

The Digital Energy Revolution

Professor David Healey
Smart Energy Director WSP

5th March 2019



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Professor David Healey SEND Keele University

Smart Energy Director - WSP

Present roles

- Developing & leading commercial, technology, regulatory and investment projects
- **2017 - Professor at Keele University UK regarding their ground breaking Smart Energy Network Demonstrator (SEND) project** £30m Smart Energy project,
- **2017 – Appointed as Industry Advisor” to the joint CENELEC / ETSI task force** developing EU energy data network and Demand Side Management standards.
- **2014 “Industry Expert” at the United Nations Committee for Europe (UNECE)** developing UN strategy on Sustainable Energy to realise the international agreements on Climate Change.

Background

- During his career David has directly participated across the full breadth of the utility ICT value chain from software and silicon systems design, hardware product development, to utility network operation and service delivery.
- David has held positions at utilities around the world (e.g. National Grid, EON, ENW, SSE, Iberdrola, Florida Power and Light etc), and major solutions vendors such as Cisco, Alcatel, Wipro SAIC and a number of international service / consultancy businesses.



Services in energy

These include planning and optimising supplies, to energy management and renewables.



Services in environmental

From acoustics, ground risk and remediation to green building design, waste management.



Services in industry

From computational fluid dynamics to energy efficiency and design management.



Services in property

From structural design to mechanical and electrical to Building Information Modelling (BIM) and project management.



Services in transport & infrastructure

From bridge, tunnel, road and rail design to transport planning and station design.

MIT Tech Review's 2019 (AI acts as the enabler)

Every year, highlights technological developments that will most impact on human life, during the coming year.

For the first time, picked by a contributing editor, Bill Gates.

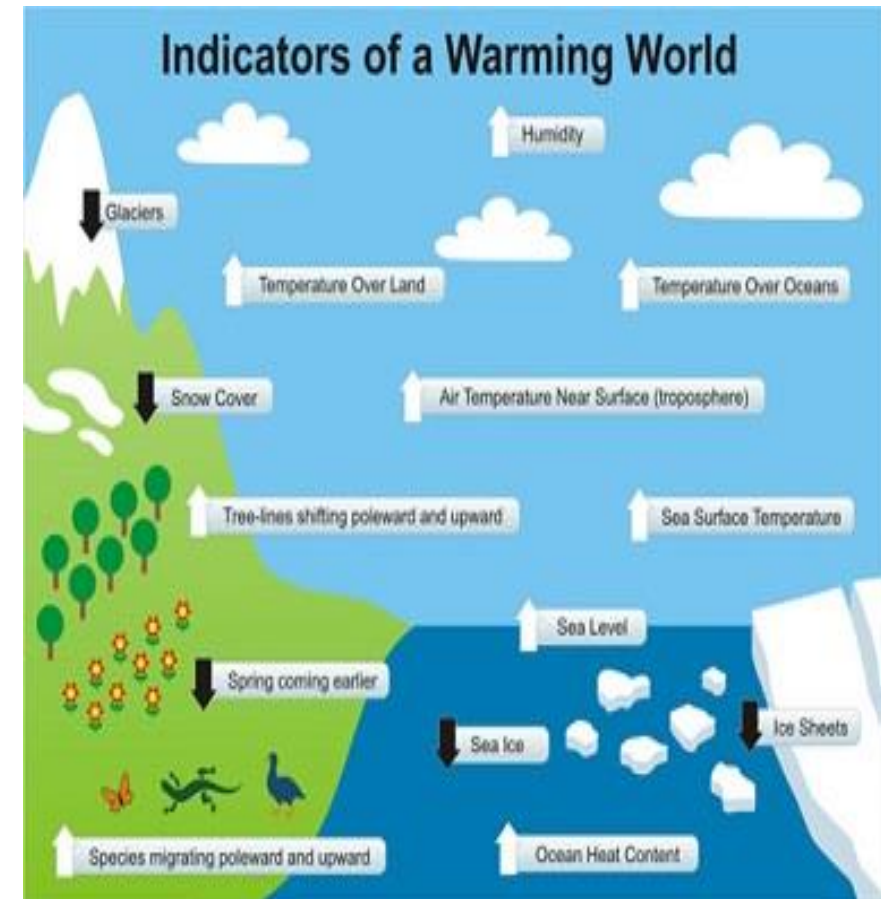
- **Robot dexterity—robot hands that can learn to manipulate unfamiliar objects on their own.**
- New-wave nuclear power—both fission and fusion reactor designs that could help bring down carbon emissions.
- Predicting preemies—a simple blood test to warn of a preterm birth, potentially saving many children's lives.
- Gut probe in a pill—a swallowable device that can image the digestive tract and even perform biopsies.
- Custom cancer vaccines—a treatment that uses the body's own immune system to target only tumor cells.
- The cow-free burger—plant-based and lab-grown meat alternatives that could drastically cut emissions from food industry.
- **Carbon dioxide catcher—techniques for absorbing CO2 from the air and locking it away that may finally become economic.**
- **ECG on your wrist— ability to continuously monitor their health and get early warnings of problems.**
- Sanitation without sewers—a self-contained toilet that could tackle disease and unpleasant living conditions in much of the developing world.
- **Smooth-talking AI assistants—advances in natural language processing make digital assistants capable of greater autonomy.**

1 Climate Change

COP 21 December 2015 – global agreement on Climate Changebut

7

- **COP 21** Success drawn from the jaws of defeat at the 11th hour - Obama
- **Bonn 2017** - climate negotiators propose a major effort to assess the world's progress on climate change to date and measure it against the 2c goal. Countries can then revise their individual climate pledges accordingly — and will do so every five years thereafter.
- Climate scientists presented on vast task ahead. To stay below 2c of warming, emissions would have to peak in the next few years and then **be cut by half every decade all the way down to zero by 2050**.
- The vested interests misinformation – Renewables cannot offer base load solutions? Nuclear low cost sustainable option?? Carbon Capture????



2018 - 12 years to limit climate change catastrophe, warns UN

- **Urgent changes needed to cut risk of extreme heat, drought, floods and poverty – IPCC 2018**
- James Hansen, the former Nasa scientist who [helped raised the alarm](#) about climate change, said both 1.5C and 2C would take humanity into uncharted and dangerous territory because they were both well above the Holocene-era range in which human civilisation developed.
- He said there was a huge difference between the two: “1.5C gives young people and the next generation a fighting chance of getting back to the Holocene or close to it. That is probably necessary if we want to keep shorelines where they are and preserve our coastal cities.”
- Johan Rockström, a co-author of the recent [Hothouse Earth](#) report, said scientists never previously discussed 1.5C, which was initially seen as a political concession to small island states.
- He said opinion had shifted in the past few years with growing evidence of climate instability and the approach of tipping points that might push the world off a course that could be controlled by emissions reductions.
- **UK weather: February temperature jump was incredible, says climate expert**
- **Meteorologists to assess if unseasonably warm weather is due to carbon emissions**

Urban air pollution – a major public health scandal

Volkswagen emissions - Dieselgate

- The **Volkswagen emissions scandal** (also called "**emissionsgate**"^[18] or "**dieselgate**"^[19]) began in September 2015, when the [United States Environmental Protection Agency](#) (EPA) found that Volkswagen had intentionally programmed [diesel engines](#) to activate their [emissions](#) controls only during laboratory [emissions testing](#) which caused the vehicles' [NO_x](#) output to meet US standards, but emit up to 40 times more NO_x in real-world driving.^[20] Volkswagen deployed this software **in about eleven million cars worldwide, 2009 through 2015**

Air pollution: UK government loses third court case as plans ruled 'unlawful'. High court says approach to tackling pollution in 45 local authority areas is 'not sufficient' and orders urgent changes

Ella Kissi-Debrah 'pollution' death: Backing for new inquest

- The family of a nine-year-old girl who died from asthma has been given permission to apply for a fresh inquest into her death. It comes after the government's chief lawyer heard new evidence her death could be linked to unlawful levels of air pollution.

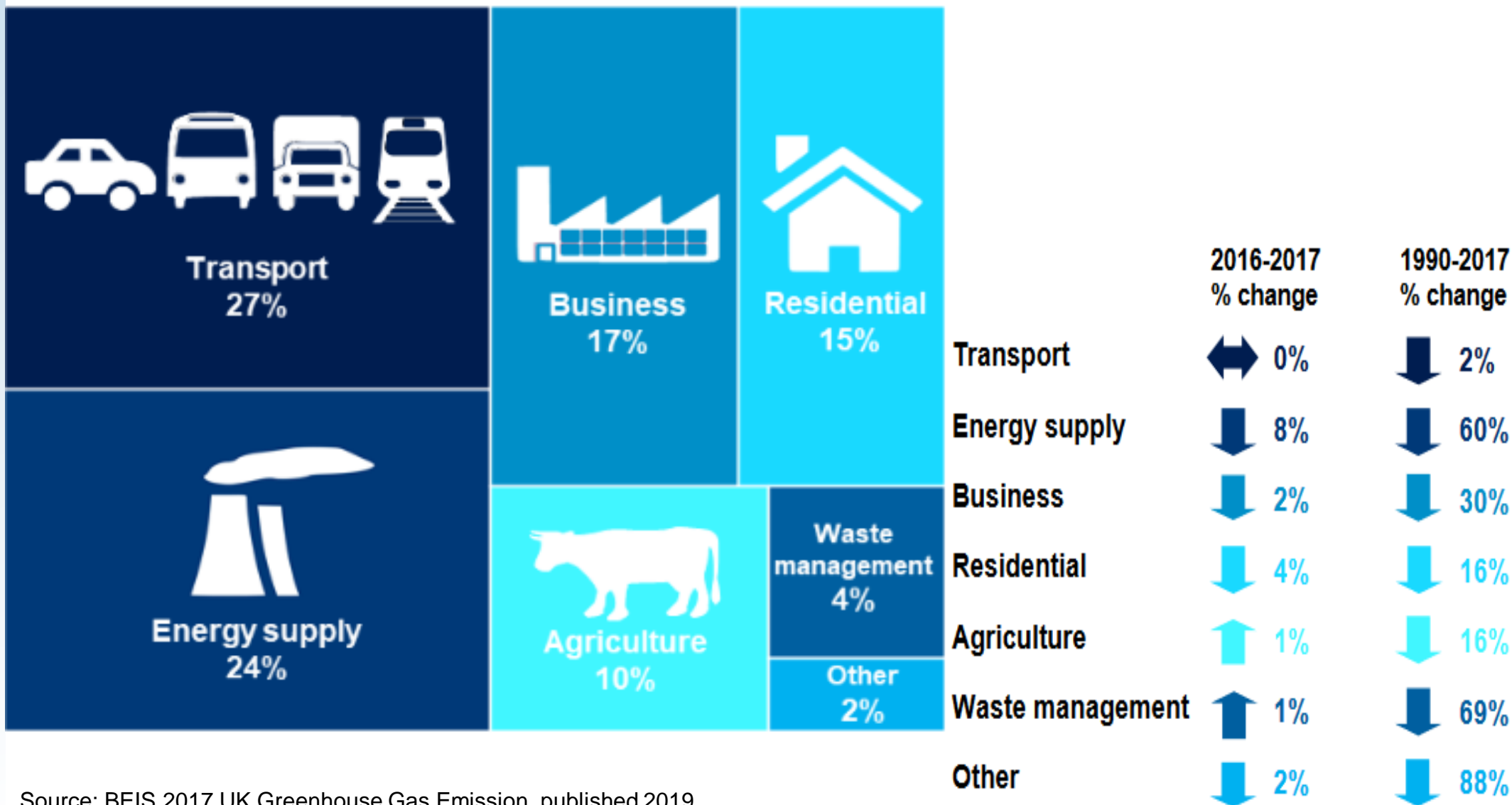




Electrification / decarbonisation is now



Electrification of energy / transportation the priority!



Source: BEIS 2017 UK Greenhouse Gas Emission, published 2019

Climate Change – wartime level investment required

Why?because vested interests and short term greed still fighting!!!!

- <http://climateactiontracker.org/>
- <https://www.nytimes.com/interactive/2017/11/06/climate/world-emissions-goals-far-off-course.html>

The Uninhabitable Earth

- Famine, economic collapse, a sun that cooks us: What climate change could wreak — sooner than you think.
- By [David Wallace-Wells](http://nymag.com/daily/intelligencer/2017/07/climate-change-earth-too-hot-for-humans.html) <http://nymag.com/daily/intelligencer/2017/07/climate-change-earth-too-hot-for-humans.html>



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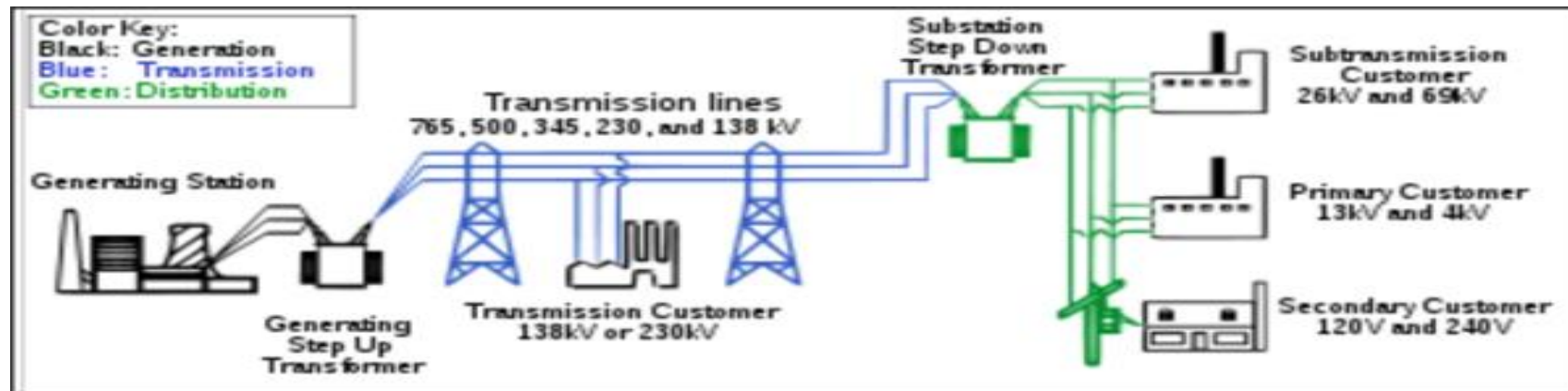
2 The first Smart steps to an Energy revolution

Today's power Distribution Networks employ minimal ICT (but still aim for 99.9% reliability of supply)

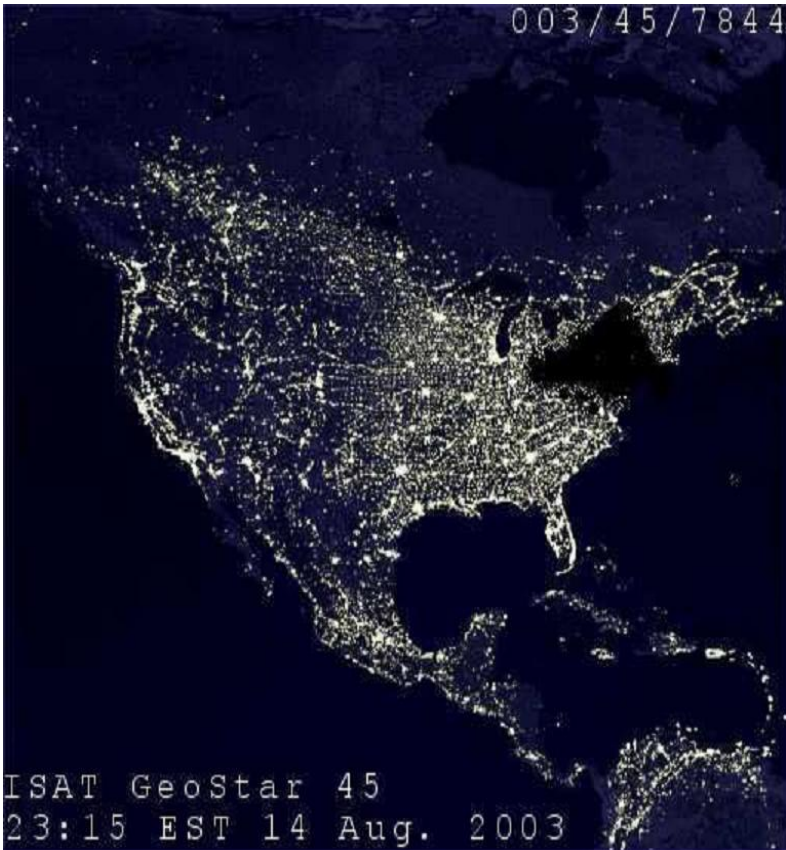
- Limited remote control and active monitoring
- Centralised generation – single direction of power flow!
- Minimal two-way communications between consumers and the utility operator
- Projected energy consumption is not measured
- Reliance on consumers to notify operator of outages
- In many countries, over 30% of energy used goes unpaid for!

The 20th century dark age of ;
Party telephone lines??
Energy 7
Coal fires
electric central heating /
bricks
transport / cars
electric trolley buses

“He’s been dead more than 75 years, but Thomas Edison – hailed as the father of the light bulb – probably could run the nation’s modern-day electric grid. It just hasn’t changed that much”







wsp

SPECIAL ★ ★ ★ ★ EDITION

DAILY NEWS

50¢ www.nydailynews.com NEW YORK'S HOMETOWN NEWSPAPER Friday, August 15, 2003

SUSANA BATES

BLACKOUT

- 50 MILLION LOSE POWER
- CITY SWELTERS TO A HALT
- RUSH-HOUR CHAOS TODAY

The Smart Grid vision

- A smart grid uses sensing, embedded processing and digital communications to enable the electricity grid to be:
 - *observable (able to be measured and visualised)*
 - *controllable (able to be manipulated and optimised)*
 - *automated (able to adapt and self-heal)*
 - *fully integrated (fully interoperable with existing systems and with the capacity to incorporate a diverse set of energy sources)*

CHANGE!

Change is a hard thing for anyone to get right!

- ***“The radio craze will die out in time”***
(Thomas Edison, 1922)
- ***“A rocket will never leave the Earth’s atmosphere”***
(New York Times, 1936)
- ***“640k ought to be enough for anybody”***
(Bill Gates, 1981)
- ***“There is a world market for maybe five computers”***
(IBM’s Thomas Watson, 1973)

.....and Energy Utilities had never faced major operational change!

3 Smart Meters to Grids to Energy toeverything!!

The first Smart steps – roll out of Smart Metering

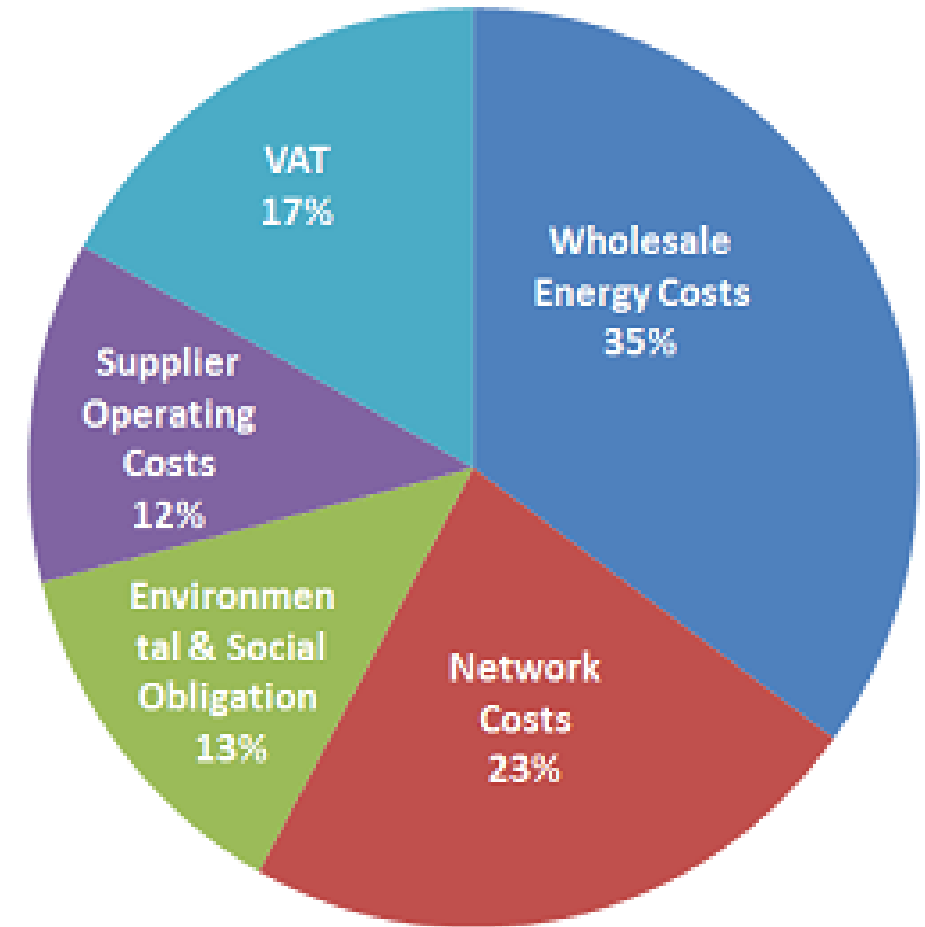
- USA's response to the 2007 Financial crash
- The 2012 budget, Chu said, is part of an administration-wide plan to win the future by ***“out-innovating, out-educating and out-building the rest of the world”***
- Primarily targeting operational cost reduction and none technical losses
- Italy Spain Sweden also implemented national “Smart” / AMI implementations

UK Smart Meter rollout – a missed opportunity (btw – Smart Meters are not “free” we pay for these in our bills!)

- The division between Retail Distribution and Generation – Balancing of regulatory ideology with environmental, operational and business imperatives?
- Regulation of Monopoly industries – examples of “broken markets” everywhere!
- Of the total projected £7bn programme benefits
 - *Profits for Suppliers 50%*
 - *Price reduction for customers 25%*
 - *Smart Grid / Network capabilities 25%?*
- Almost 70% of cost is the construction / operation of a dedicated national communications network
- Assess the analysis and experiences of other Smart Meter strategies; e.g.
 - *Italy - desired supply cost reductions but possible technology barrier to SMART future?*
 - *Germany – pragmatic view of Smart Meter value – limiting / targeted rollout ? Germany decide to go forward (see article in One note Germany – compare with UK)*
 - *Spain – Iberdrola designed low cost communications rollout for integrated SMART UTILITY*
 - ***To build out intelligence across power distribution to support Smart Energy objectives (EVs Distributed Generation etc) requires a second telecoms network costing a further £10bn??!!***

The price you pay on your bill is made up a number of constituent parts:

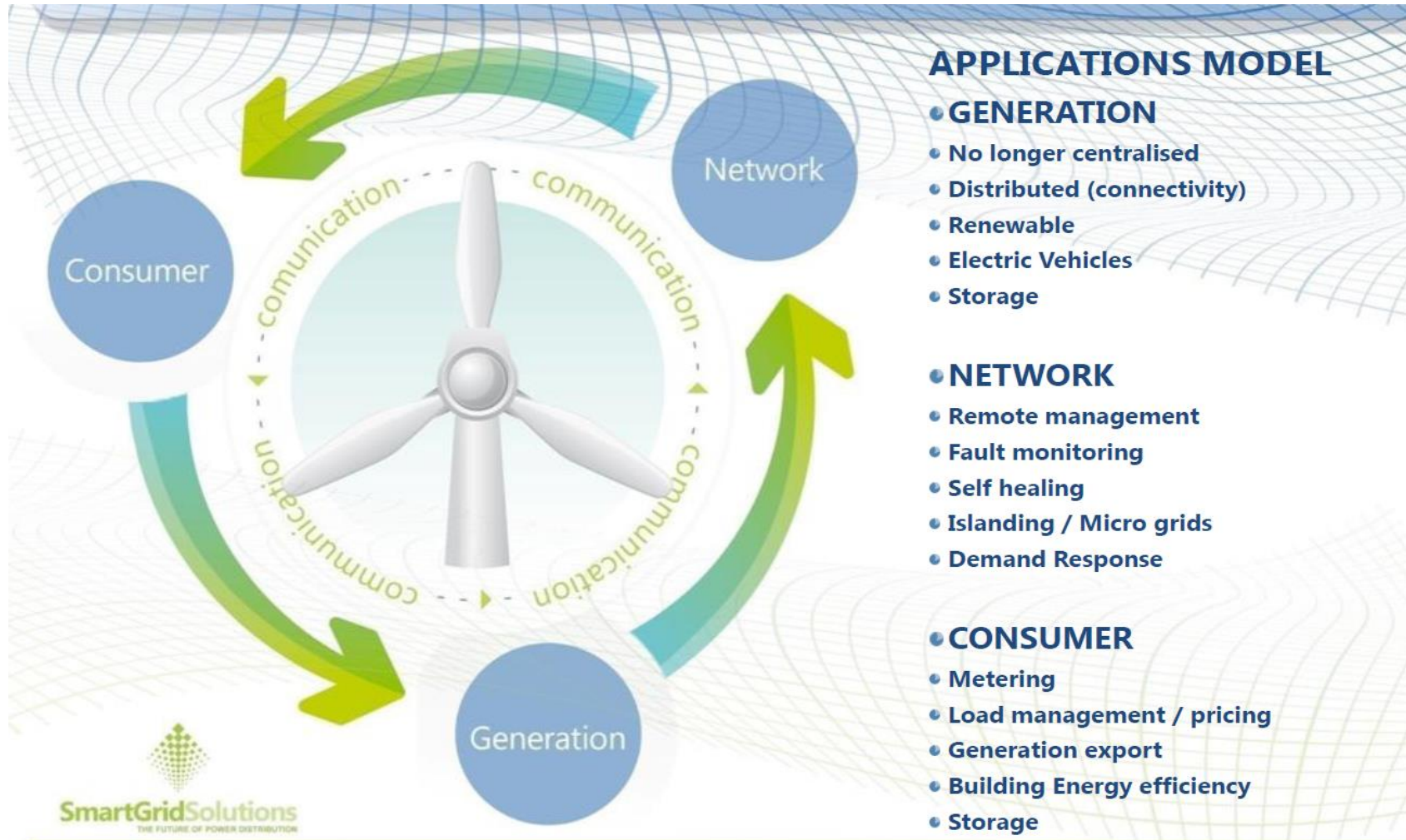
- Energy cost (or wholesale cost)
- Network - transmission & distribution
- Losses (or unbilled volumes)
- Levies (environmental / social obligation costs)
- Metering costs ie. supplier operating costs
- Supplier's margin (or profit)



Plentiful / Infinite Renewable Energy And lowest cost

- A total of 173,000 terawatts (trillions of watts) of solar energy strikes the Earth continuously. That's more than 10,000 times the world's total energy use.
- Solar thermal systems covering 10 percent of the world's deserts — about 1.5 percent of the planet's total land area — could generate about 15 terawatts of energy, This amount roughly equal to projected growth in global energy demand over the next half-century.
- On 18 December 2018, [Balancing Mechanism Reports](#) showed that onshore and offshore wind farms hit a new high of 15GW, providing 34.7% of UK electricity needed during the peak evening demand.

The Smart Energy value chain - A new model of Distribution!



4 Smart Grids Transport and Cities

Smart Energy / Grids / Cities critical to achieving global climate change objectives (IEA - 69% of total global energy consumption in 2015 attributable to cities)

Global policy drivers (COP 21)	Economic and Market Shifts
<ul style="list-style-type: none">Climate change / CO2 reduction / renewables <p>The private sector is the engine that will drive the climate solutions, “a clean \$trillion needed annually” to fund sustainable energy investments (Ban Ki-moon (January 2016))</p> <ul style="list-style-type: none">Electrification of energy, transport and heatingHealth / lifestyle concerns in developed economiesSustainable development goals in less developed economies	<ul style="list-style-type: none">Tipping point in the economics of renewable energy – cheaper than fossil fuelCollapsing cost curve for electric storageIncreasing adoption of innovation in mobility and transport – EV’s, Autonomous Vehicles, DronesConsumer participation and prosumer revolution in utility services imminentLocal Energy Systems / Microgrids

Action to combat Climate change is realising a global “Green Economic model”

Smart Energy requires scalable IoT solutions – and can deliver efficiencies across ALL major vertical sectors



In traditional cities ...

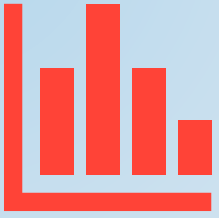
- 1 Treatment of waste water has been controversial, and water quality is often uncertain
- 2 Transportation of people and goods is made less efficient by congestion, wasting time and resources
- 3 Citizens' access to information about their own healthcare is typically limited
- 4 Public safety agencies have difficulty using all the information at their disposal to ensure public safety

Whereas in smart cities ...

- Monitoring, managing and forecasting water-based challenges through advanced sensor network and real-time data analysis
- Car-sharing and connection with live traffic information or forecast to minimise congestion and pollution
- Instant access to health records, achieving higher satisfaction and lower error rates for medical professionals**
- Real-time video surveillance and analysis of data allows faster reaction to threats to public safety

Climate Change imperatives now being embraced as drivers for UK economic growth

- The Government's new [Clean Growth Strategy](#),
 - *recognises that the transition to low-carbon growth should be at the heart of the UK's economy over the next few decades, with the aim of bringing greater prosperity, higher living standards and enhanced wellbeing.*
 - *Previously perceived as a constraint is now seen as the driver of future growth.*
 - *Smart Energy and Digitalisation are key enablers*
- **Dieter Helm Report –**
 - **Local networks / services**
 - **Vertically integrated Operators?**
 - **Introducing the DSO!!**
- **NIC's interim National Infrastructure Assessment “Congestion, Capacity, Carbon”, outlining seven priority areas to 2050.**
 - *Building a digital society*
 - *Connected, liveable city regions*
 - *Infrastructure to support housing*
 - *Eliminating carbon emissions from energy and waste*
 - *A revolution in road transport*



Why does this change matter to the UK?

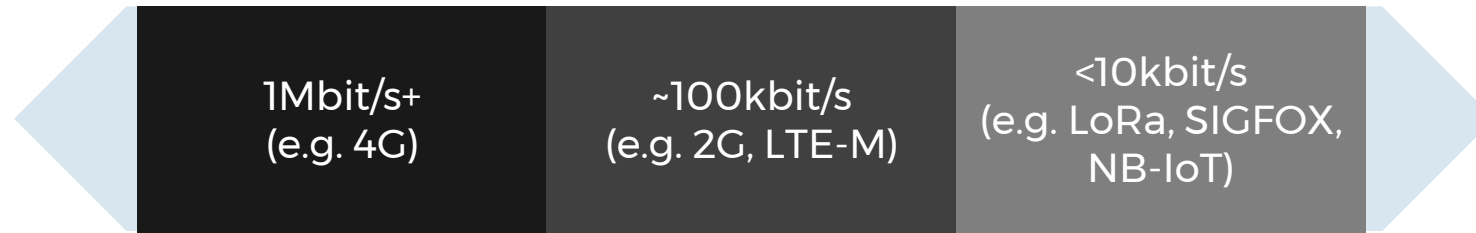
Accidents
-£35bn
per year

Congestion
-£30bn
per year











Air Quality
-£54bn
per year

New
benefits
+£?bn
per year

A mix of networks will be needed for Smart Energy / City IoT and M2M services



Example use cases

 Smart phone	 Connected car	 Smart grid	 Smart watch	 Low value object tracking	 Smart meter
 CCTV		 High value object tracking		 Smart parking	 Smart street lights

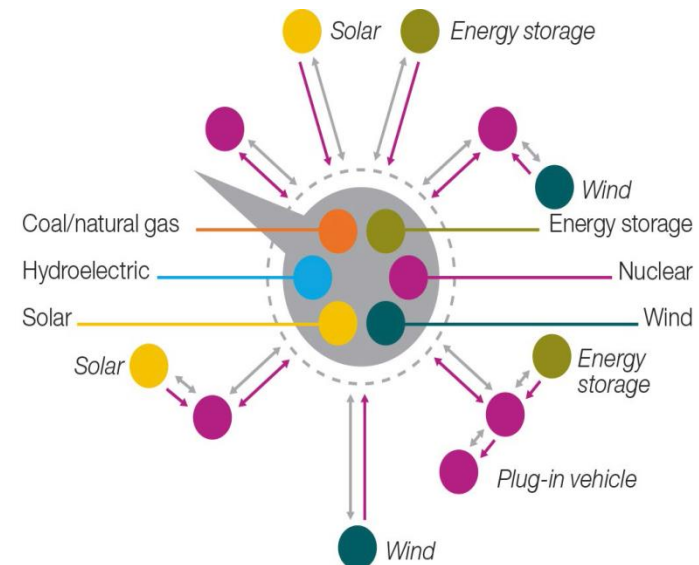
Smart Grid – Integration and optimisation of energy sources and demand side

- Self-healing from power disturbance events / Optimising assets and operating / configuring efficiently in real time
- Operating resiliently against physical and cyber attacks
- Providing power quality for 21st century needs (remotely monitored reconfiguration of generation transmission and distribution networks)

▪ VIRTUAL POWER PLANTS

Delivering integration of any generation and storage option:

- *renewables*
- *centralised*
- *distributed*
- *electric vehicles (mobile generation and storage source)*
- *storage (centralised and distributed)*
- *Demand / load management*
- Enabling new products, services and markets
- Smart meter / smart home

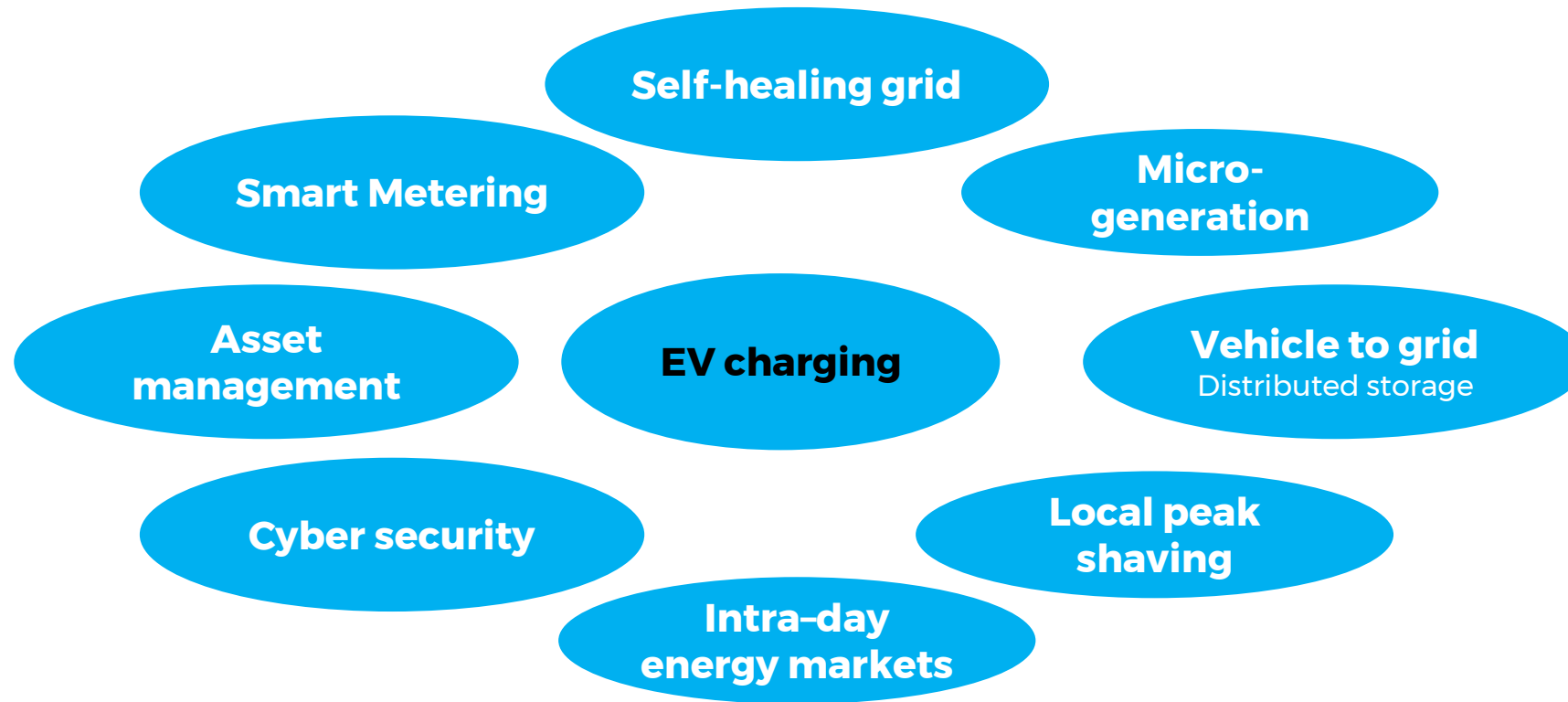


Source: IBM
The Future of Energy and Utilities 2014

Microgrids – Local energy Prosumption and Virtual Power Plants



Data Aggregators at the junction between Smart Grids / Cities (Energy and Transport)



The sharing and processing of Big Data needed make components operate efficiently. New Data Aggregators create additional value by processing analysing creating and offering access to new Data services

Do not forget Energy efficiency!!

- EoN – could reduce London's energy needs by 30%
- Lighting = 20% of global electricity consumption
- Replacing incandescent bulbs with compact flourecents or LEDs can save 70% to 90% of consumption
- Japan “Top Runner” programme 1999 – most efficient products set the “Top Runner Standard” for any future products to be sold. Businesses have 3 to 10 years to comply to a new standard
- e.g. Refrigerators sold between 2005 and 2010 became 43% more energy efficient

MIT “Utility of the Future” December 2016

Important changes in the provision and consumption of electricity services are now underway, driven to a significant degree by a confluence of factors affecting ***the distribution side of power systems.***

A variety of emerging ***distributed technologies***—including flexible demand, distributed generation, energy storage, and advanced power electronics and control devices are ***creating new options for the provision and consumption of electricity services.***

At the same time, ***information and communications technologies are rapidly decreasing in cost and becoming ubiquitous, enabling more flexible and efficient consumption of electricity, improved visibility of network use, and enhanced control of power systems.***

<https://energy.mit.edu/wp-content/uploads/2016/12/Utility-of-the-Future-Full-Report.pdf>

A new UK Utility Regulatory model is needed

- Economy Energy collapse leaves 235,000 in the lurch Jan 2019 / Ofgem urges customers to take meter readings after ninth small UK supplier goes bust in a year
- [Energy bills](#) for millions of UK households are set to rise after [Ofgem](#) hiked its [price cap](#) due to higher wholesale gas and electricity prices.
- The price cap, which was [introduced in January at £1,137](#), will rise by £117 for customers on default tariffs, including standard variable tariffs on 1 April. affecting around 15m households
- **The Big Six are British Gas, EDF Energy, E.ON, Npower, Scottish Power, and SSE. As of Q3 2018, the Big Six hold a combined market share of 75% for electricity supply and 73% for gas supply in Great Britain. The Big Six previously held a combined market share across both markets of 100% in 2004.**

RAIL

Delays give rail operators £100m a year profit Oct 2018
Rail companies are paid compensation by Network Rail when unplanned infrastructure failures cause delays NETWORK RAIL Train companies make up to £100 million a year in “profits” from disruption on Britain’s railway, analysis has shown.

Figures reveal that over the past five years rail operators collected £535 million more in compensation from Network Rail for unplanned infrastructure failures than they passed on to compensate passengers for delays. Delays give rail operators £100m a year profit Oct 2018

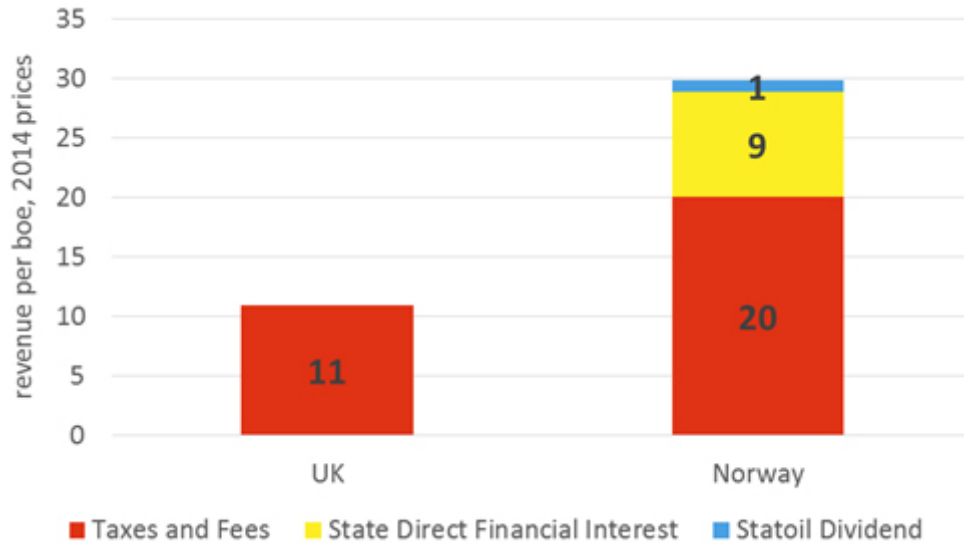
Mobile Comms

UK among countries with priciest mobile data plans in Europe

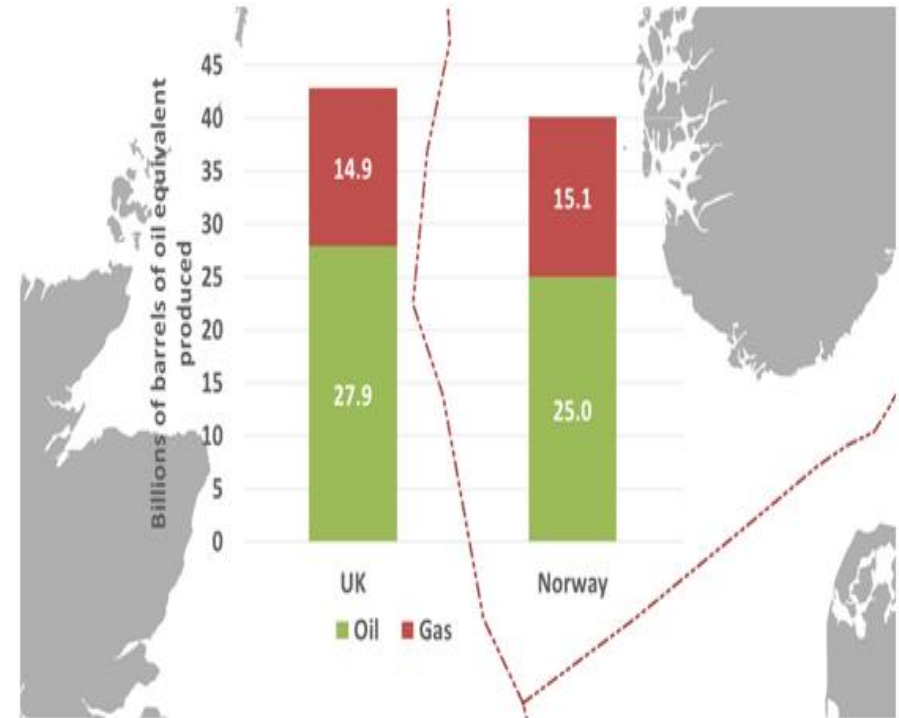
Ranking of 230 countries placed UK 136th, with India as cheapest country

Dan Howdle, an analyst: “When looking at the UK compared to our European and EU counterparts, it’s disappointing to see the UK among the most expensive countries for mobile data. Despite a healthy UK marketplace, our study has uncovered that EU nations such as Finland, Poland, Denmark, Italy, Austria and France pay a fraction of what we pay in the UK for similar data usage.”

Did the U.K. Miss Out on £400 Billion Worth of Oil Revenue?



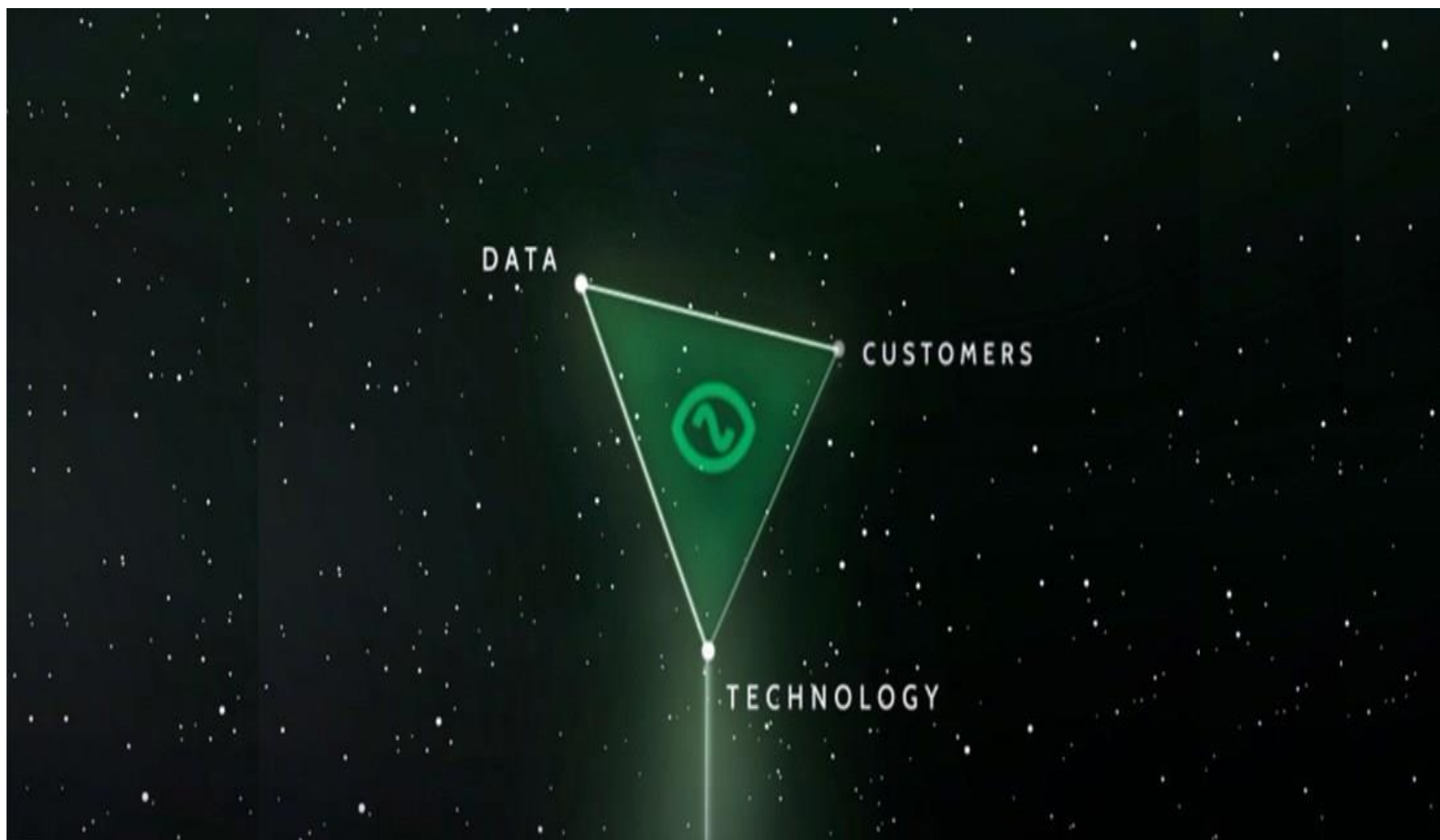
Government oil gas revenues in 2014 prices since 1970



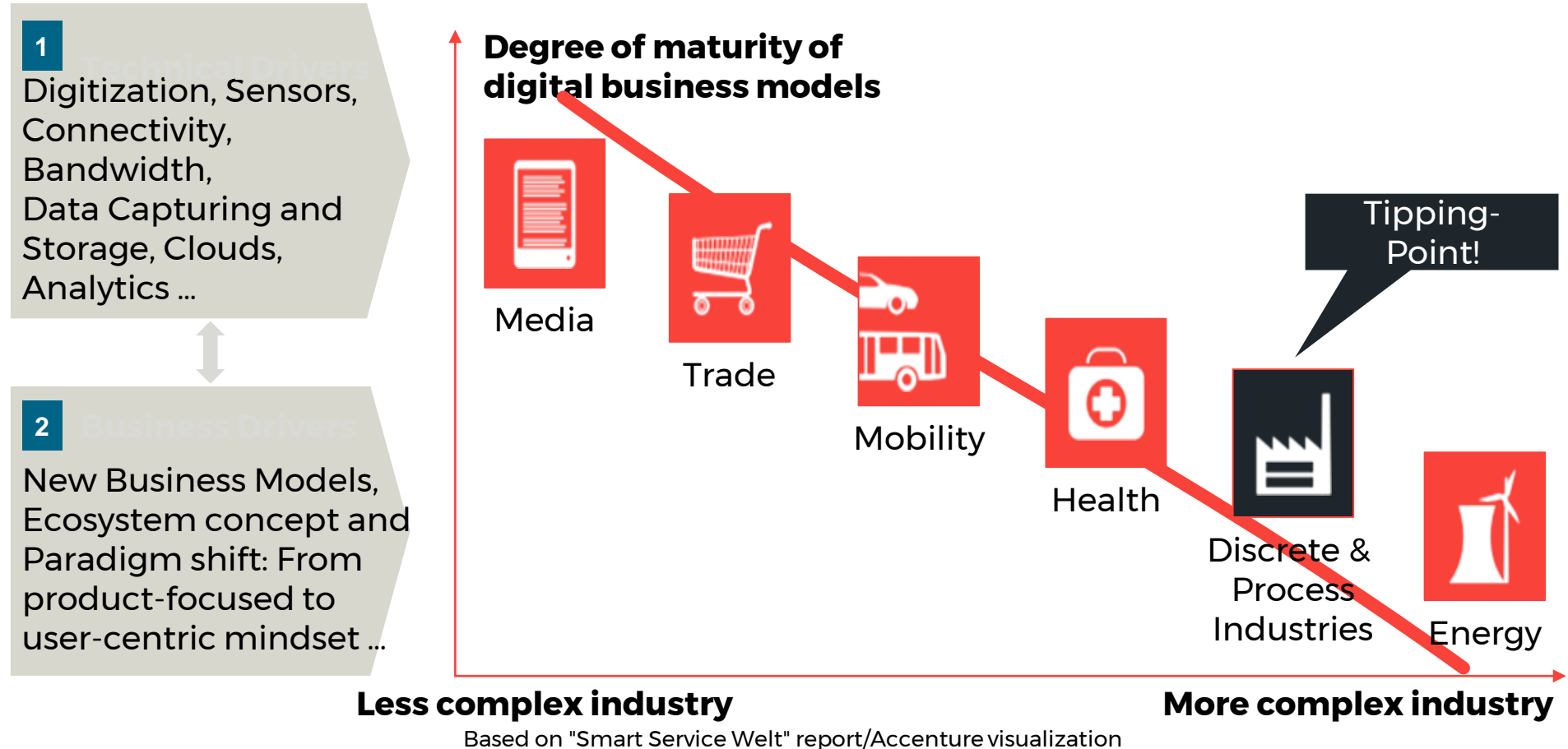
U.K. and Norway oil and gas production since 1971

The Norwegian Government Pension Fund Global, known as the Oil Fund established in 1990 to invest the surplus revenues of the Norwegian petroleum sector. It has over US\$1 trillion in assets, including 1.3% of global stocks and shares, making it the world's largest sovereign wealth fund.

5 The Digital Energy Revolution



Easy to digitize industries have already started to changemore complex industries will follow



We're seeing an increasing digitization of industries



Core principles

**Digitally
connected**



Automated



**Business
Models**

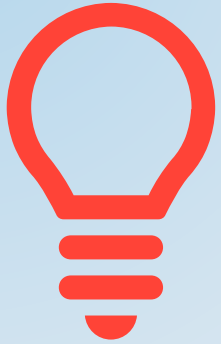


Electrified

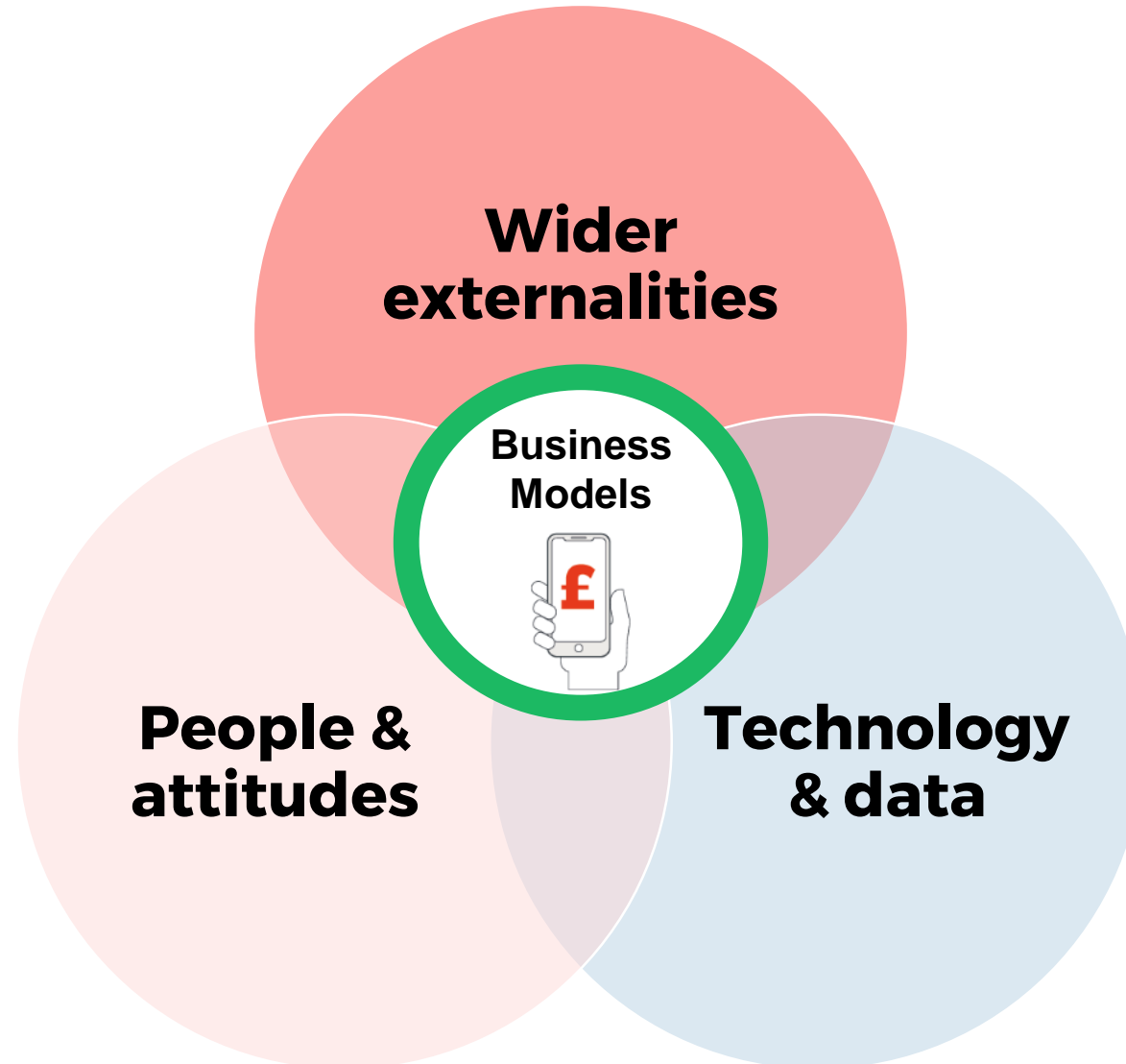


Shared



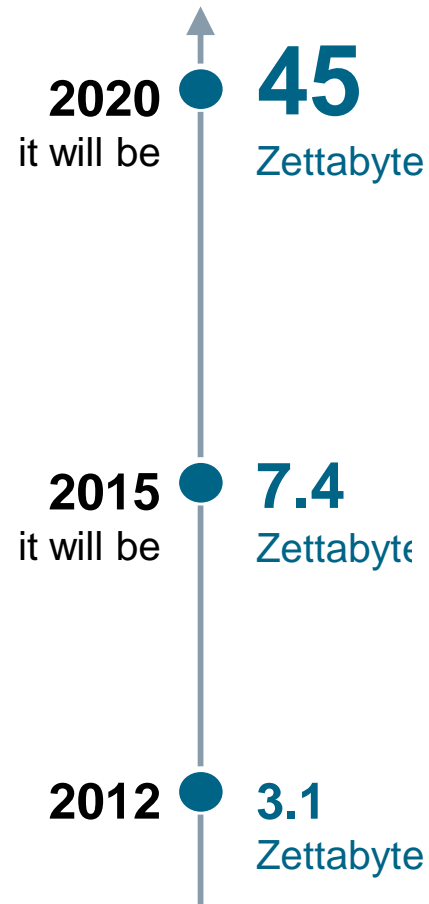


Creating new solutions / models

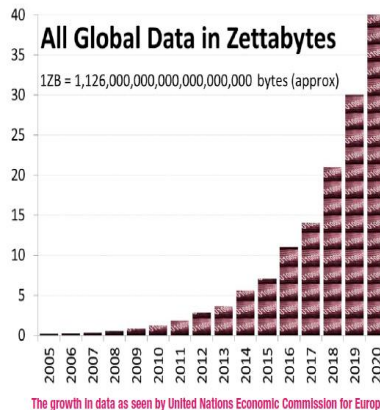


Think
•Amazon
•Air BnB
•Uber

Data Evolution: IoT / Big data / Cloud / AI / M2M



The total volume of data generated on earth summed up to



Big data / cloud applications

From machine to machine – the focus today and in the future

Machine2Machine

Sensors, meters, devices, industrial machines

Internet of Things/"Industry 4.0"

Enabling additional productivity levers and new business models



From person to person – that was the beginning

People2People

Network of virtual communities



People2Machine

Medical technology, digital TV, cameras, computers, mobile phones



Audi

Dr. Hagen Seifert, Head of Sustainable Product Concepts at Audi, commented:
“We are looking at electric mobility in the context of an overall energy supply system that is increasingly based on renewables. We are playing a pioneering role with the prequalification of the balancing-power market – **enabling producers to feed power into the grid, as part of the pilot project. That is now for the first time also possible down at the level of individual households, which helps balance the entire power grid,”**

Majority of new cars and vans should be electric by 2030, Government climate advisers demand

UK plans to ban sale of new petrol and diesel cars by 2040



Shell uses Digital Tech to transition to Sustainable Energy

Step 1 EV market entry

Royal Dutch Shell, has agreed to buy NewMotion one of Europe's biggest electric vehicle charging companies, marking a significant push into a market that threatens to one day upend the oil industry

NewMotion, provides more than 30,000 private home electric charging points for EVs as well as 50,000 public sites.

While the numbers aren't huge yet—for example, Shell's \$1 billion in renewable energy and EV investments amounts amounts to just 4% of its annual capital expenditures—they're growing fast. Globally, [\\$334 billion](#) (pdf) was invested in global clean energy in 2017, reports Bloomberg New Energy Finance (BNEF)

Other Oil Giants follow

Earlier this year **France's Total** bought Dutch company PitPoint, which provides natural gas refuelling for vehicles as well as operating a number of EV charging points in Europe.

FT Oct 2017

BP takeover of Chargemaster includes 6,500 charging stations within the UK is part of its bid to “support the successful adoption of electric vehicles.” The newly renamed BP Chargemaster will soon begin introducing 150kW “rapid chargers” that promise to power up an electric car for a 100-mile journey in just 10 minutes It's projected to be a big business.

Footnote

McKinsey counts more than [350 new electric vehicle \(EV\) models](#) debuting by 2025, one of the conditions for mass-market adoption.

Shell RechargePlus – Energy service founded upon Data

- **Shell RechargePlus is a new EV charging service that benefits both the customer and the grid by minimizing additions to peak loads and the resulting costs.**
- It's **intelligent APP** helps minimize your costs by maximizing the amount of EV charging that occurs during the lowest demand periods throughout the day.
- It provides **flexibility** to drivers by allowing them to select the settings of their charging sessions based on their schedule.
- Wall Mount EV-RS Charger with Linux Processor : \$879 per unit
Ground Mount Pedestals: \$426 per pedestal
Communications Router and Modem Set-Up* : \$1,064
Monthly Data Plan* : \$20
- **Communications costs and data plan charge are spread out over every 10 units in a deployment so incremental costs per charging port is \$108.**
- **Also a \$20 per month Network Management Fee per charging unit covers all back-office support, software upgrades, reporting and program management.**



Shell acquires Limejump and Sonnen

- Just days after announcing it is set to acquire European energy storage specialist Sonnen, oil giant Shell has agreed to buy UK based demand response technology pioneer Limejump.
- Shell has agreed to buy German residential solar battery maker sonnen, as the oil and gas major expands its electricity business in its bid for a bigger role in the global transition to low-carbon energy.
- Sonnen, which has 40,000 battery systems worldwide and in 2017 had sales of 65 million euros (\$73 million), is the German market leader in home storage batteries and has expanded into EV charging systems.
- VP Energy Solutions at Shell New Energies, Brian Davis, [said](#): “We are impressed by the Limejump team and their track record of building a digital energy platform that connects and optimises a diverse range of assets.
- Shell’s buy follows a round of consolidation in the UK demand-side response market. [Kiwi Power’s founders sold out to Engie](#) in late 2018, [Centrica bought Restore for £62m](#) the year before, with [Enernoc bought and renamed by Enel](#) in a deal that valued the firm at £236m.



4 AI / M2M / Data Analytics / Robotics – the Digital Revolution is here

Eight things you need to know about the future of energy

The energy industry is changing. Artificial intelligence, blockchain and distributed networks are altering how we think about energy and the grid

- Little pushes can add up to big changes in customer behaviour
- Cutting down CO2 emissions isn't enough – we have to remove them too
- AI isn't a fix-all cure, but it is a powerful tool for energy efficiency
- Smarter energy forecasts could cut down on the amount of energy used
- Energy users might be the people that end up driving change
- It's time to stop thinking about energy supply and start thinking about demand
- It's time for the green battery revolution

Smart city data – such as energy and water consumption and availability, traffic and pedestrian flows and weather conditions – has potential to reduce the need for costly additional infrastructure and cut pollution and congestion.



THE LARGEST COMPANIES BY MARKET CAP

The oil barons have been replaced by the whiz kids of Silicon Valley



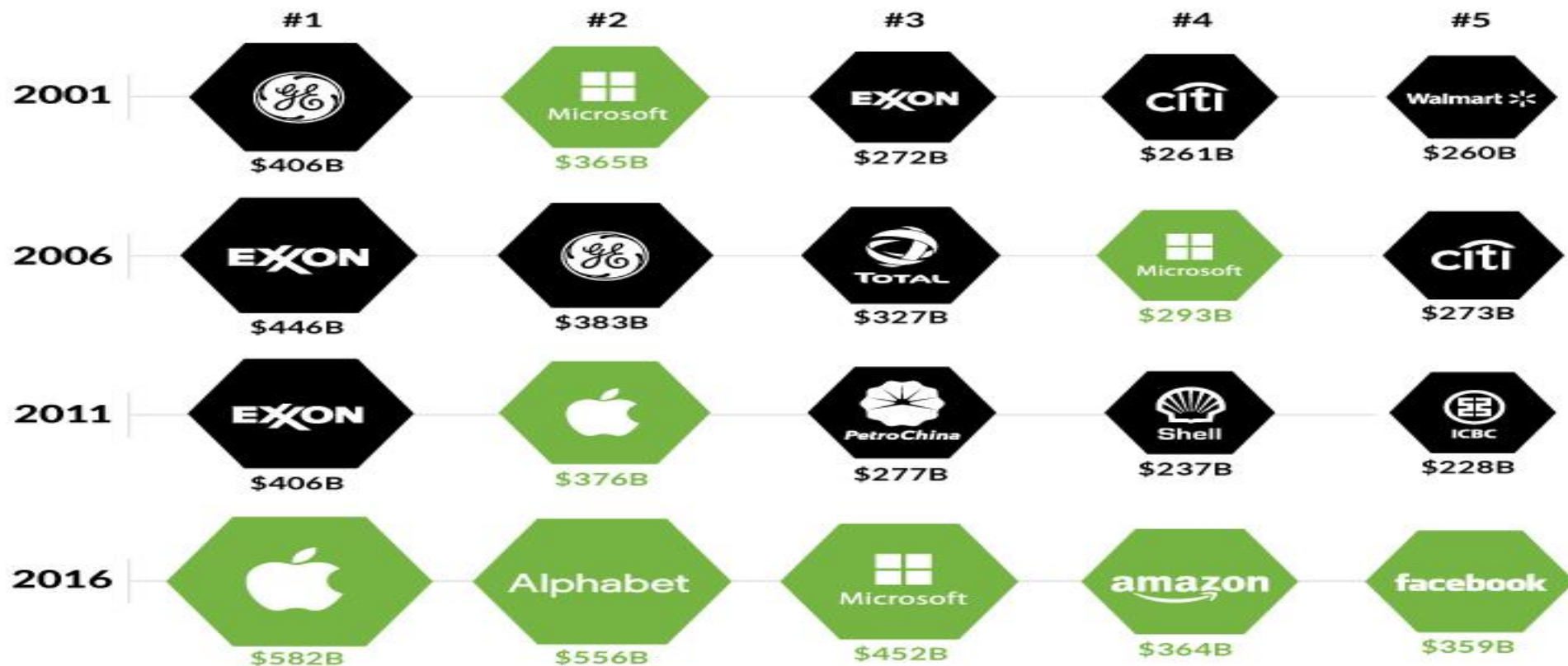
Top 5 Publicly Traded Companies (by Market Cap)



Tech



Other



Agents of Change – the data giants

GOOGLE

- Google world's largest corporate buyer of renewable energy - off-setting 100% of its energy usage = over 3GW of capacity. (Amazon, at about 1.5GW) Citing cost decrease of 60%-80% in wind / solar since 2010
- AlphaGo applied to optimise energy usage at global data centers – **reduced by 40% in months**
- ***Location of anything at anytime anywhere*** - GPS locates within 1cm anywhere 100 per sec

AMAZON

- 'Alexa, please balance the distribution grid' Nearly 50% of USA homes are Amazon prime members
- XU Energy Texas offering Alexa as energy and billing gateway

TESLA

- **After a series of regional blackouts that shook South Australia in February 2017**, a fierce debate emerged over how to manage the grid. Musk inserted himself into the debate, saying on Twitter that he could deliver 100 megawatts of storage **in 100 days or it would be free.**
- "The world's largest grid scale battery charged and reached 31 MW in 2 mins and on time"
- **Orchestrated Energy – AI DER** controlled via access mobile app, MyHome. Through smart thermostat optimization, reduced peak HVAC load by 70- 90% during demand response (DR) events--up to three times more load shift than typical DR event, while keeping the homeowner's temp within 1c of their typical set point.
- **NorthQ** home gateway with AI / data analytics to optimise energy management & usage



Estimated job displacement by AI (to 2037)

Industry sector	% of existing jobs (in 2017)			Number of jobs (000s)		
	Creation	Displacement	Net effect	Creation	Displacement	Net effect
Health and social work	34%	-12%	22%	1,481	-526	955
Professional, scientific and technical	33%	-18%	16%	1,025	-541	484
Information and communication	27%	-18%	8%	388	-267	121
Education	12%	-5%	6%	345	-158	187
Accommodation and food services	22%	-16%	6%	518	-371	147
Administrative and support services	23%	-24%	-1%	698	-733	-35
Other sectors	13%	-15%	-2%	466	-533	-67
Wholesale and retail trade	26%	-28%	-3%	1,276	-1,403	-127
Construction	12%	-15%	-3%	279	-355	-75
Financial and insurance activities	18%	-25%	-7%	209	-286	-77
Public administration and defence	4%	-23%	-18%	64	-339	-274
Transportation and storage	17%	-38%	-22%	296	-683	-387
Manufacturing	5%	-30%	-25%	133	-814	-681
Total	20%	-20%	0%	7,176	-7,008	169

AWS and Siemens

- **Siemens-AWS Partnership Further Bolsters Mindsphere Digital Solutions**
- The AWS re:Invent event this week, saw over 65,000 attendees. From developers to large OEMs, there is a buzz with the possibilities of a cloud-enabled innovation. Siemens is one such partner announcing that the latest release of [MindSphere](#), the company's open cloud-based Internet of Things (IoT) operating system, will be hosted for the first time on Amazon Web Services (AWS). This provides the ability to develop robust industrial IoT solutions on a shorter timeline for customers across various industries.

Data and communications in the energy transition can open the door for application of the new age of data and AI

- IoT, Analytics, Machine learning and AI now accelerating transition
- This places Data, communications, privacy & security at heart of the energy transition
- LV and consumer data has become key as the falling costs of renewables, and distributed energy technologies including storage are causing a structural shift
- Proprietary development of key Data Sets!
- “The utility death spiral” the only question is the pace of change and the resulting outcomes
 - *Transition of leading utility businesses e.g. Eon RWE, Enel, California, NYC Australia etc in advance of UK*
- Consumers expectations are fundamentally changing across all service sectors (meters v smart phones)

AI solution for self balancing Microgrid

- In the **Swarm Grid**, every component learns how to adapt to the current state of the grid by observing the grid parameters and adapting its behavior with the use of artificial intelligence." :
- *"Our next step will be, to integrate an IoT communication and get real-time data from the field. With this information, we can feed the AI algorithm to learn how to adapt to the various high speed and low-speed supply and demand challenges within a mini-grid."*
- **So the first step is to teach the AI how to learn; the next is to teach it how to react.**
- *As a smart grid gets bigger and more individual and uncontrollable prosumers get active in the grid, a **centralized controlled approach will not work at a certain stage**. There is a need to employ every element to stabilize the grid – and storage devices have this ability."*
- **Distributed energy (including renewable sources) and local energy storage are integral to a more robust and stable power grid.**

Energy storage is key because it has the ability to deliver and absorb power as needed, unlike pure generators and loads. Distributed generation and storage allows considerably more flexibility

- The basic Power-Blox unit consists of a battery - either Li-ion or AGM (a variation of lead acid) - capable of storing 1.2 kWh of energy and delivering a continuous 200 W of power and up to 370 W in short bursts (to cover a motor's startup surge, for example). A built-in charge controller allows connection to a solar array for off-grid or grid-tied applications.



AI M2M and robotics converging – the Future is here!

announcements just last week

Amazon GO

No checkouts and no cashiers. “Just walk out shopping” made possible by technology that can identify each customer and what they are picking off the shelves. A receipt pops up on the shoppers phone, for items they have bought moments after they leave

Mass production of “Humanoid Robots”

Turkey's first factory which will produce human-like robots.. AkinRobotics, established by AkinSoft software company. One of the first robot factories in the world that has started mass production The robots **are able to process what they hear, speak, smell, and use the internet, Akin said, adding that they also recognize faces.** The new generation human-robots -- named "Ada GH5" -- for use at malls, fairs, airports, hospitals, and even at homes,

Canadian energy company to replace 400 truck drivers with self driving trucks

Suncor Energy Canada's largest oil company cutting 400 heavy-equipment operator positions over the next six years as they phase in self-driving trucks. Suncor will deploy over 150 driver-less trucks. Who already operate nine self-driving trucks in Alberta,

Off shoring in recent decades has eaten up physical jobs and whole industries, jobs that were not replaced. The current transfer of jobs from the physical to the virtual economy is a different sort of off shoring, not to a foreign country but to a virtual one. If we follow recent history we can't assume these jobs will be replaced either.” W Brian Arthur

The race to achieve General intelligence!

Tesla to build their own AI chip to retain ownership of the data and the algorithms that might achieve Autonomous transport



5 The Local Energy Service Operator

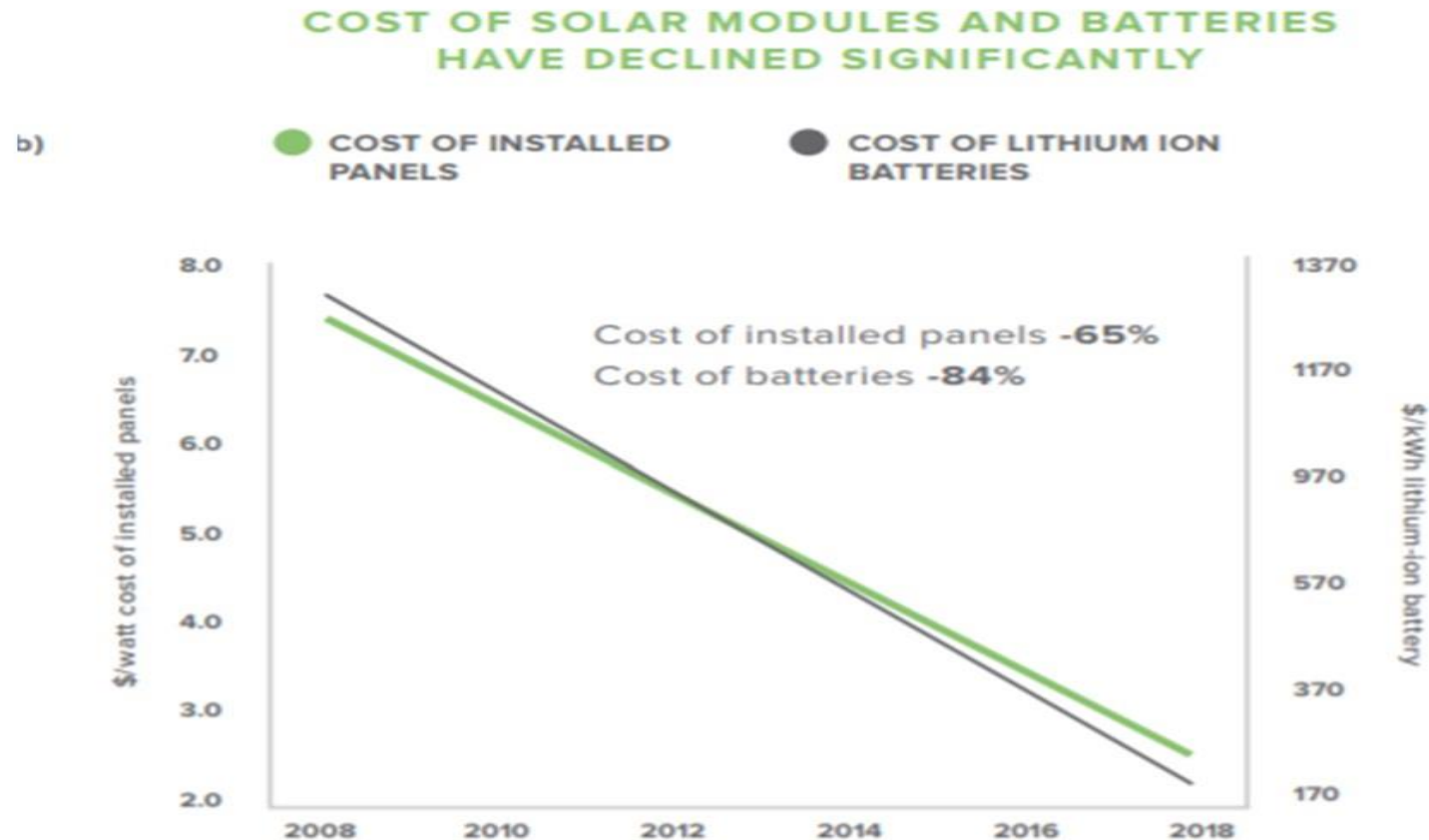
On shore Wind lowest cost energy source

- Onshore wind is the cheapest form of low carbon electricity generation available to the UK. New projects' costs are forecast to drop beneath BEIS's forecast wholesale electricity price from 2023, demonstrating net benefit for UK consumers.
- If five CfD auctions are held at 18 month intervals between 2019 and 2025 with a 1GW ceiling in each, the net payback to the consumer could be more than £1.6 billion over the 15 year CfD period, benefiting household bills up and down the country.
- The auction clearing prices are forecast to be £49.4/MWh in 2019 falling to £45/MWh by 2025 (2017 prices) (£45.6/MWh and £41.6/MWh in 2012 prices).
- Over the five auctions modelled using projects in the Renewable Energy Planning Database, 86% of the projects by capacity would be built in Scotland and 12% in Wales. Less than 2% would be built in England made up of small scale projects (sub-50MW) of a type typically developed by communities.

In 2017 two offshore wind farms came in at £57.50 per Mw hour and a third at £74.75. These “strike prices” - are expressed in 2012 figures, as is **Hinkley's £92.50**

Plummeting costs of Renewable / Distributed Energy ... and Storage

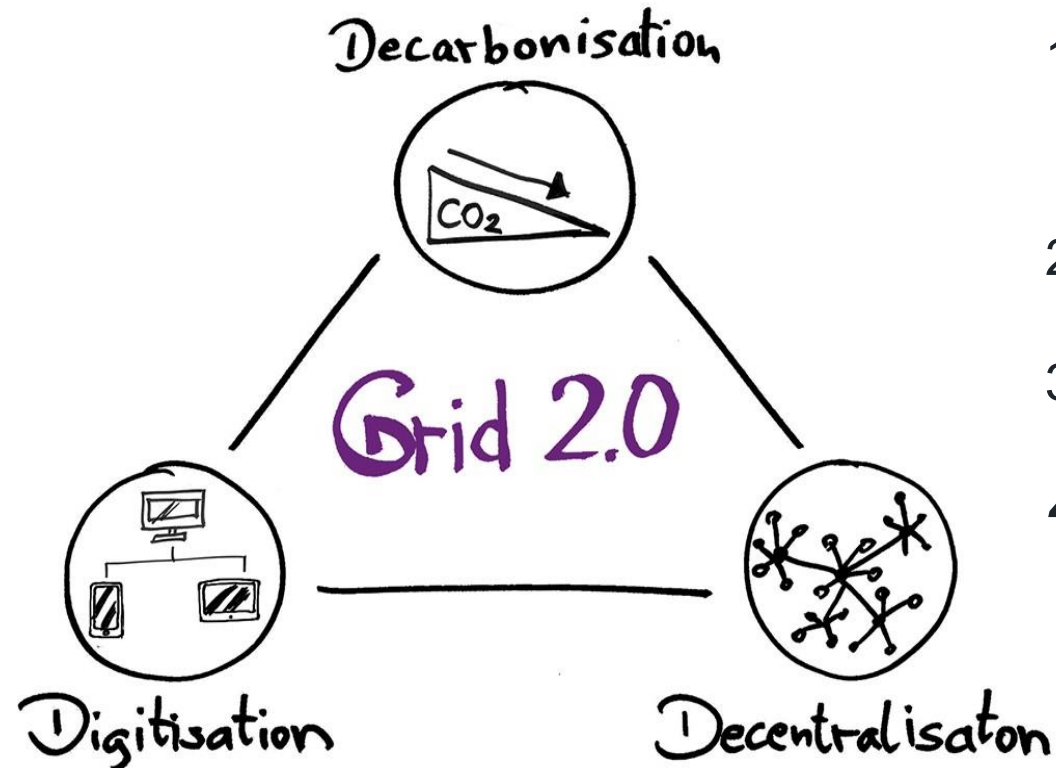
Time of Use tariffs, Demand Management / Aggregation and Micro Grid solutions increase value further for the end user



Plummeting costs of Renewable / Distributed Energy

- Colorado utility Xcel says its 2013 all-source solicitation yielded 55 bids. The November 2017 equivalent received 430 individual bids, for 238 separate projects.
- The median bid for a wind project was \$18.10/MWh; the median for wind+storage was \$21, just three dollars higher. The median bid for a solar PV project was \$29.50/MWh; the median bid for solar+storage was \$36, just \$7 higher. (NB Half the projects bid cheaper than this.)
- The cheapest previously known solar+storage price in the US was \$45/Mwh signed by Tucson Electric in 2017. The median Xcel bid for solar+storage beats that by \$9.
- At an auction in Chile last year, a solar+storage project won at \$34.40/MWh,
- Saudi Arabia recently saw bids for utility-scale solar at under \$20/MWh, which is less than half Lazard's lowest estimate for the range of solar LCOE (\$46/MWh).

The Energy transition – the consumer's role and experience central i.e. The Prosumer and the democratisation of energy!

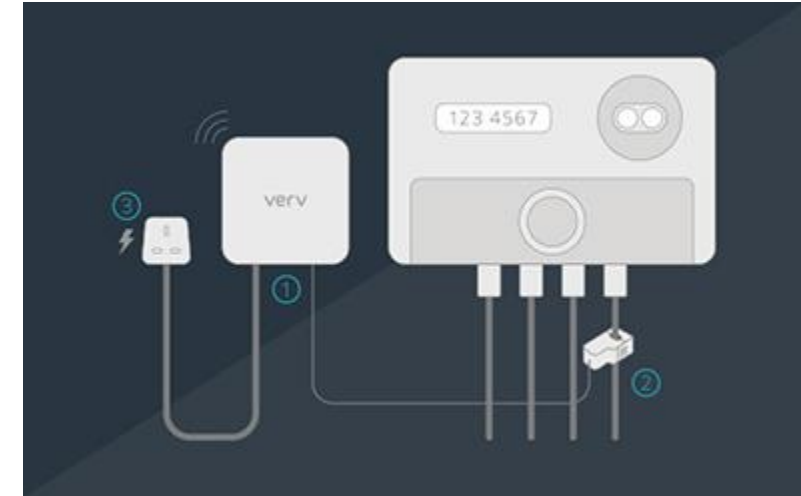


1. Transforming the energy system is heavily centred around changes to the distribution grid and changing roles and interactions with customers;
2. This will impact how consumers utilise all critical infrastructure - energy transportation water etc
3. Hence supporting new entrants to the market and new business models is key
4. *All of this requires changing processes underpinned by a more complex and intelligent system - enabled by data / communications*

Verv – AI Energy Gateway to enable P2P consumer trading

The Verv Hub

Verv attaches directly to the electricity meter in a home via a simple current clamp, enabling the hub to 'listen' to the whole electricity usage of that residence. Verv has a 'sample rate' that is up to 5 million times faster than a smart meter (known as 'high frequency data'), which is how it is able to gain more detail from the electricity mains than any other monitoring product in the UK. Much like taking a very high resolution photograph of a subject and being able to see far more detail and clarity than on a normal picture



Under the Hood

While the hub takes care of collecting high frequency electricity data, our clever, patented algorithms have been taught to recognise key household appliances via their unique energy signatures and feed their usage data to the user via the Verv app as, soon as it is installed. Our algorithms are continuously learning and the more data they gain the more accurate our algorithms become, eventually identifying new appliances in individual homes and providing smarter insights into usage patterns.



A new UK Energy sector – Local ESCOs

Greater Manchester Combined Authority – a regional Low Carbon Energy strategy

Rationale for GM Investment (£105m pa benefit from 15% energy cost reduction in CI sector only)

- Costs savings opportunity – self supply enables retention of supply margins cost and energy efficiency
- Opportunities to retain spend in the region and generate revenue
- Potential for multiple revenue streams (stacking – Capacity market, Frequency response)
- Increased energy security – protect against economic uncertainty
- Job creation & inward investment
- Support investment in and accelerate low carbon generation
- Future opportunities to disrupt the market and offer a better deal for the city
- Circular economy opportunities – energy from waste



The UK Energy sector in process of radical transition

The Smart Energy definition and DSO transition

- The UK government consulting industry on how our Smart Energy future should progress. Demand Management and Storage, role of future Distribution Service Operators (DSO) and the potential creation of a new local energy Balancing Authorities.
- UK Governments Industrial Policy “***The Clean Growth Strategy Leading the way to a low carbon future***”
- OFGEM – “***Upgrading Our Energy System – Smart Systems and Flexibility Plan***”
- Dieter Helm report – “***Cost of Energy review***” - Local integrated service providers – DG Storage and DSMend of the Trilemma
- ***Bloomberg – Sustainable energy socio economic model realisable due to Digitalisation***

5 The Keele SEND Project

Keele Smart Energy Network Demonstrator

A national R&D facility to deliver
UK comparative advantage in
global smart energy markets

<https://www.keele.ac.uk/pressreleases/2018/keeleuniversityandsiemensinlandmarkenergypartnership.php>



Keele: 'at scale' demonstrator

>10km of underground gas network

6 primary metering points (MP/LP)

>18km of electrical network (cable)

18 sub-stations (HV/LV) (4 to be added in 2017)

>28km of fibre-optic cabling

>16km of surface and foul water drainage

>16km of mains water network

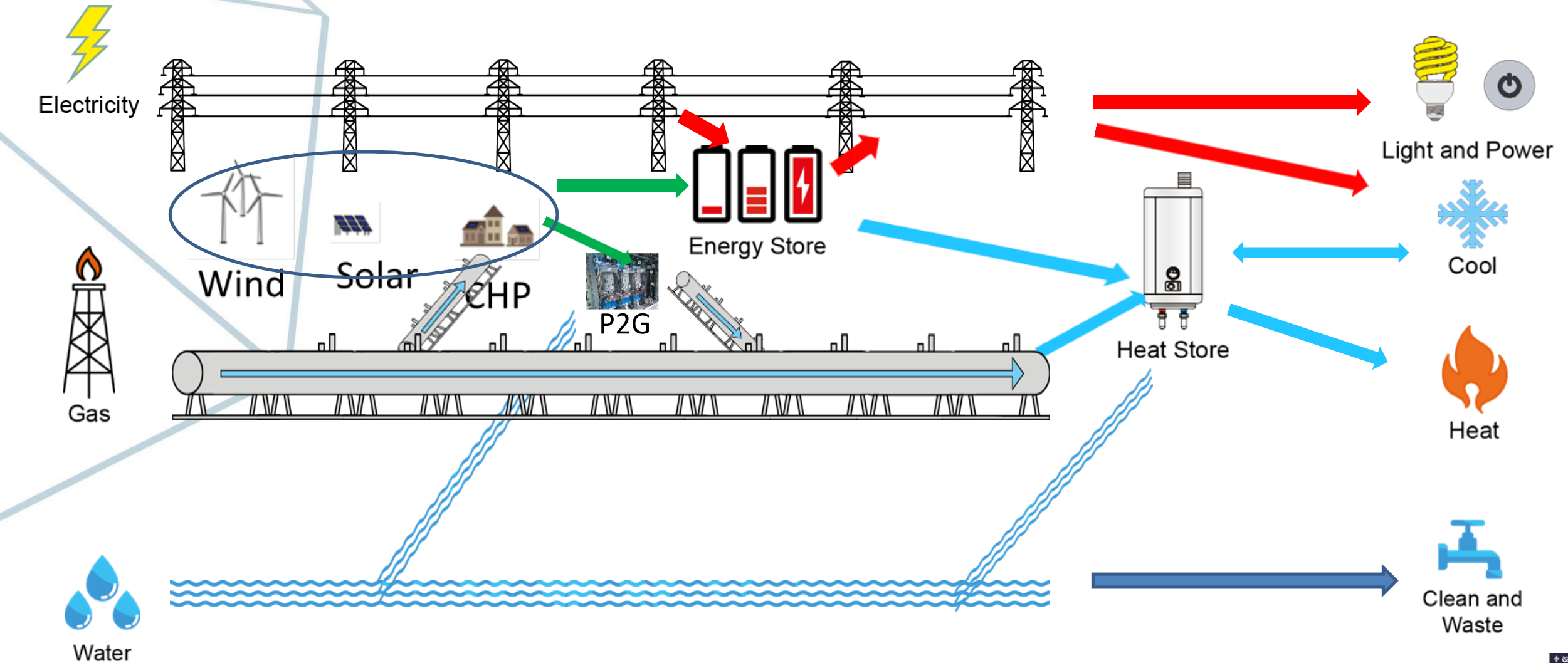
Refurbishment/extension of 6km district heating

Targets

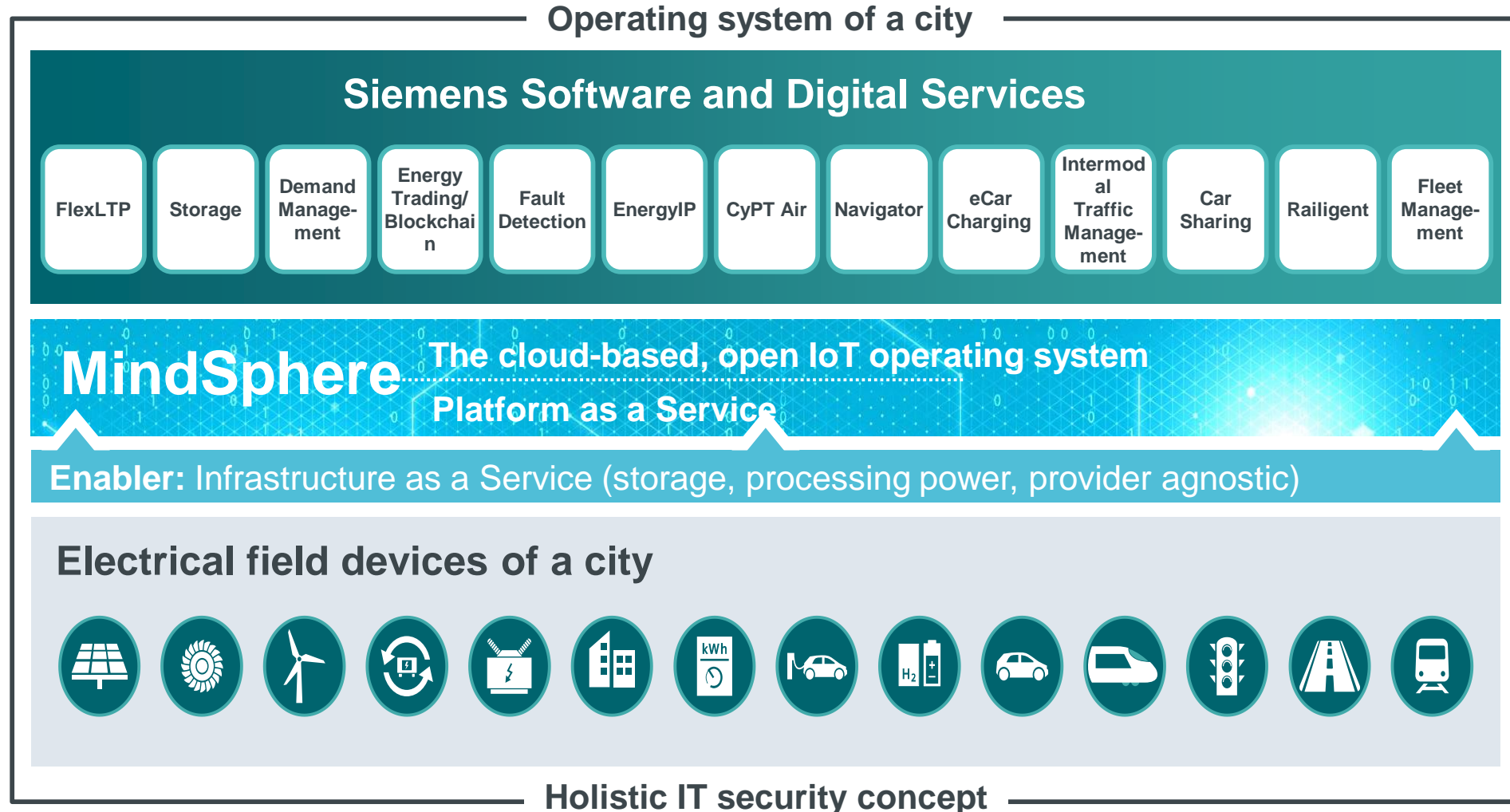
- 4096 T CO₂e reduction pa by 2021
(circa 30% current emissions)
- 243 Staffordshire SMEs supported
 - 26 – 3-yr RD&I projects
 - 9 – “new enterprises”
 - 7 – “new to firm” products

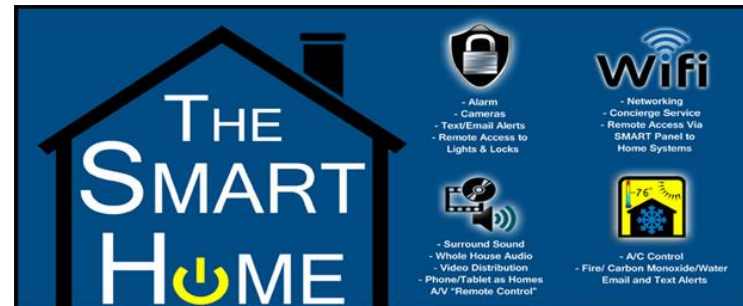
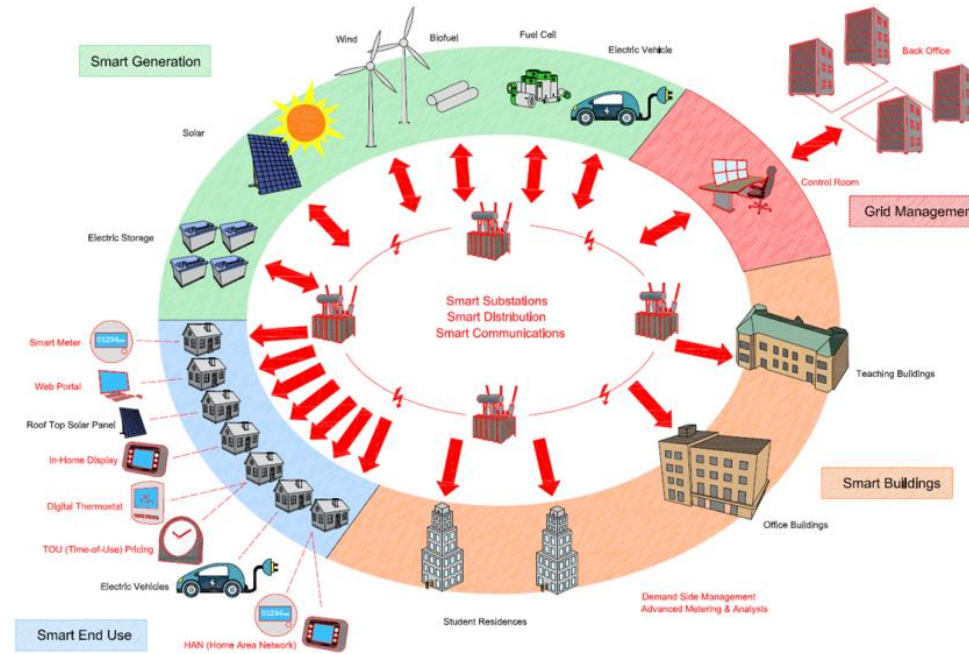
A view of future energy supply

Introduce Balancing



A unique digital offering for the infrastructure needs of a city



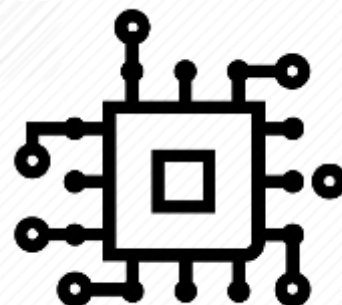
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6 What when ...and if



Interdependencies

People + places + activities



Energy + digital + access

The UK Energy sector facing a Revolution

Smart Energy will deliver a Localised energy model

- UK Governments Industrial Policy “***The Clean Growth Strategy Leading the way to a low carbon future***”
- OFGEM – The Targeted Charging Review is critical
- Dieter Helm report – “***Cost of Energy review***” - Local integrated service providers – DG Storage and DSMend of the Trilemma
- *Bloomberg – Sustainable energy socio economic model realisable due to Digitalisation*

Critical Role of Data Communications across the Energy system to combat Climate Change

- *To deliver the Smart Grid, a robust open communications infrastructure must be developed over the coming years.*

In conclusion

The Digital Energy Revolution – can it save our climate from the precipice?

Yes!if it is allowed to!

Worthwhile Reading

- **The Great Transition - Lester R Brown**
- **AIQ - Polson and Scott**
- **The Third Industrial revolution – Jeremy Rifkin**
- **Energy and Civilisation – Vaclav Smil**
- **The Four – Scott Galloway**
- **The Platform Society – Van Dijck Poell and De Waal**
- **Climate of Hope – Michael Bloomberg**
- **Fundamentals of Energy Regulation – Jonathan A Lesser and Leonardo R. Giacchino**
- **The Future - Al Gore**
- **Energy Revolution – Mara Prentiss**

Thank you

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