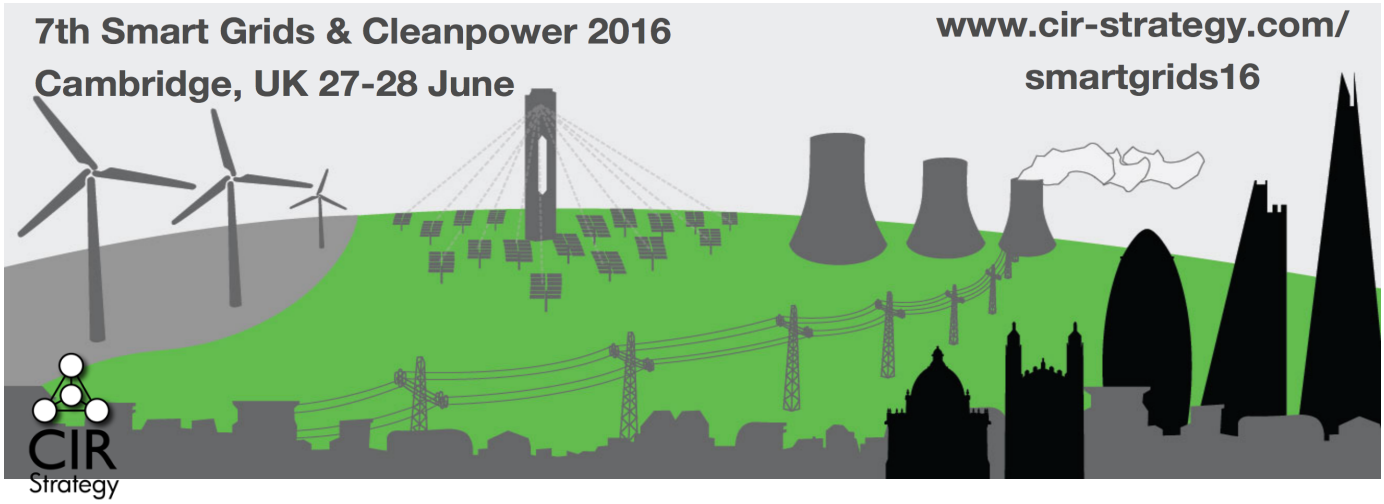


SMART GRIDS & CLEANPOWER 2016 BUSINESS CONFERENCE JUNE 28

Registration 28 June 09.15 - 9.45a.m.

Session I 09:45 - 11:15 am

09:45 Introduction - Dr Justin Hayward, **Cambridge Investment Research** & Gavin Jones, **GJC** & Jeremy Nicholson, **EEF** Senior Adviser EIUG

10:00 Energy market structures for UK - Ben Willis, Generation Strategy Manager, **RWE**

10:20 Keynote: Engineering IOT-based System-of-Systems Automation for Smart Grids - Professor Jerker Delsing, **ARROWHEAD** SG (EU) Project Co-ordinator, **Luleå University** of Technology, Sweden

10:40 Guiding future investments for infrastructure & sustainability growth - Peter Sharratt, Leader of Strategic, **WSP Parsons Brinckerhoff**

11:00-11:30 Panel Q&A with chairs

11:30 Coffee networking break

Session II 12:05-13:15pm: Connected Homes and Grids: software, IIOT, meters, big data, analytics | Moderator: Peter Drake

12:05 M2M, Distributed Computing & the Dark Arts of Communications - The Software powering the real "Smart Grid" Fraser Durham, Commercial Director, **Argand** Solutions

12:15 Smart grid measurement - Marieke Beckmann, Centre for Carbon Measurement, **NPL**

12:35 Aggregating behind meter storage for Grid services & sales - Chris Wright, CTO, **Moixa** Technology

12:45 Patents: potential threat or opportunity? Pawel Piotrowicz, Partner, **Venner Shipley** LLP

12:55 Keynote: Cormac O'Prey, Director, **Sentec Sensus**

13:10 Panel Q&A with Peter Drake, CEO, **Intelligent Networks**

13:25-14:25 Lunch & networking

Session III 14:25 -15:30pm: Smart grid projects globally | Moderator: Gavin Jones

14:25 Case Study: European infrastructure stress, large-scale storage - Georgina Dingley, **AMT Sybex**

14:40 Case Studies - USA & Canada - Dr Frank-Schultz, Master Architect, **IBM** Global

14:55 Case Study - Grid solutions for India & Iran - Dr Sean Cochrane, **Cyan** Technology

15:05 Case Study: SNS - Value of Grid-scale Energy Storage, **UK Power Networks** - Christos Keramisanos

15:20-15:40 Panel Q&A

15:40 Coffee networking break

Session IV 16:10-17:40pm: Plenary - Policy discussion on grids & energy | Moderator: Jeremy Nicholson

16:10 Risks and rewards of fracturing for shale gas - Dr David Reiner, **CJBS Cambridge University**

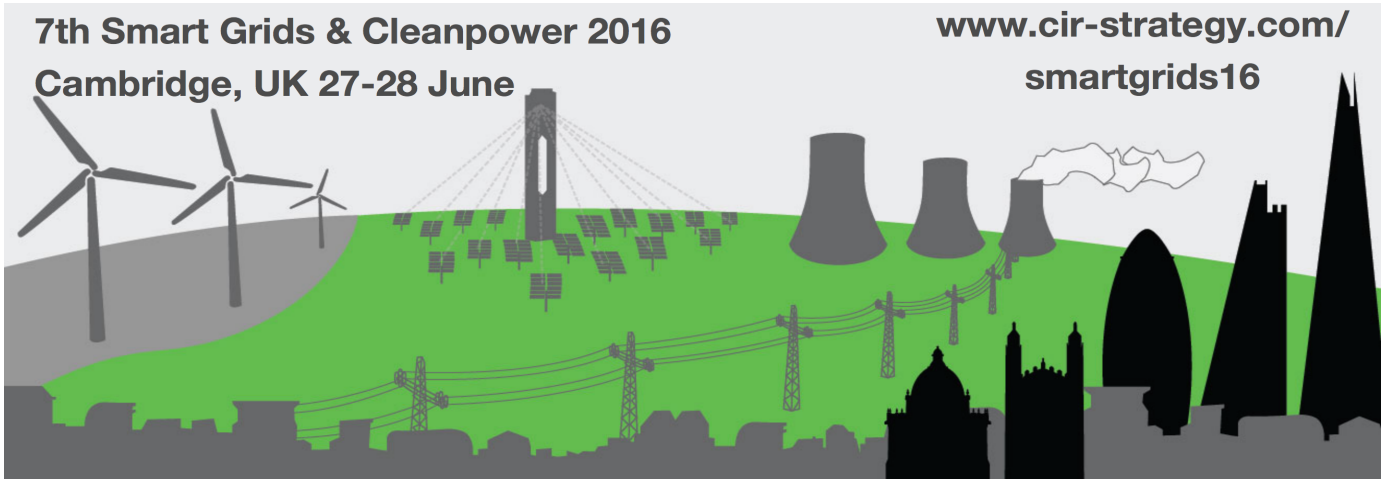
16:25 How regulation can be a win-win for stakeholders - Susan McDonald MIET, **National Grid**

16:40 Network Price Controls and Smart Grids Flex - Maxine Frerk, Partner, **Ofgem**

16:55 Long-term energy outlook & impact of emerging & disruptive technologies, Anant Prakash, **BP**

17:10 UK energy management innovation - Sally Fenton, Innovation, **DECC**

17:30 Panel Q&A 17:40-17:45 Summary of Day by Chair Gavin Jones **Close**



This 7th Smart Grids & Cleanpower Conference at Robinson College was organised by the business methods consultancy Cambridge Investment. It is part of the CIR Conferences Series, which has run since 2007. The next event 2016 takes place November 2016: http://www.cir-strategy.com/events or 01223 303500

Smart Grids & Cleanpower 2016 Business Conference Day - June 28 – Notes by Gavin Jones, Gemma Siddall and Christopher Jackson, edited by CIR Strategy

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 issues with the market as well as the roles of National Grid, Ofgem and DECC. We've heard about the challenges of smart cities around the world
I have a new worry to keep me awake at night IP trolls
We have learnt about technology developments in smartgrid from Sweden, Devon and here in Cambridge, and storage both in the home and in the grid. We have learnt of the importance of analytics and information. We have heard about the challenges of fracking and we have heard about smart grid use cases from Leighton Buzzard to Ontario and from China to Brazil
So I want to thank you all for coming and being so engaged in the discussions and also to our speakers throughout the day.

I thought was an excellent conference. I only heard positive views from others.

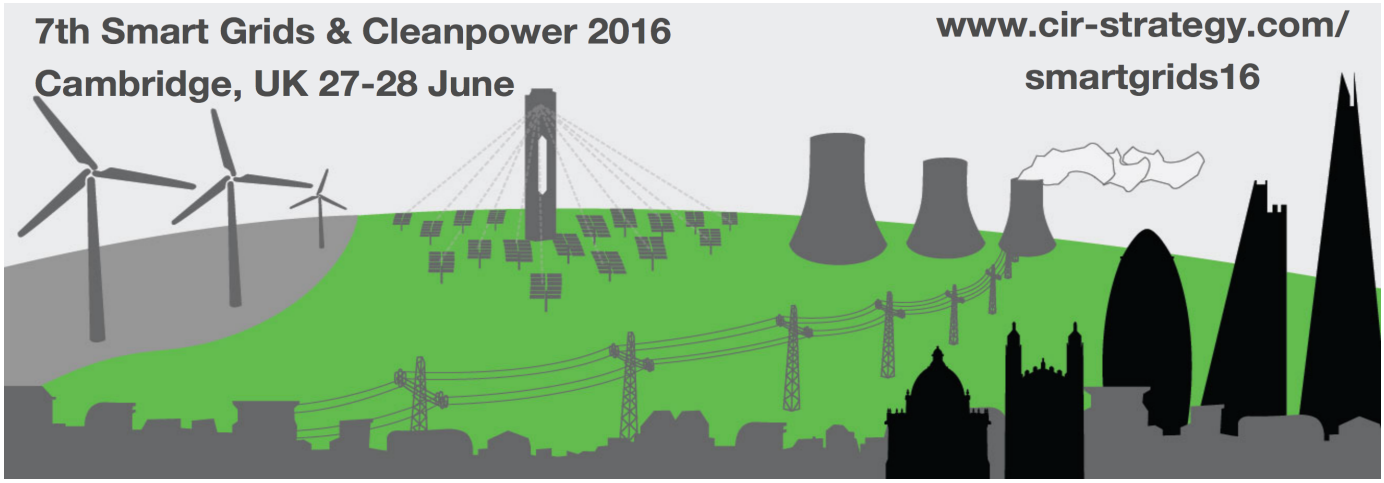
Gavin Jones

CIR strategy

1.0 Session I

1.1 Introduction

Thank to the sponsors and leading participants and Exhibitors; Argand solutions on energy data analytics, Briton EMS OSI Electronics, CIR. Further participant and supporter logos below.
Gavin Jones
Role of Data
Transformative business cases
Addressing the barriers
Manufacturing industry and service industry – moving to a smarter system



1.2 RWE

- Strategy department
- Germany and Netherlands
- Portfolio = coal, gas
- The all-important balancing across
- 2001, in essence the market has not changed
- 1990s, the renewables 'became a thing'
- stable market structure
- 2006, 2007: Is this the right market framework?
    - Premium tariff
    - Accessible term – regulated assets
    - Generation assets
    - Intentions to close based on economics
    - EMR, 2012, carbon price support
    - Tax on the carbon content on the fuel
    - Intention of competitive mechanisms, encourage new entry, as many
- Piece meal approach
- 2001 Energy market + Scotland = Present market landscape
- Piece meal design issues
    - Big change
    - Incremental iterations
    - Impact
    - Carbon press support
    - Competitiveness
        - Shutting down Steel works, Wales
    - CFD, justified around government, increased alliance
    - Capacity mechanism – technology neutral
    - New entrants of choice, diesel engines
    - Main impact: outside market, small engines, wholesale market, capture, avoid cost, suppress very cheaply, devalue the wholesale market and contract the difference.
        - Set of perverse rules and unintended consequences

- Wholesale energy market
- Increasing number of investments
- Centralised and decentralised
- PV
- Risk of a vicious cycle
- Lower charging base
- Distribution networks – circularity
- Charging machines is creating
- Peak demand shifts to the afternoon, to avoid distribution charges
- Increase the need fro services to balance the system
- Undermined the balance
- Conventional generation closes
- Cost of the services is likely to rise
- Creating new services
- Frequency responses
- New technologies will provide some competition
- Capacity mechanism
- Non-UK based in capacity mechanism
- Transition versus
- Essentially – interconnections

- Future
  - Participants will always optimise multiple value streams
  - Market structures need to be robust
  - Need to accommodate
  - Network costs
  - Level of decentralisation
  - How the network operstinn 10 -15 yrs

- Jerker Delsing – Arrowhead IIOT Project EU funded
- Smart Grid situation
  - Very many actors involved
  - Houses, buildings
  - One of the big challenges

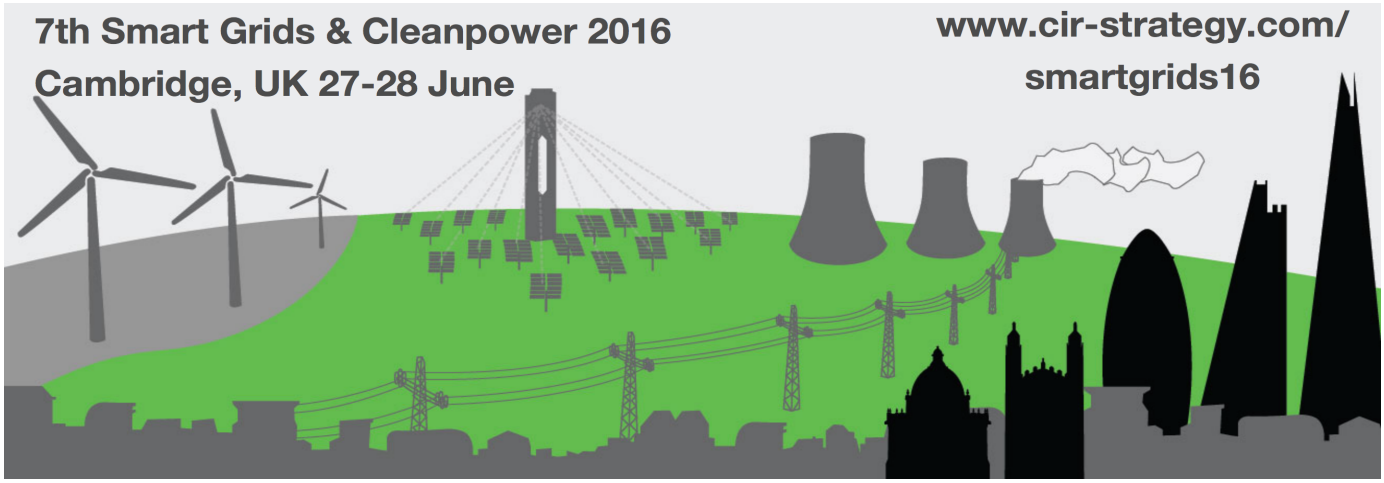
- Sony ericisson
- Automation systems
- Current technology
- Human brain automation
- Vast field of applications
- Interconnect
- Smart cities
- Smart buildings
- Everything is connected in different ways
- Factory is not a factor
- Surroundings
- Building automation systems
- Suppliers
  - Emerson
  - Schneider Electric
- Building automation to the cloud
  - Automation pyramid
    - More flexible, cloud based, protocol based
    - Is this possible
    - Explored in a number of projects
    - Can they talk?
    - Can they communicate?
    - How can we integrate?
    - Can we do that
    - Engineering on a high level

- Global cloud
  - What about
  - Security
  - Engineering
  - Amazon's cloud
  - Enable security, reduce the number of dependencies
  - Local clouds
    - How can we create automation technology?

- Street lamps
- Energy related, capabilities
- When is this producing energy? Usage of energy?
- Flexible in how much?
- Within a certain time frame?
- Many examples for that
- Every individual device can be flexible user
- Can we get an understanding of that?
    - Find the devices
    - What is your flexibility?
    - This is for this building,
        - Part of the city is connected to one local supplier
        - Create a flex offered
        - Enables us to, on a contractual level
        - Usage of energy
        - More dynamic way
        - Is this computative to imprint?
        - Smart car, street lights, different types of sensors
        - Part of arrowhead is providing
        - Basic technologies
        - Open source
        - Demonstrators of commercial situations
        - Exposed these flexibilities
        - Expected usage
        - Flexibility
        - Individual machines
        - Requires we can talk to each other
        - We do have the tools and understanding
        - Interesting numbers
        - What is actually necessary?
        - What is going to be the differences?
        - Engineering cost
        - Automation systems

- 2 examples
- to build an application for the customer
- engineering costs
- how can we connect different units?
- Which part of the plant?
- Definitions
- Open source code,
- Trying
  - Flexoffer
    - Tutorial available
    - Working code, working systems
    - Higher level functionality
    - Already available
    - Is this type of technology?
    - Different type of high level requirements
    - Is this there in the market?
    - Products of the market
    - SAP level

- WSP
  - Development infrastructure
  - Less technical presentation
  - Thoughts on the complexity issues
  - Global picture of urbanisation
  - Less GDP – city led
  - Generation of money and wealth
  - Top mega cities by GDP – New York, Tokyo
  - By growth – 2 thirds – Asia → China
  - Huge concentration
  - Cities as drivers of the global economy
  - Urban growth patterns are informal
  - Infrastructure, power and provisions
  - Less century's investment in end of life
  - Comprised to meet the changing demand in an effective



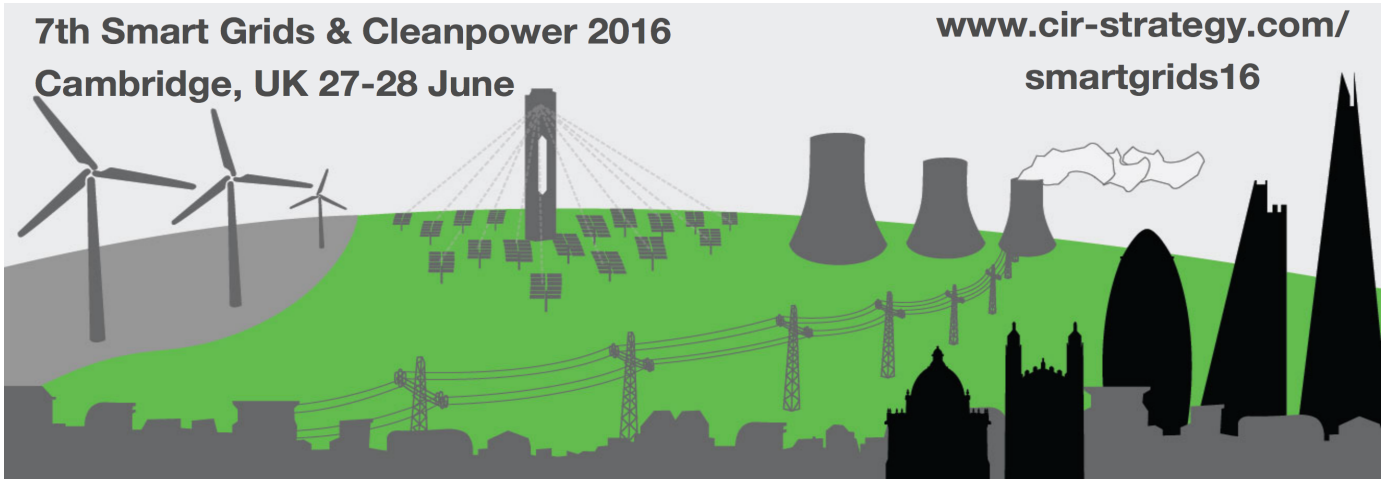
- Governments
- Figures are so big, unfundable
- How do you invest into a revenue model
- Asian assets
- Complexity and the need to account for the value
- Particularly
- Interconnected with land use
- Urban plan and national plan
- Accountable land value
- Balance on the return of the investments
- Huge impact
- How do you repurpose and reuse aging infrastructure?
- Land
- How do you repurpose these?
    - Technology substitution
    - 1-2 examples
    - green growth models
    - integrated approach to infrastructure
    - resilience review
    - role of shifting away from peak demand management
    - fit and forget
    - key point of departments
    - how do we engage and link up
    - what role do electrical vehicles
    - ownership model
    - what happens next?
    - Mobile convertor, tanker
    - Transport led development
        - Huge growth in London
        - Analysis for responses
        - Densify the city fringe
        - Eco towns
            - Less promising

- Population dispersive model
- Big question
- What is all the connected infrastructure
- Network rail
    - Power corridors
    - Change
- Strategic case, locate station
- You are not allowed to account for that value
- Look, explore and collaborate
- Small area
- Life cycle
- Cost benefit analysis impact
- Strategic planning
    - How does the country modernise
    - Rapid over-capitalised investment
    - Growth challenges
    - Primary energy sources
    - Development
    - 80% renewable sources
    - low, clean cost energy
    - support integrated strategic planning
    - how do you reset the buttons
    - much more sophisticated strategy for planning

Questions and Answers

Q: not all growth is good, where is your company positioning yourself?

Ans; WSP: changing enormously, things are changing
Phasing out coal.
RWE: EDF colleague – we are waiting for the button to be pressed
Q: who's the button presser
RWE: French government – French growth area for industries – EDF shareholders – what they say goes, colleague from EDF – bullish



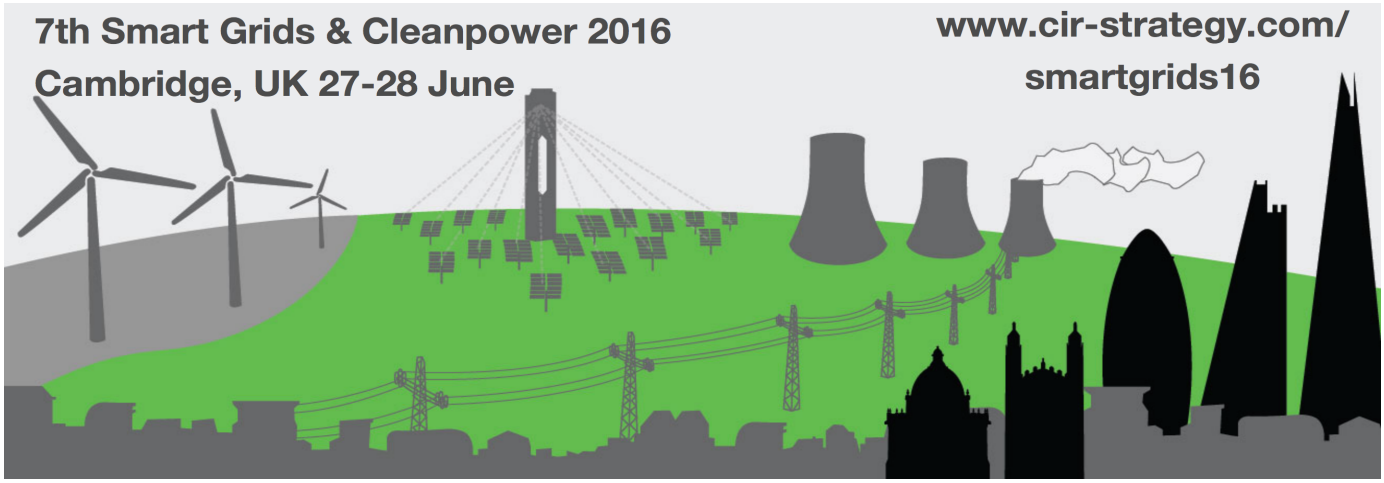
JONES: the drive, the value is not what they get from building that model, couple of projects that has not gone quite so well, prominent flaw, way over budget and scale.
RWE: learning opportunities,
WSP: developing small-scale reactors, the future is huge, on screen for 25 years

Q for professor: Datasets, Swedish system
Ans: which datasets?
Q: Assumptions?
Ans: Example temperature is standardised, semantics in my language, one of the really huge, number of groups working on this, technology can bridge, bridging across semantics, still something to address, it doesn't matter that UK solve it, there is probably 30-40 different approaches, yes the understanding is needed, number of iniatives

Q: Government – 2 way relationship?
Ans: not my knowledge
Q: whose idea was to actively deal
RWE: don't know, we are the least integrated company,
Q: whose idea was it cut?
RWE: production levels, wind turbines, incentive oversell sell your costs and under sell your sales.

Q: Nicholson: there is no rush to large scale generation, **solar tariff - solar is becoming competitive, unexpected - returns are excessive** - we do not need conspiracy theories - where do we go from here? What is the evidence: both in renewables & non-renewables?
RWE: if we are looking for means to getting costs down – government is assuming new builds, essentially bespoke bits of kit, made by the million, least cost capacity, energy: very expensive to run, emissions – those are not the concern.
Jones: Amendments in the government's thinking, better fit, subsequent fit,
RWE: localised generation is not a bad solution, large centralised generation, easy to transport, the move towards the centralised generation, PV, best use of resources, think about it more holistically

Q: is it diesel or is it is gas?

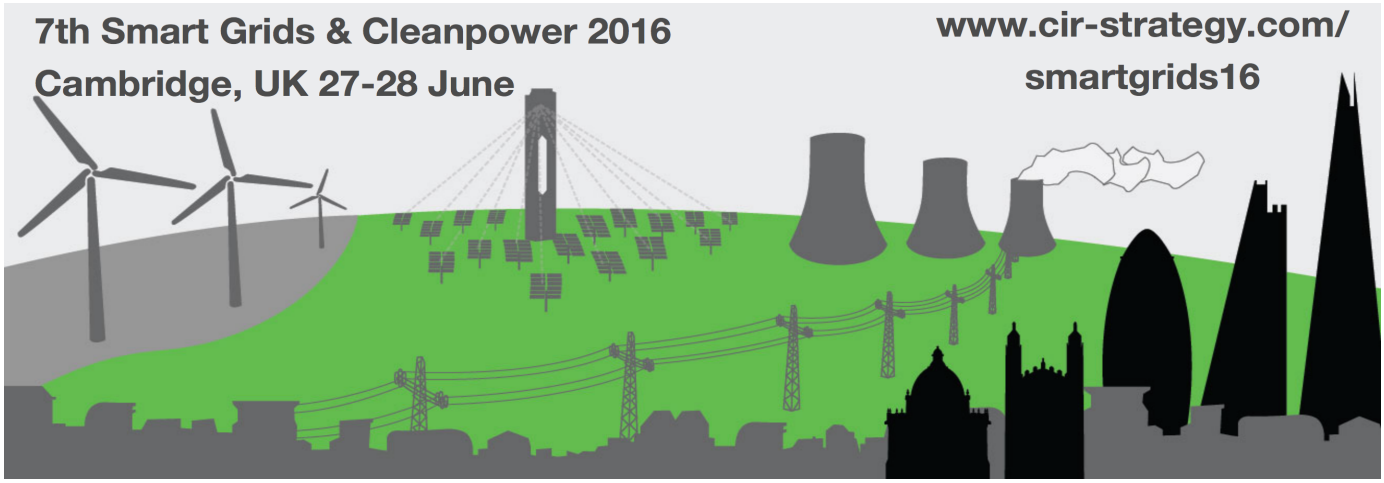


RWE: holistic vision should be, it was an unintended consequence, more sulphur oxides, 2 or 3 orders of magnitude, how that fits holistically.

Q: how do you deliver efficiently?

That's effectively, the issue that capacity mechanism is not the driver, capture, business model – the risk – 2 gigawatts – peak demand – the longer the more generation that is funded, the longer it is captured – the more it is installed, the longer it has to run,
WSP: Too complicated
Hayward: What is success over time
Professor: criticised by others, necessary to explore, what is possible to get? How many people use lifts/escalators? What are the investments for big production, peak capacity, energy scenario, the only fossil fuel, policies for energy houses, houses should be producing energy as a starting point.

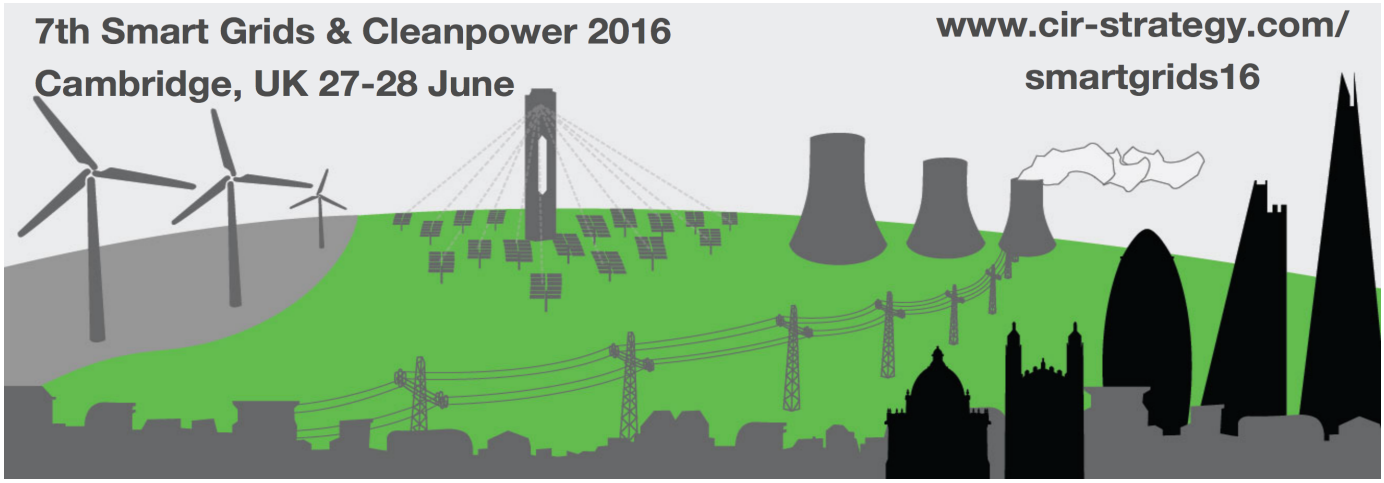
Q Briton: how safe is it?
RWE: Safety is one of the key issues, we have to assume, if safety issues is not overcome, I think we can assume, whatever happens , there is no product, there is no value, 700 applications, 1.6 kW, only for of those, had a similar level of interest, significant amount of capacity, its something you talk about in the golf club
WSP: the role the consumer played, the consumer is put in the frontline, here we are, we are going to phase out, replace,
Professor: what is the cost, number of experiments, even to the single person, as soon as you can touch the wallet – cost is part of it, you don't have to go out and buy the highstate to get from one place another, you can buy a small car, cost is only part of those decisions, you know what those cost is, you don't know how much it costs to make a cup of tea (about 1.6p in energy bill), even if you knew, still want the tea (probably, yes!)?
Professor: agreed, we need the information, when energy costs become a very small proportion, certain level of cost
RWE; favourite example – material changes in the well being – to step changes in the efficiency, the invention of thess - industrial of these – the steam engine – burning wood to burning charcoal where we are now, consumers, we want to know. The next question what is the actual damage if any and best way forward.



Session II

Argand Solutions

- 3-4 years old
- Background = dark arts of communication, dark arts of money, parallel from the financial markets and apply to the smart grid, a lot of people with funky analytics
- Insights what we have had, integrity of layer, all of the different sensors, cheaper, Linux, cheap software, messaging layer, smart grid, developing infrastructure
- Vertically integrated – predicted maintenance + smart grid solutions
- Main focus, constrained, this communications layer
- Two vertically stacked, n to n communications,
- Message protocols
- Repeating – two way communications – cloud based processes, good consistent communication, high level of data integrity
- Also we need solutions that start, much smaller packages, GPRS network
- Smaller packages
- What I would like – this may not be the fault – how you are trying to send it, we do not think it is fair to blame to GPRS
- What are the financial markets?
    - Messaging protocol has become – no data loss, highly scalable, take an example – lost into the flow diagram of the data, we want to open a port, particular address, really hard, IT department; they do not want us touching their network, we do not actually talk – problem – when you are sending GPRS – network goes down – real issue with integrity of communications network – problem we have come across – the way we try to solve this – apply that to read energy measurements, and so we take these breakers and in a format – sensor or meter – now when you post this message, what the device onsite
    - Always looking at that particular letterbox – what do we need to do? Respectively acts, what happens – we want to ensure –
    - Message Letterbox – day to milliseconds – you will not lose the commands – this has actually been done, subtle change, communications layer, we have also seen

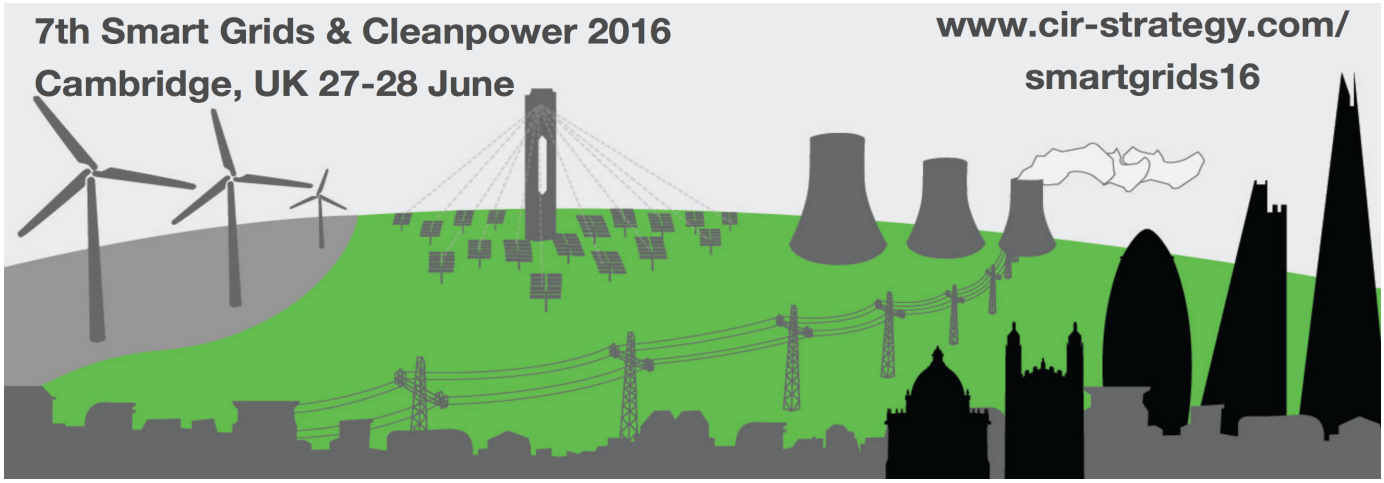


- very, very high levels, different areas, we think is key, we believe is really interesting,
  - Cheap processing = raspberry pie
  - Control signal - I would like to read this meter, essentially your processor can undertake - multiple communication protocols - you can program these Linus processes to enable control signals - really interesting - all of these individual - predictive maintenance - each meter - break each of these points - all of these messages and then you can start to breakdown all of the data - enhances - handshake - enabling - elastic servers - amazon webservers - data every 30 minutes - all this processing - 29 minutes - use the elastic servers -
  - Letterboxes - sensor-agnostic approach

NPL

Metrology
Unique perspective -
Modelling and physical aspects

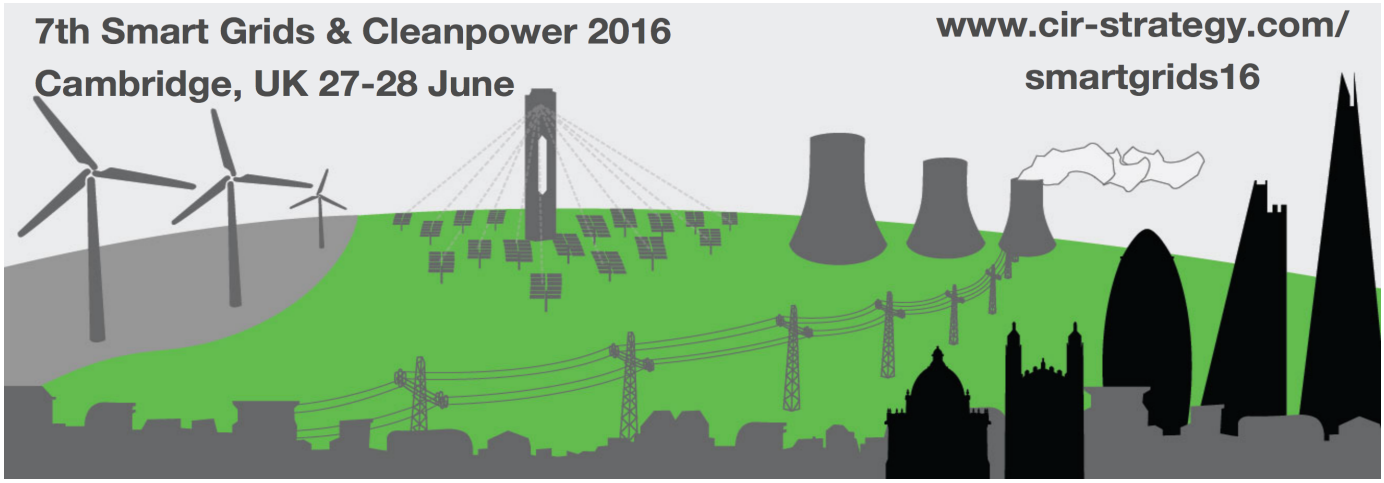
- All your plugs
- In this sphere - harmonics, superharmonics, modelling carbon saving, do the sensor networks - fit for purpose - we provide that flexibility - why do we need them? The strains on the power systems - increased the renewable - increased stresses coming from the urbanisations, we will have more mega cities (21 ++) we need to be smarter, we need to innovate at absolute scale,
- We talk about the support - innovation - grid measurements
- In order to plan - we need a good understanding
- Wind versus solar
- How can we manage than?
- 1 example - when you plug into the system
- GPS enabled
- We currently applying that
- Denmark - case study >50% renewables, what lessons can we take, we started measuring things later this year
- Non invasive techniques to support decision making



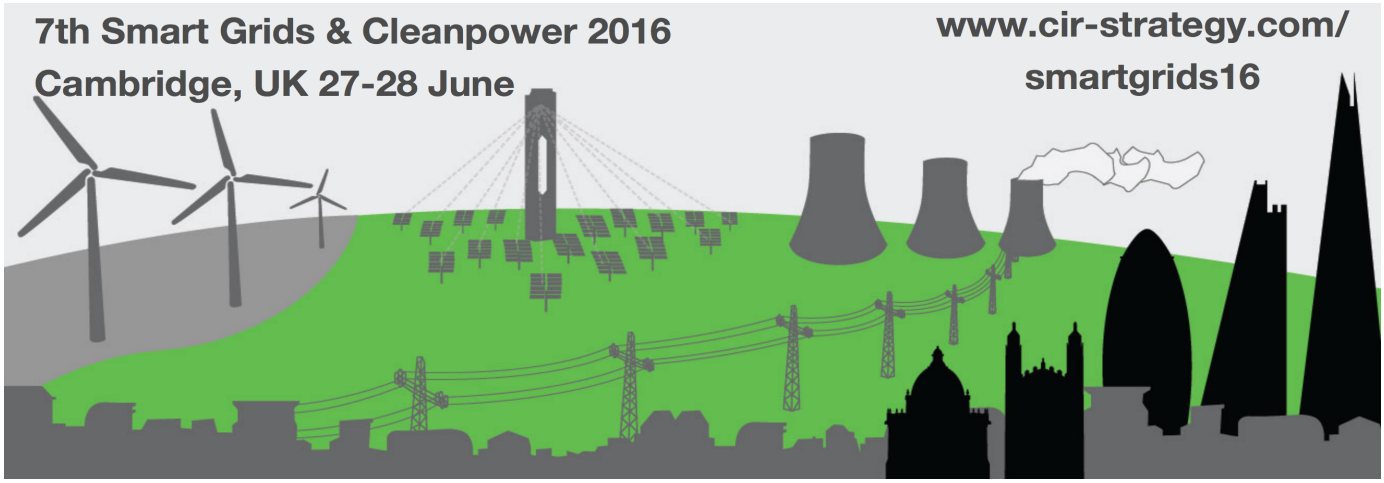
- Significant investments
- Ofgem – model the carbon impact – flexible carbon factor – be able to predict, forecast, more accurate.
- We need to be smart or implement
- Crucial question
    - Big data challenges – smart grid discussion – traceability – we are actually - emerging field
    - Examples
    - Asset management
    - Still functional
    - Large scale
    - Combine 2 data sets – how do you combine?
    - Air quality, London issues
    - Low cost sensors
    - Combine high quality to calibrate the low quality
    - Understandable?
    - Low carbon technologies
    - How might you be able to calibrate the smart sensors, rather than calibrate time
        - Micro to macro

Moixa Technology

- What it is we do
- We manufacture the Maslow
- Fairly deployable
- Grid share
    - We are connecting
    - Treated as if there was one large
    - Various energy storage
    - Why do you want to do this?
    - Increasing proportion of renewable energy, what was the solar?
    - That is not measured
    - We apply government projections, around quantities of solar
        - Governments gone green



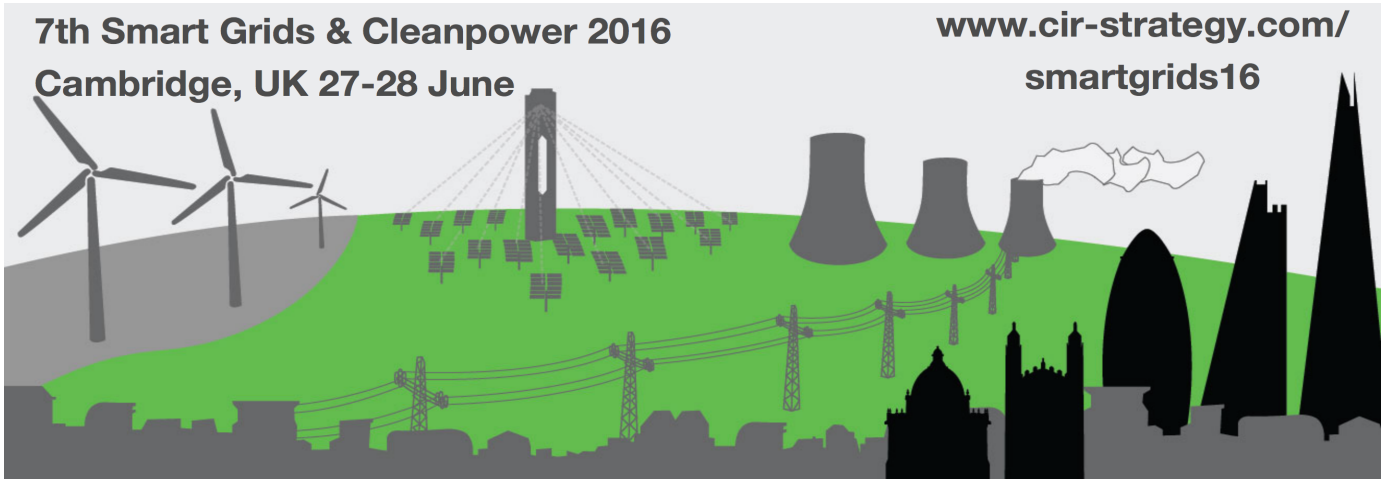
- We might have issues
- How that really is beginning to affect
- Start eat into things, why would you do storage in tiny lumps, more or less
- Lake at the bottom of the mountain
- We really said – relatively quickly to harness
    - Sky installed 15 mi
    - Not different level of capacity
    - Solar panels – time shift, we connect the system,
    - FFR, capacity market,
    - Working with utilities
    - What is interesting – you make a system that is reliant
    - 10 megawatts of battery
    - monetise a series of revenue stream in the home
    - aggregate the resource
    - what will storage look like
    - demonstrating – working in Manchester science park
    - we got patents granted
        - transitioning from a bunch of projects
        - commercial contracts
        - large number of residential land lords
        - why would you want to do this?
        - Germany Energy consumption
            - Fossil fuel = night time
            - Implies the capital deployed to pay for that generation
            - Relatively small proportion
            - Wholesale of energy
            - Recover their money
            - Smoothing mechanism
            - Lots of storage
            - Started much later
            - Support for solar
            - What you can see
                - Blue = used



- How are they using energy
- Assets = 40 years
- Can be dramatically in less in a decade

Patents

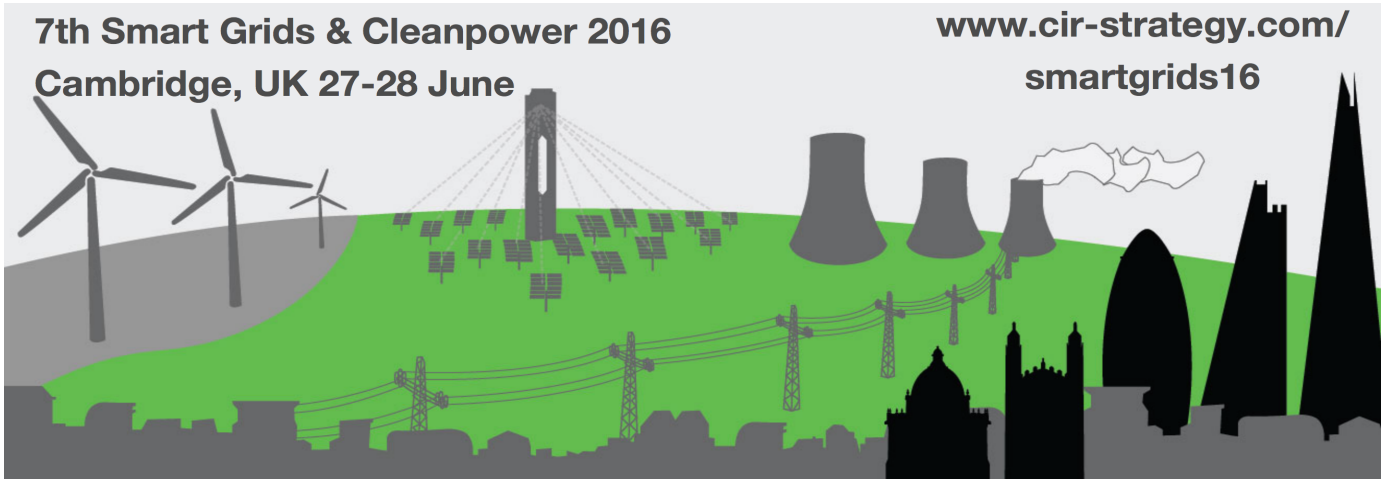
- Potential threat or opportunity?
- Complexities of obtaining
- Necessary evil
- Patents = opportunity + threat
- Companies need to think about IP they are generating, IP audit, what will happen in the future
- Experience from different sectors
- Smart grid sector
    - Evolved and changing concept
    - New ways to mange that power
    - A lot of consumers
    - Model/ analogy = look at the telecoms
    - Context providers
    - Network providers
    - Lots of consumers
    - Data
    - Mobile devices
    - Supplies also from parties
    - What can the smart grid sector learn?
    - Threats
    - Smart phone wars
    - Blackberry devices ruled supreme
    - Used research
    - 600 m dollars, what is the take home message?
        - Embedded
        - US market is saturated
        - Who now own the patents?
        - Trend – US companies, Korea, China



        - We do not own the intellectual property that covers the smart grid in the UK
        - ARM
        - Diverse and complex
        - Exploit industry
        - To be able to develop technology
        - Plenty of opportunity to take place
        - If you were to look, competitors of a particular
        - Go to court
        - Outside players
            - Try to monetise
            - Increasingly
- Generating IP
    - Aware of other people
    - If not generating IP
    - Third party bias – beware
    - Evasive action
    - One last factor
    - Red hat = open software company
        - Anti patent
- Brexit
    - Unitary patent system

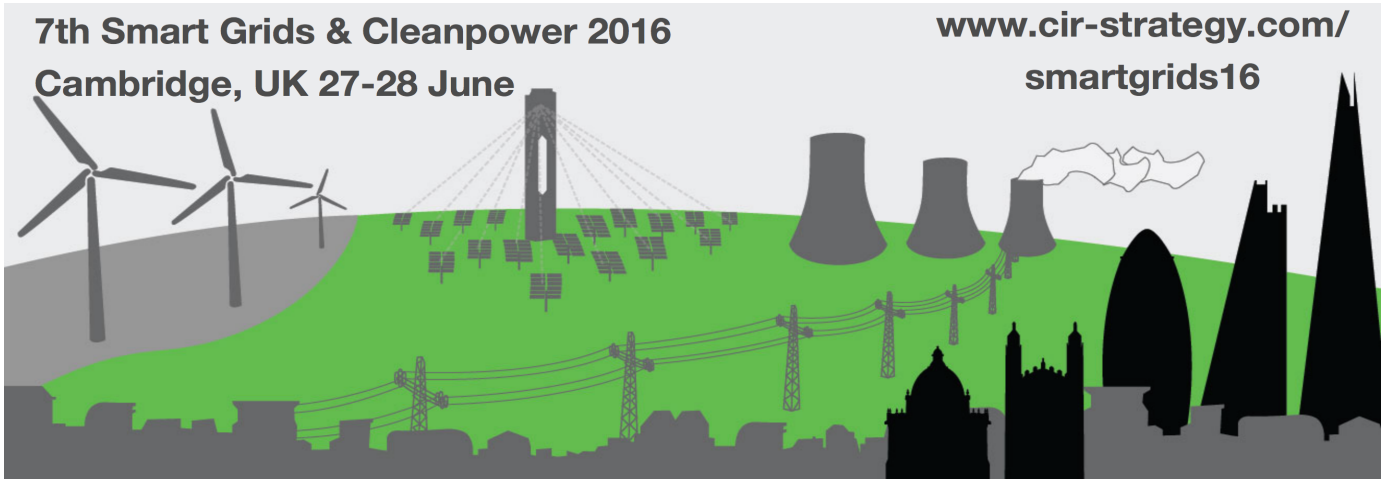
Sentec

- This summary will sound familiar – which is a positive I hope
- Incoherent systems and descriptions of complexity
- Smart grid
- Scalability
- Fractal grid
- How are we going to make it all work?
- Transmission lines
- Nice and simple grid
- Distributed generation



- Significantly changed – lots more distributed data centres
- Picture/analogy = nervous system = complicated generation
- This represents a flow of information
- Flow of power
- Two work together
- Power of working together
    - Out of control
- Traditional energy supply = power stations
- Power is coming in from the wrong places in the transformers
- Real data, captured, from the transformer during the trial
- Patterns and pulse energy from renewables
    - The power is flowing form the wrong direction
    - Pipeline doesn't work very well
    - Need to understand the grid
    - No longer operating
    - That is the result
    - They
- What is the problem
    - Fractal grid
    - Metal box manufacturers
    - Battery storage
    - Multiple different power sources
    - What can we do to control this system?
    - No overall control
    - No optimisation
    - Communications interface
    - A way of controlling your grid
    - What does it look like?
    - Commercial, domestic, industrial
    - Scale
        - You need a buffer
        - Buffer is energy storage
        - Tesla battery storage

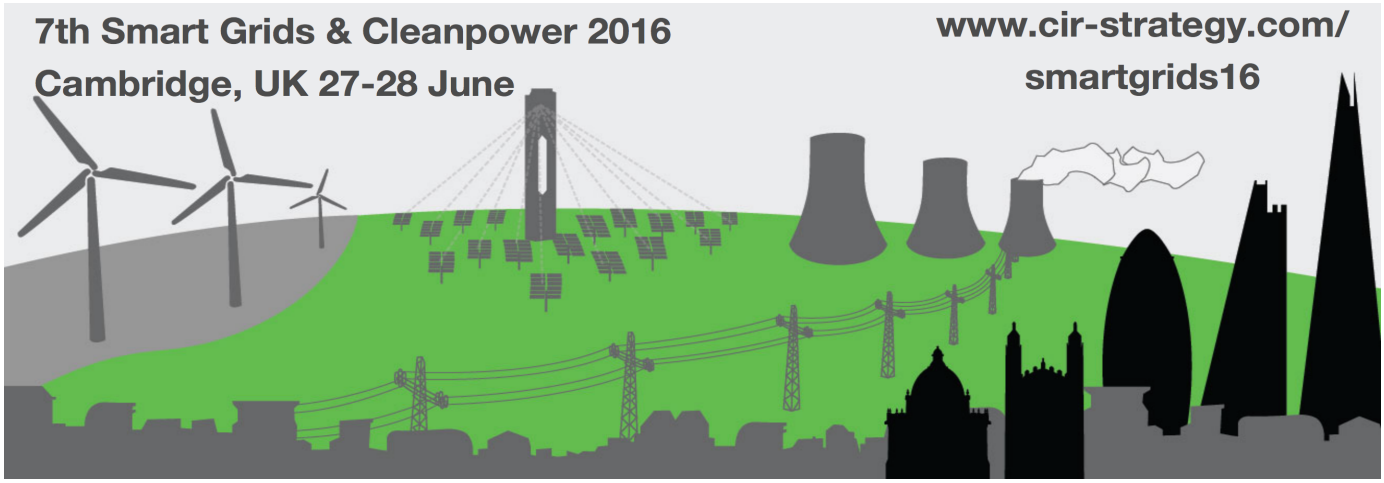
- Really interesting idea
    - Will it be enough?
- Solution?
- Scalable?
- Interconnectors
    - Scaling to international
    - IBM: bewailing trying to communicate data between Germany and Denmark
    - Icelink
        - Global
    - Desertec = supergrid
        - Africa to Europe
- Knowledge leads to control
    - Data to knowledge
    - Knowledge to data
    - Different levels
    - Challenge = make them all work together
- Summarise all the thoughts, what is the smart grid?
    - A lot less interest and discussion
    - Do we know more?
    - Ground up perspective?
        - Engineering problem
        - Traditionalists are risk averse and unfamiliar
        - DNOs = culturally allergic
        - On board to do this
        - This is a big problem
        - Pace of change
        - Way forward, scalable way
        - Small mature steps are need, but they are still steps, and needed



Session III

AMT Sybex

- Software company
- In the workplace, supporting industry
- Product = networkflow, storage optimisation response
- Forecast energy flows and constraints
- Commercially driven
    - What can you do within?
    - National grid contacts
    - Wholesale markets
    - Assets and market
    - Storage device
    - Capacity now and the future
    - Network assets
    - Maintain
    - Safe
    - DNO example – need to use energy storage
    - Commercially
    - Physically
    - Still need to forecast
    - Still need to communicate
    - Storage is not the same as solar
    - Full optimisation – more management systems, more enabling systems
    - Forecasting functions
    - Use a lot of energy
    - Fuel generation – energy storage
    - Peak energy requirement
    - High carbon impact
    - Opportunity
    - Maximise energy
    - Simple optimisation



  - Forecast and optimise
  - Earn revenue 95% part of the time
  - Managed the on site cost of the operations
  - Systems in place
  - Reducing cost
  - Non optimised solutions
    - Add costs
    - Breakeven much soon
    - >>> growth margins

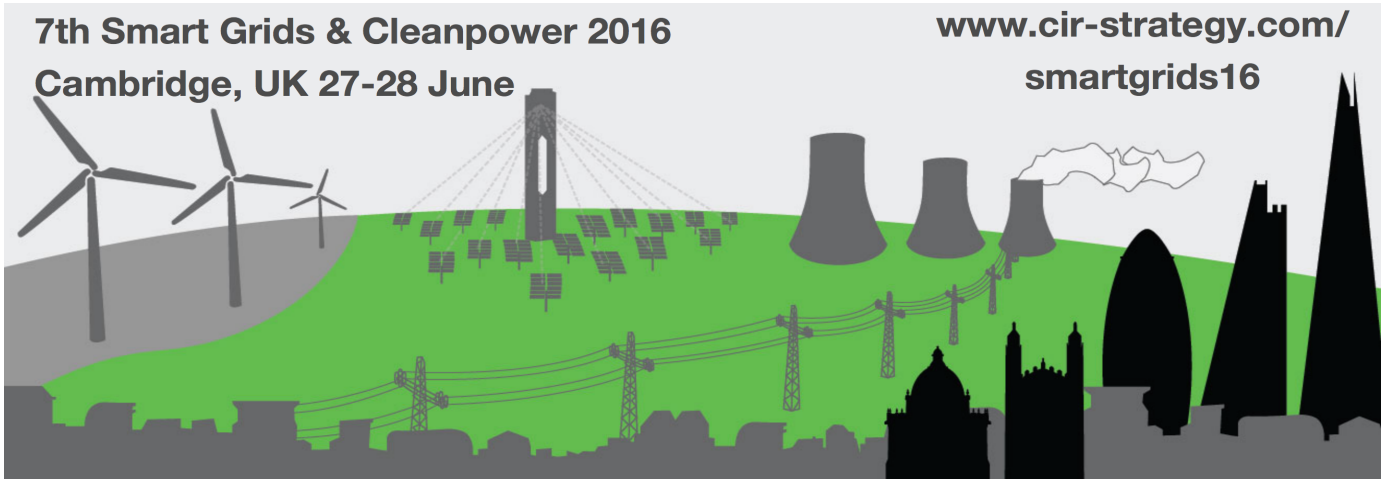
  DNOs: similar, owning the storage, particular site, do not by default.
  Energy storage
  Network maps – impact
- MWh: 36 MWh

IBM case study
- Flavour
- One proposal, one completed
- Hydro one networks
  - Radial network
  - IBM = integrator, overall systems, analytics
  - GE
    Schneider
  - Hydro one = client, civil engineering
  - Multi-faceted project
  - Multi-programme
  - Substation automation
  - High penetration of solar
  - Sun shines particularly well
  - Additional solar installation
  - So little demand
    - Solution
    - Greener alteration
    - Disconnected no a randomised basis

        - PV supplier – negligible
        - Small peak
        - Distributed
        - Required the cooperation all the parties involved
        - Service arrangement
- 2nd example – US electricity distributor
    - solution
    - historically data to predict the failures, where they are going to be
    - reduce that down and identify those at risk
    - IBM Analytic model
        - Benefits wee are hoping to get
        - Relatively simple
        - Data cleansing
        - Overall maintenance
        - Strategic asset management project
        - Maintaining

Cyan

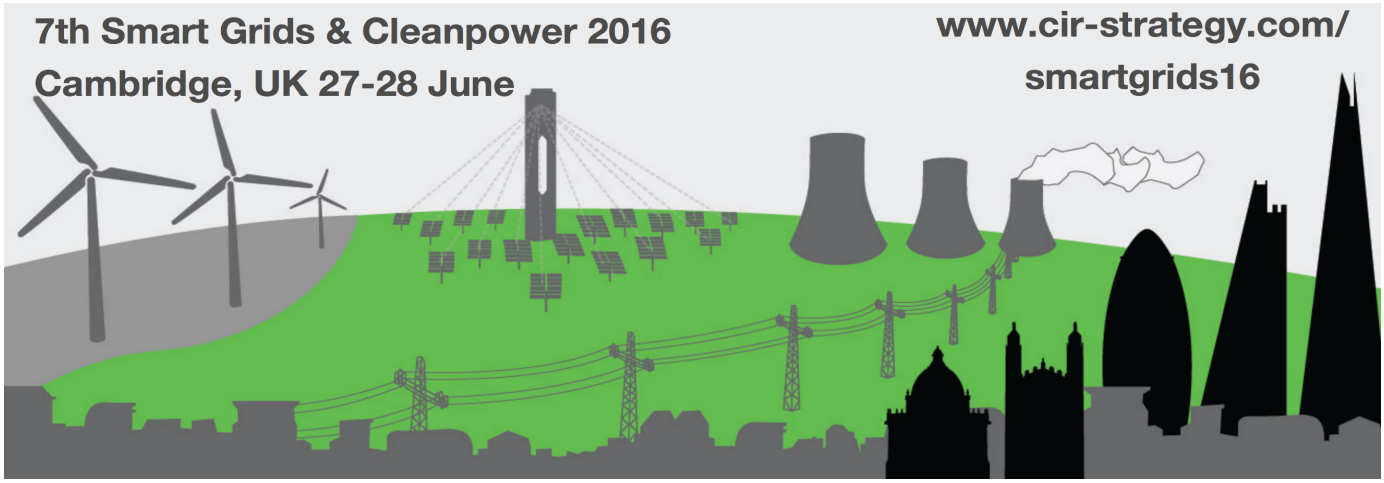
- Communications platform
- Smart meters, smart lighting
- China and India
- 34 000
- in the last 18 months: offering in different territories
- the local partners for international deployment
- each territory
    - different applications
- free payment revenue issues
- Shows a lots things are associated with revenue protection
- The issue of collecting revenue
- Very helpful – real time alarm
- in addition – lighting control – lighting system – dim
    - granular control



- potential savings: maintenance, performance target, smart lighting
- radio devices, partners into the lamp
- manage maintain and again – lighting projects
- alongside territories – merged
- combined lighting control
- ground up
- most recent announcement – acquire Connode
- consolidated network of cities
- by combining the capabilities
- expertise of cyan
- high performance networks

UK Power Networks Services

- Who are the stakeholders?
- Lithium-ion technology
- Automotive technology
- This not decreased the battery costs
- A lot of money is invested
- Energy storage helps the power system
- Energy storage can save those peaks
- In the UK market, leading company
- Sept 2015 – National Grid – dynamic, consultation
- Why energy storage?
  - 55 gW
  - 500 mW
  - Additional demand
  - Forecast demand
  - Different triggers
  - Very versatile tool
  - However
  - Different countries, different requirements
  - How different entities are affected by different applications

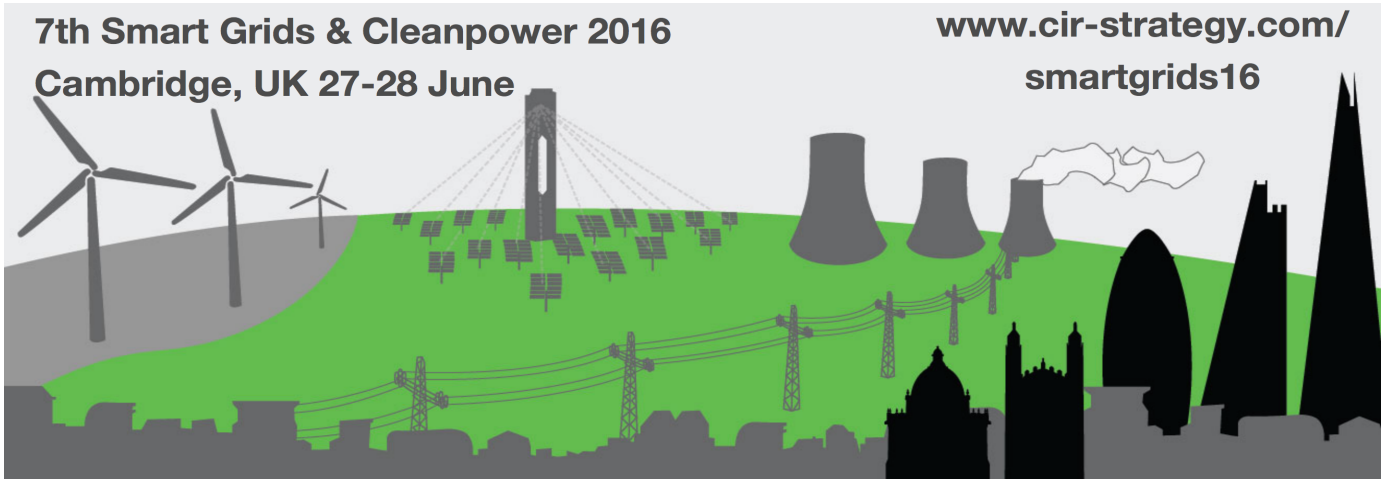


  - These rates equations to different applications
  - No one reply
  - AGGREGATORS
- Stakeholders
  - Large scale energy storage
  - DNO owned, 3rd party, 3rd party commercial/industrial
  - Commercial /industrial application – benefit
  - Focus control
  - Smarter network storage project
  - Cannot be hold in one of the circuits
  - Energy storage device, 17 million
  - Demonstrated
  - London Underground, Network Rail
  - Reducing cost
  - Energy storage has to be tailored to customer requirements
  - Tailored product
  - Different storage device
  - Different ratio
  - From finance to operations
  - We want to work with all people

Questions and Answers

Q: Different business case – why cant DNO achieve through contractual

Ans: have access to the planners, traditional method, it should be difficult, more cost efficient. Who could potentially. I almost disagree with the 10 MW, largest energy storage, other technologies, metal acid batteries, liquid air, compressed air.
Storage is a priority for Africa
Data quality, more transparent,
Q: Regulation barriers
KPN: DNO perspective - exploitation,
Business cases are temporal



Uses of storage

- Costs and benefits

Session IV

Dr Reiner
'clearest policy disaster'

- Some of the same figures
- Former PM = David Cameron
- False claims
- Claims of cutting energy bills – sovereign wealth fund
- Without ruining precious countryside
- Seismic data
    - Drilling exploratory wells
    - Minor earth tremors
    - Very hard to get to production
    - The other challenge = complex of concerns
        - Validity
        - Concerns over cancer and land contamination
        - Exploration of shale gas
        - Very effective mobilisation
        - Shale gas exploration
        - UK: liberalised gas market to exploit gas
        - To operate and to move on
        - The amount of attention
        - Northwest
        - Has led to significant scrutiny
        - 2013 – no huge appetite for shale gas exploration
            - Poland is the outlier – 32%
            - Priorities
            - Euphoria
            - NGOs mobilising

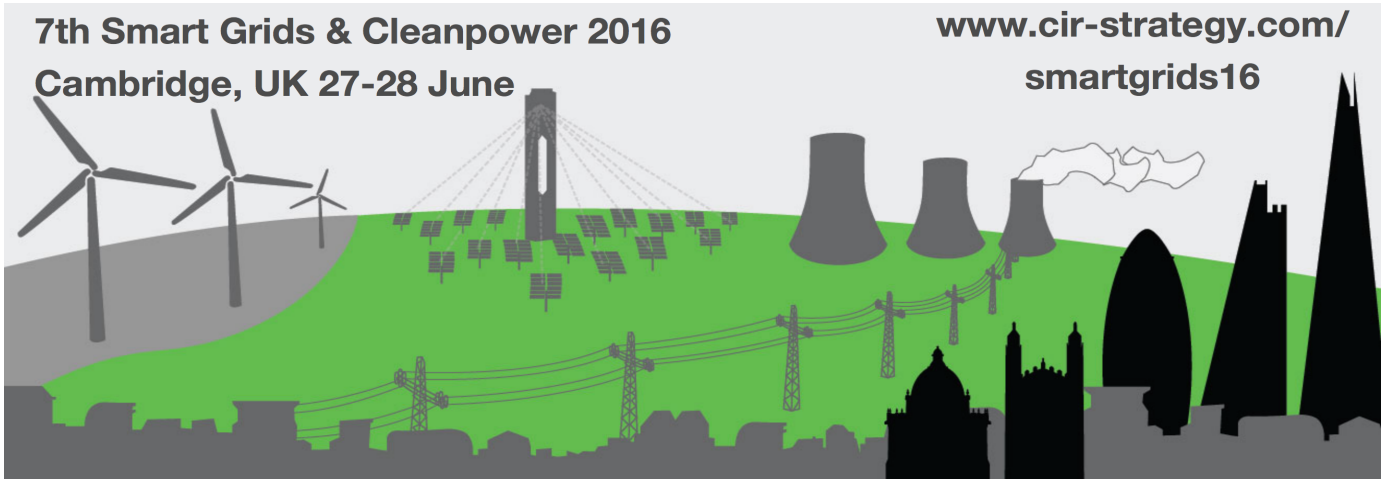
- Right move, wrong move
- Fracking mobilisation – Sussex police
- Focus groups
- We used experts
- Many places
- These are very poor regions
- Lack of trust in the capital, government, regulators
- Strong sense, people have formed their opinons

- **Consultations: clearly there is a negative framing, versus little positive framing**
  - Explicit trade off, with risks and benefits
  - People use
  - The geology is different
  - Reputational damage
  - Strong public opposition
  - Natural gas royalty estimate
  - Dialogue with public
  - How far off do you have to be?
  - Preferred answer

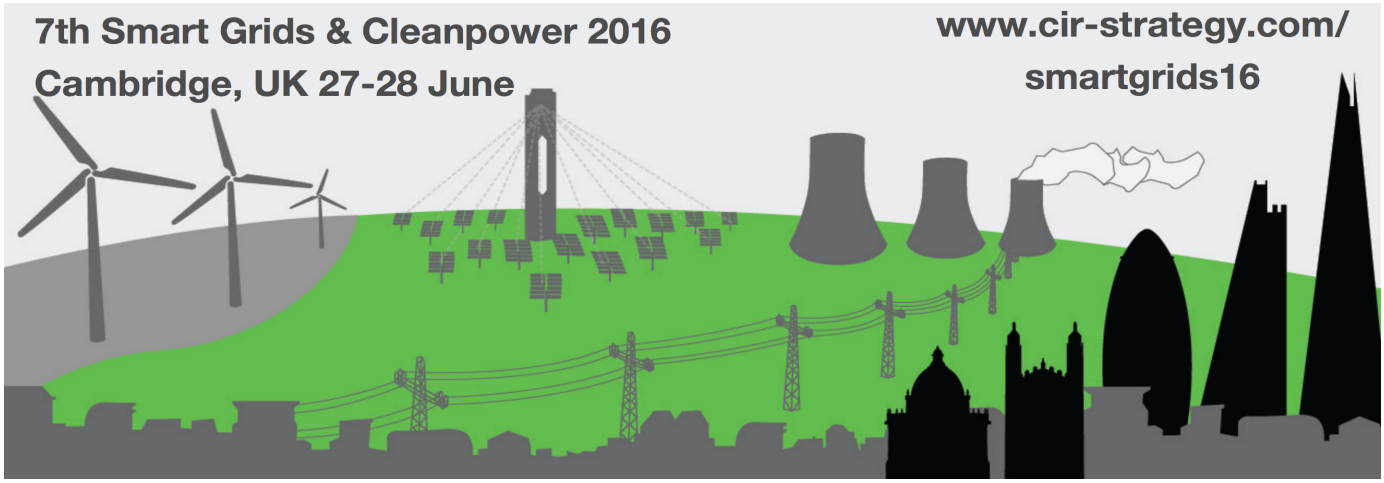
Regulations

National grid = own the networks in Britain – who are the stakeholders?

- Those you are affected, or who have a project
- Nuclear power station Ofgem
- Land purchases
- Multi-stakeholder is very complex
- RIIO
- How are delivering for consumers
- Key rewards and penalties
- Commercial and technical innovation
  - Network innovation competition
  - To ensure we are delivering a leading network that is fit to purpose
  - What are the changes?



- How to they provide that clarity?
- How do we get stakeholders engaged?
- what does that mean,
- safety is number one priority
- reliability
- environmental impact
- supporting narrative
- how we selected a particular investment design
- keeping open dialogue
- new creation SWW
    - area from the national grid perspective
    - created from uncertainty
    - we have to engage the community
    - we welcome competition
    - transitional project
    - how do we manage it for our stakeholders?
    - Moving to the summary
    - Critical part on energy
    - Lots of supply risk margins
    - Decision making process, development
    - Customer requirements
    - What type of technology should it be?
    - Complex decisions
    - You cannot underestimate the level of information underestimated
    - Very complex, can you justify this to the consumers
    - Most importantly
        - No impact – 2 processes
        - Planning, Regulation
        - Delivery of a project
        - Making we are engaging in communities
        - Going to the planning process
        - Regulation timeline
        - The consequence of that



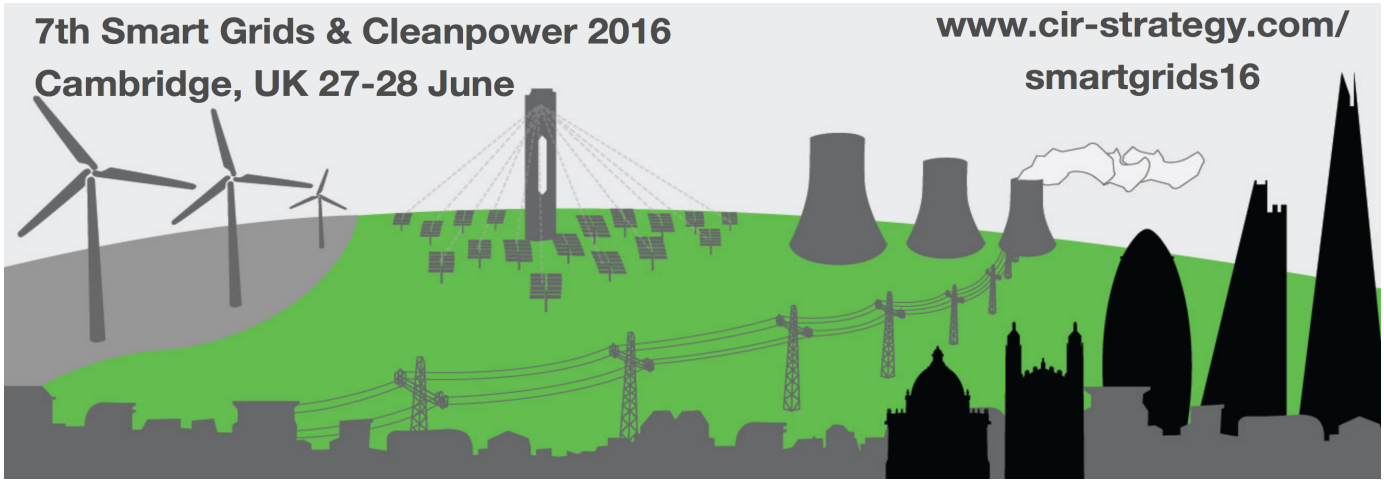
Ofgem

As a regulator we have an important role to pick winners

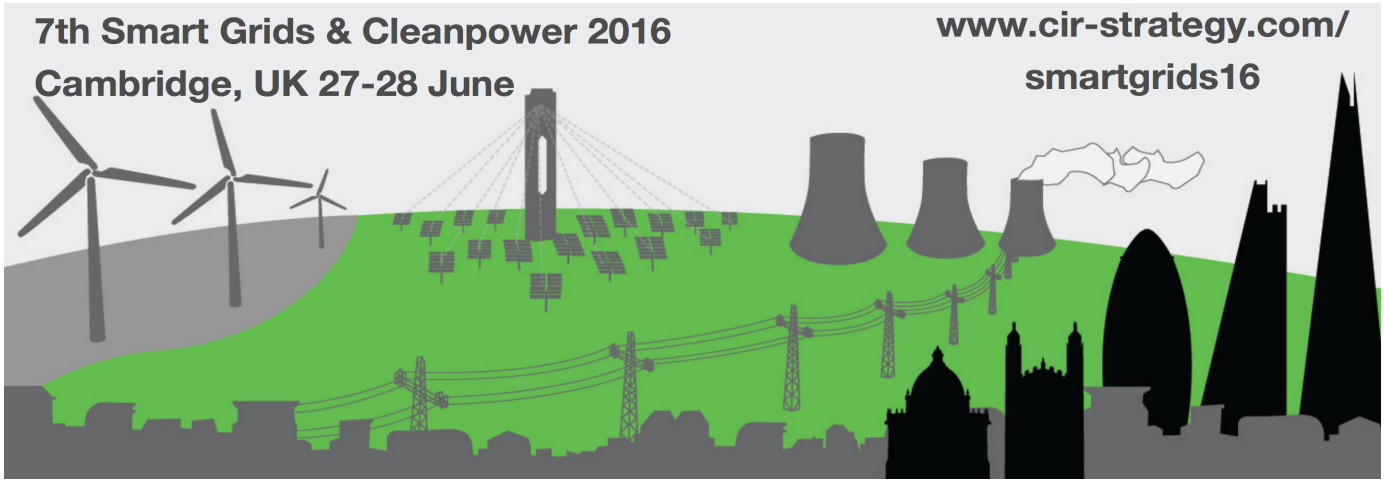
- Energy systems as a whole
- Primarily around networks
- Price control are designed to get us into the more innovative space
- Driving outputs
- Quantitative measures
- Efficiency, sharing incentive
- Reduce their costs, below
- Incentive on efficiency
- How to reduce interruptions
- Self healing networks
- Predictive maintenance
- Enables them to run their networks

The basic components of RIIO

- Works in a static world
- To think about the future and a very different type of world
- Price control regulation
- We were really convinced to get a culture shift
- DNOs = culturally allergic to move into the grid space
- Slow moving network operator, not always going to be in that space, price control, intend to send the signal
- Slightly paradoxically
    - World is changing a lot, lot faster
    - What is going to happen the fast grids
    - Encourage long term thinking
    - Wider stakeholder engagement
    - Fast changing technological world
    - Developing plans
    - Capital intensive solutions
    - How they use more sophisticated solutions
    - Innovation solutions



- Small amounts
- Bigger projects
- The predecessor – usual funding
- All benefit from learning : sharing and dissemination
- Encourage participation
- Network innovation competition = drive and creativity
- Network partner – to deliver change
- Many of these challenges run wider
- Stack of sources of revenue
- Market
- Benefits of demands
- Exposure in the wholesale
- Network innovation
- Flexibility
- Where is the value
- Call for evidence
- Initial thinking in those spaces
- Storage
- One of the barriers to storage
- Separate category to storage
- Connection rules
- Some elements of the charging are linked
- Clarify the role of aggregators
    - Independent company providing the services
    - No regulation, Restricted
    - Issue around consumer protection
    - Self regulatory participation
    - Cross party impacts
    - Does your supplier know, if you are going it
    - Greater transparency
    - Storage demands
    - Clarify the regulatory status
    - Network charging



BP
Strategy

- Four big trends to impact the energy ecosystem, not related to one particular technology
- Plan our strategies for adaptation
- COP21 Pledges
- The intention is clear
    - Enabled, galvanised by China, USA to reduce greenhouse emission
    - Direction of travel in the right place?
    - Is intention enough?
    - INDC trajectory versus pre-COP21 pledges
    - We drift to an unsustainable planet
    - 'Policy interventions will not be linear, but will be sudden'
        - ie coal industry
        - Policy and regulation are elected by change
        - Demographic changes
        - Price correction or paradigm shift?
        - Accommodate price
        - Irrational exuberance in the oil and gas industry
        - Shale revolution
        - Returns starting falling and project complexity
        - Cost of supply = supply chain + human element + geographical
        - The key consideration

Renewables – rapid scaling up

- Policy
- Technology
- Cost
- Renewables
- 330 BN in renewables, far greater than in oil
- Producers as well as consumers get together
- Experimental basis if it scales up
- As costs fall

- Who actually is making money?
- Predictions in their industry
- The bank of Japan
- Internet scalability

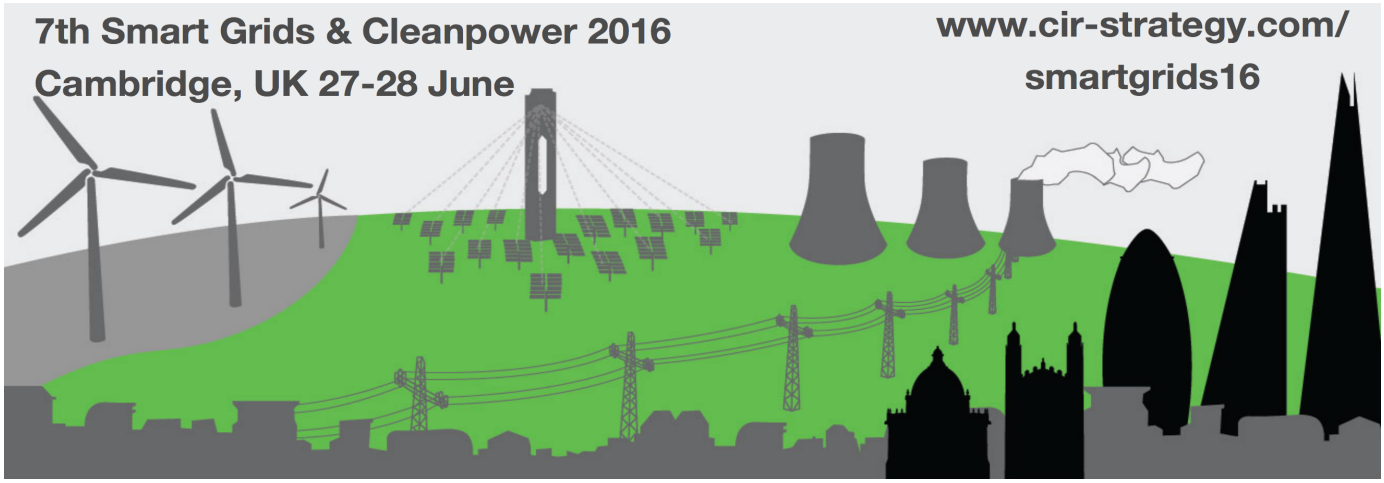
Future transportation

- Battery limitations
- Consumer preferences have adapted – dramatic scale up – Iphone
    - When does it saturate
    - There loops in transportation
        - Uber
        - 2 costs = fuel + drivers
        - electrification = -fuels
        - driverless cars = - drivers
        - so these are the 4 big trends I see
        - commodity price
        - when we forecast →

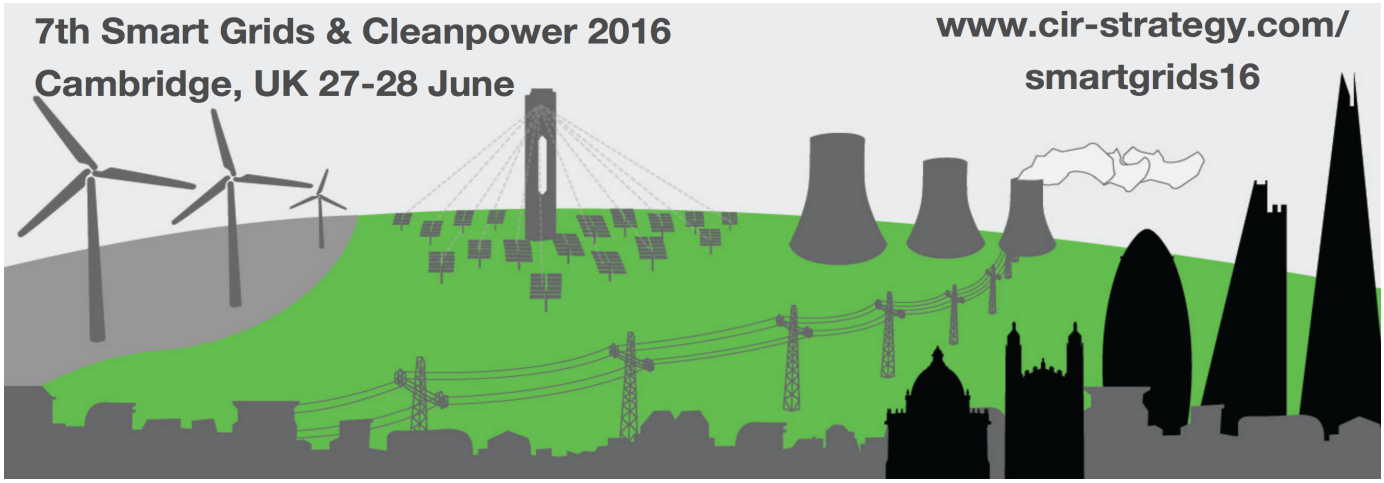
DECC

Review of activity

- report from the national infrastructure
    - emphasising the benefits and aspects
    - best of the flexibility
    - secure that flexibility
- policies
- energy storage
- regulatory issues
    - mirrored in the same issues
- peer to peer
- there are definitely opportunities
- focus on flexibility
- UK Energy Innovation Support
- National programmes only
- Low carbon energy
- Allocated



- Next five-year period
- Ring fenced for nuclear research
- Research on the small modular reactor programmes
- £250 million
- non-nuclear research
- earmarked on the smart sign
- activity and funding
- heat network
- deployment end
- business innovation and skills
- National innovation plan
- BIS ownership and funding to the Innovate UK + Research Councils
- → UK Research and Innovation Body
- Catapults Offshore renewable catapult
- More recently → energy systems catapult
- ETI
- Funding particularly
- 8 Great Technologies
- Actively looking
- Without ofgem
- Energy research partnerships
- Innovation landscape
- Innovation project
- Focus on support and clear market failures
- Clarifying objectives in terms of UK growth
- Internal and external analysis
- Internal/external modelling
- Specific research
- We compliment the work of the bodies
- Capture the flexibility
- Looking forwards to the wider connections
- Operator issues
- Call for evidence

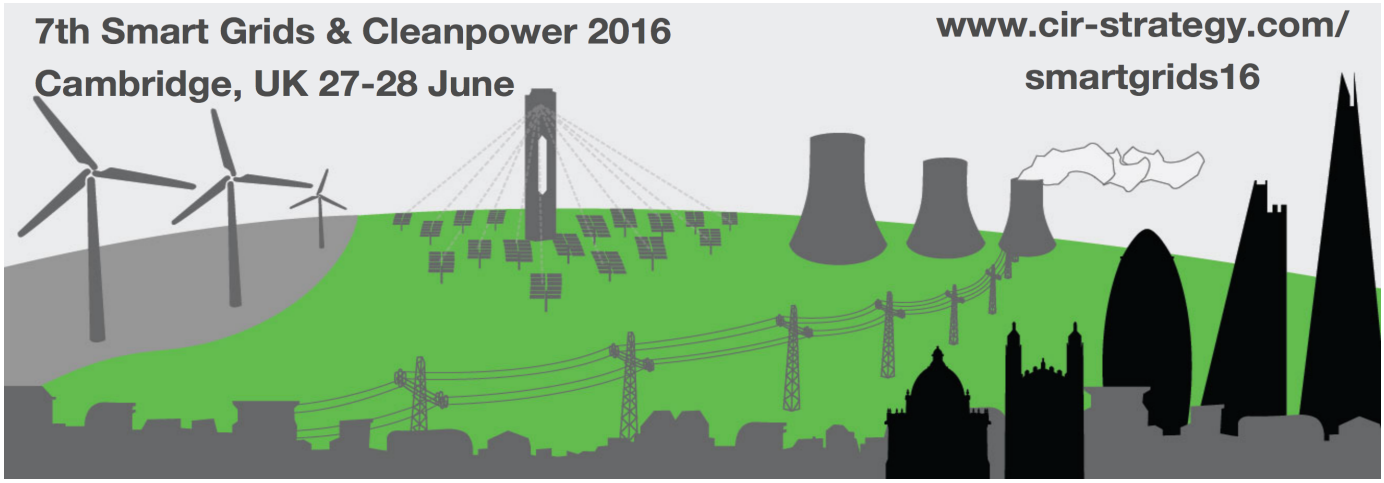


- Underlying analysis
- Set out the detail of cost & benefit
- What we think is needed
- In terms of innovation support
- We had a commitment to have at least funding
- Smart umbrella
- The call for evidence
- The areas we are thinking of funding
- There will be some questions
- We are very keen to have proposals back in
- Main mechanisms of support
- Equity routes
- Other technology areas
- Deliver and make sure so other delivery bodies
- Widest routes of stakeholders
- In terms of area we are looking at
- DSR
- Key identifying them
- Business case
- Energy uses and needs
- Small business, models
- Local levels of the system
- Cost reduction of technologies
- Storage devices

Panel

Q: Uncertainty – complexity – unpack the link

Starting off with complexity, the complexity of that – we have a number factors, a time of generation, in order to secure – triggering significant project – how can we consult stakeholder – technical complications – factor into the decision making – we have to remember – how will



we engage – that's all complex – for instance – timeline – national grid – additional submissions – we have to have to get planning, issues, timing,
Certainty – offshore

Q – 2 questions what is different, when we venture into alternative energy

BP: BPAE venture was the wrong timing, technology is competing on a level field, the intentions were great, but the commercial timing was not suitable, looking at it now, new commercial parameters – the energy outlook – 2 degrees centigrade – interventions will be needed, what the future could be like, make more needs to be done, what we see as happening,

Q: the current role in regards, to distributing licenses, incorporate widen up to incorporate – when is this happening

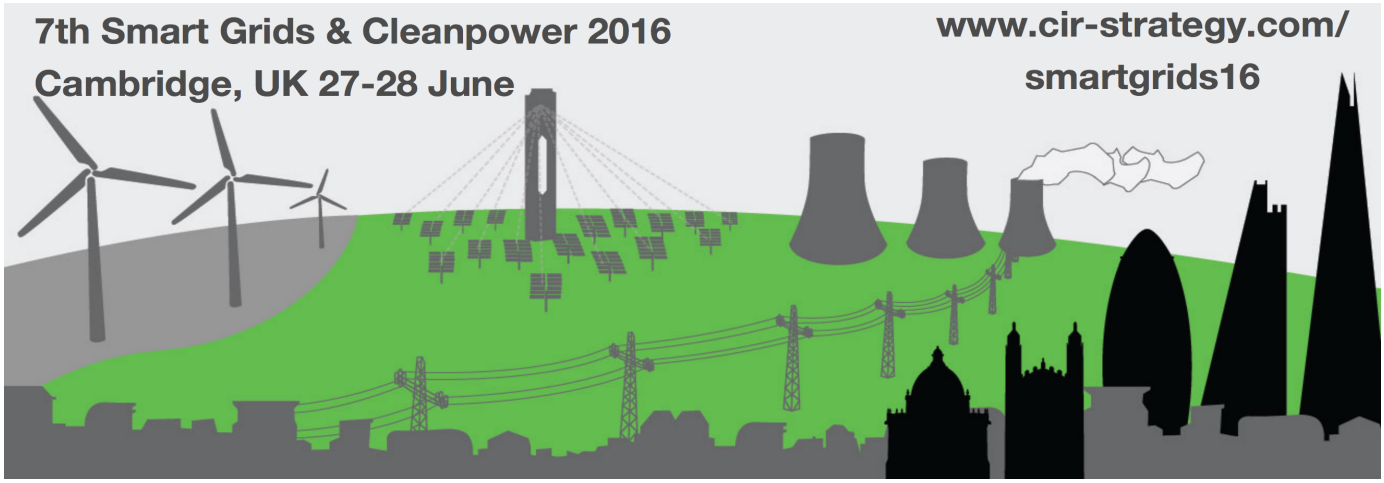
Ofgem: What are your model of the barriers? There are some speak, piccolo – looking at what needs to happen – will we need
BIS: innovation is broad – innovation funding,

Q: Nicholson: would you imagine giving the same presentation in 1 years time?

Professor: Yes! Price environment, hostility, permission to go ahead, market economics stopping major change.

Additional Notes Day 2 (CJ)

Energy market structures for UK - Ben Willis, Generation Strategy Manager RWE
"We are the least vertically integrated vertically integrated company."
Professor Jerker Delsing
Luleå University Sweden
Many predictions such 500 billion IoT devices by 2025. Heathrow has 5 million devices in 2016.
Movement from an ISO Pyramid based automation to a cloud based automation system for the IoT.
Arrowhead/Processit.eu is a EUR68million consortium to develop cloud based sensor networks.



Some examples: Streetlights, thermostats car heaters.
Denmark 5% reduction of peak load in USA will save USD 35 billion over 20 years

Guiding future investments for infrastructure & sustainability needs - Peter Sharratt, WSP Parsons Brinckerhoff

40,000 person engineering consultancy
Top 23 cities have 5% of population and generate 14% of GDP
Current and aging city infrastructure is unable to deliver the performance and sustainability required.
Renewal of aging assets costs trillions of dollars.
How to repurpose old infrastructure, eg the power and water connections to decommissioned power station?

Q&A

Energy Intensive Users Group: Solar subsidies cut because ROIs were too high.
Diesel Generators: very cheap to install, expensive to run.
700 applications 1.6GWh in 2015 but only 4 projects progressing – most projects not progressing.
Energy price awareness in consumers is absent.

Patents: potential threat or opportunity? Pawel Piotrowicz, Partner, Venner Shipley LLP

UK owns few of the patents regarding smart cities, this is a risk for UK freedom to operate.
However, there is plenty of opportunity to create an IP based business model like ARM.
European Patent Office and agreements entirely independent of the EU/Brexit effect.

Keynote: Cormac O'Prey, Director, Sentec Sensus

What is the Smart Grid? Analogy of the nervous system transporting data, and the circulatory system transporting power. Moving from a linear pipeline to a multi directional web. The grid is no longer operating as it was designed to do. The Fractal grid incorporates anything from laptops and mobiles to substations and power stations.

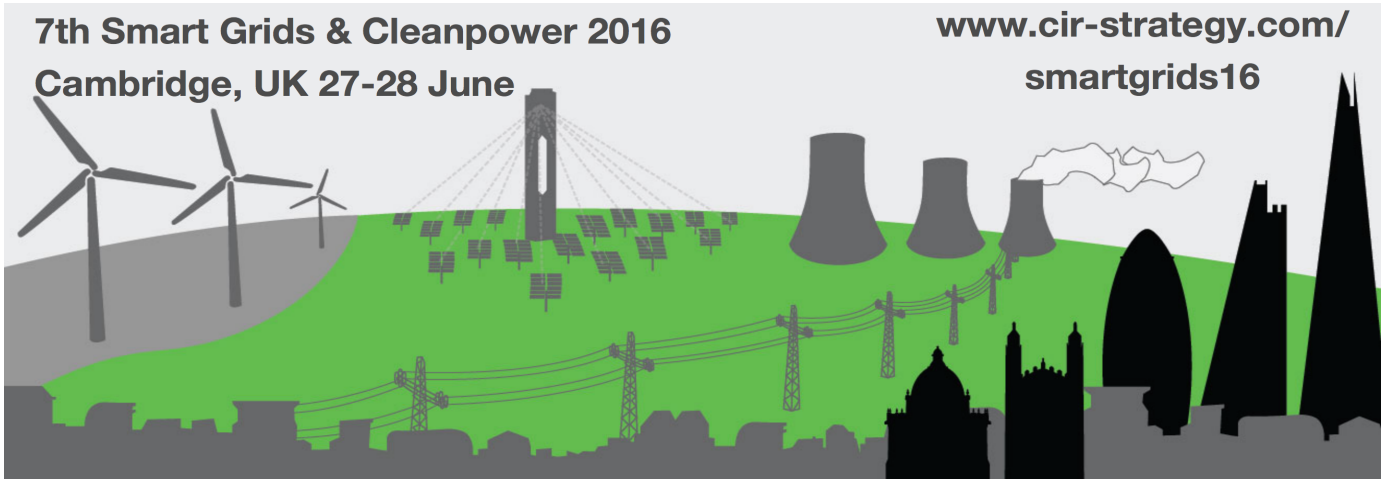
Q&A

Bottom up verses top down approach to smart grid. Super distributed sub kwh grid edge batteries in devices or mid grid 20kWh devices. The key is the cost of controlling small "dollops" of energy storage.

European infrastructure stress, large-scale storage & software-Georgina Dingley, AMT Sybex

AMT run multi-year forecast and optimisation from half-hourly meter data which have demonstated IRRs of 20%. Energy storage is more complex than solar systems. Multiple stakeholders, uncertain business models and technical immaturity.
High energy users are a case study for energy storage eg water companies. 1) relieving high peak time bills, 2) storing excess renewable generation 3) reduce carbon emissions.
MWh cost money, MW earn money: Selling frequency response services to the grid is valued in MW not MWh.

USA & Canada - Dr Frank-Schultz, Master Architect, IBM



1) PV case study for load management
2) Safety case study

14:30 Case Study - Grid solutions in India and Iran, Dr Sean Cochrane CTO

Cyan plans to acquire Connode, who are providers for smart meters in the EU.

The Importance of Grid-scale Energy Storage, Christos Keramisanos, UK Power Networks

Drivers for energy storage globally: 1) falling cost of battery costs due to EVs 2) increasing renewable energy peaking.

The drivers are difference

2015 Trial Project for EFR call: Leighton Buzzard 6MW/7.5MVA/10MWh EES energy storage solution. £13.2 low carbon network fund, £4.0 million investment form UK Power Networks. Demonstrated multiple services and business cases

UKPN own and operate Stanstead, Gatwick and Heathrow airport electricity infrastructure.

Q&A

Energy storage works best when it is integrated with many services leading to the optimum integration of the system.

DNOs currently uncertain of best price for storage and so are hesitant to purchase their own storage systems. That's why they are contracting out storage via the EFR tender.

10MWh is not big for an energy storage project, it is only a battery option. Compressed air, hydro etc are other larger projects but have difference (and slower) responses.

The danger for investors is that the business case lifetime is shorter than the product lifetime.

Risks and rewards of fracturing for shale gas - Dr David Reiner, CJBS Cambridge University

Large support for fracking by Poland public, large rejection from UK public. However, fracking industry in Poland failed as gas prices collapsed.

Given that the state owns mineral rights in the EU whereas the landowner owns mineral rights in the US largely prevented the development of shale gas. Also a smaller and more fragmented services industry.

How regulation can be a win-win for stakeholders - Susan McDonald National Grid

RIIO the price control mechanism used by the national grid Revenue = Incentives + Innovation + Outputs. 8 year price control 2013-2021. National Grid use Totex (total operational expenditure) as a principle measure. Such a long term price control mechanism is too slow to react for fast moving technology.

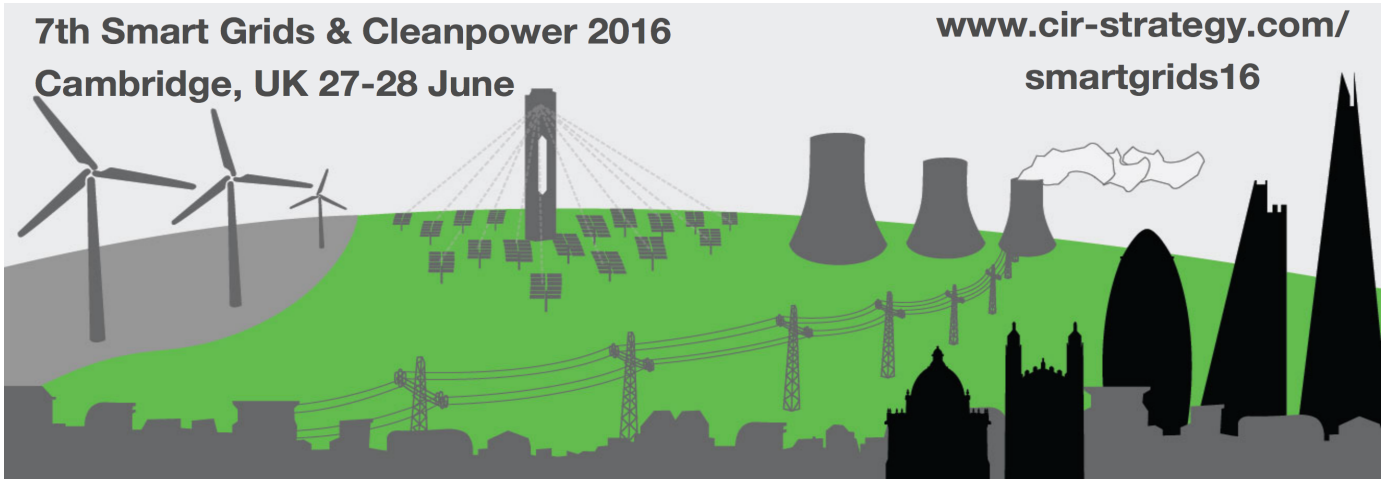
Vital that complexity and uncertainty is removed from the delivery of major infrastructure in order to facilitate private sector investment.

Network Price Controls and Smart Grids Flex - Maxine Frerk, Partner, Ofgem

NIC/NIA Network Innovation Allowance/Competition funding for new technology.

UK energy management innovation - Sally Fenton, Innovation Delivery, DECC

Feb 2016 National Infrastrucutre Commission Smart Power Report



March 2016 IEA-RETD Policies for Storing Renewable Energy
May 2016 Open Utility report on Picolo (online peer to peer market for renewable energy.)
Latest spending review £250million for Nuclear, £250 for renewables.
Innovate UK rebranding to UK Research and Innovation and merging research councils.
17:00 Long-term energy outlook & impact of emerging & disruptive technologies, Anant Prakash, BP
4 big trends for energy ecosystems 1) COP21 2) upstream returns are now 5% not 35% due to more expensive extraction. 3) cost of renewables falling wind 50% since 2009 PV 80% since 2008 4) intelligent mobility

End of Additional Notes Day 1

END OF NOTES

This was a full business conference day run by CIR Strategy (Cambridge Investment Research Ltd) on 28 June 2016 at Cambridge University for executives seeking to update and receive knowledge about Smart Grids and Power Generation. The event included in-depth talks throughout the day, a lunch, breaks for private meetings and high level networking with other delegates and the leaders & speakers. The day was preceded by a dinner in a roundtable dinner at Trinity Hall, Cambridge and a masterclass day.

Strategy consulting and upcoming Events run by CIR in this and the HVM Series are available for booking via http://www.cir-strategy.com