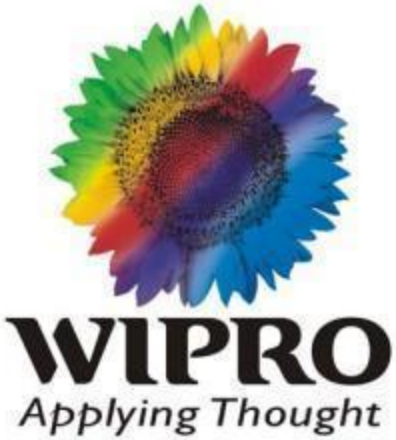
SmartGridSolutions

THE FUTURE OF POWER DISTRIBUTION

Smart Grids for more effective Energy usage

16th September 2011

www.smartgrid.co.uk



David Healey

Smart Grid Practice Head Emea

Contents

1 WHAT DOES SMART GRID REALLY MEAN?

Who are you talking to?

Where in the world you are?

What date / time is it?

The U.S. DoE's $29.5 bn budget for FY 2012

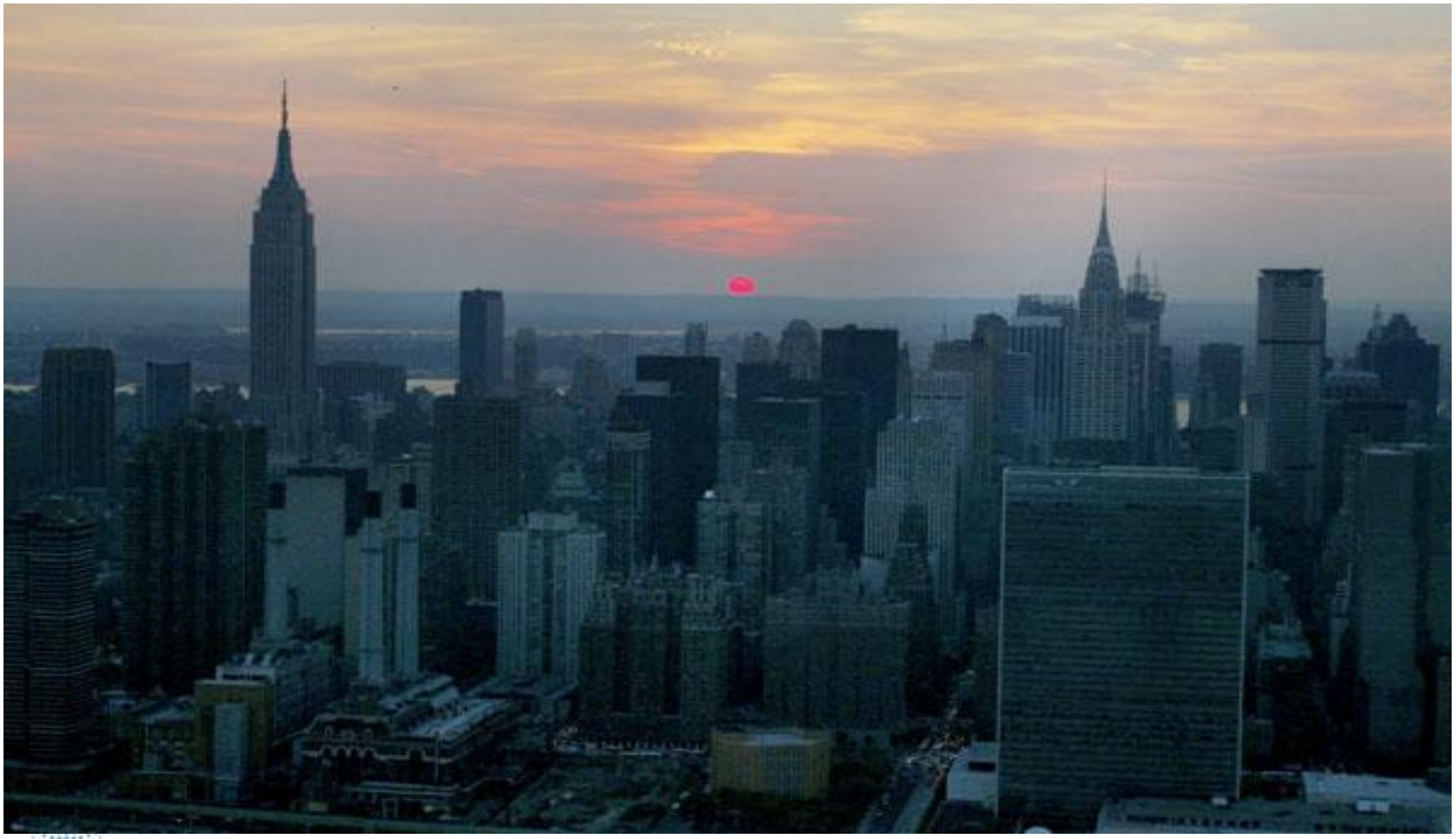
The FY 2012 budget, Chu said, is part of an administration-wide plan to win the future by ***"out-innovating, out-educating and out-building the rest of the world,"***

The budget request includes $3.2 billion for energy efficiency and renewable energy programs, $36 billion in loan guarantee authority to help jump start the domestic nuclear industry and $5.4 billion for the Office of Science to expand investment in basic energy sciences, advanced scientific computing and biological and environmental sciences.

Apac installed Smart Meters to Reach 350m by 2016

increase from 52.8 million in 2010 to 350.3 million by 2016, representing a compound annual growth rate (CAGR) of 37%

Cisco: Smart Grid will eclipse size of Internet??



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

“There is a world market for maybe five computers”

IBM’s Thomas Watson 1943

Utilities have never faced major operational change!

SMART GRID DRIVERS - POLITICS AND MONEY!!!

CLIMATE CHANGE / CARBON REDUCTION

OIL PRICING / PEAK OIL

NATIONAL AMBITIONS TO BECOME ENERGY INDEPENDENT

BLACKOUTS / DEMAND / GENERATION GAP (30% increase by 2030)

ELECTRIFICATION OF ENERGY – Transport / Heating etc

GROWTH OF THE CITIES (Asset replacement costs)

ECONOMIC STIMULUS / COUNTERING RECESSION

2 HOW SMART IS A SMART GRID ?

A UK utility based perspective

TODAYS GRID

LIMITED LV / HV REMOTE CONTROL AND ACTIVE MONITORING

CENTRALISED GENERATION

MINIMAL TWO WAY COMMUNICATIONS BETWEEN CONSUMER AND OPERATOR

ENERGY CONSUMPTION PROJECTED NOT MEASURED

RELY ON CONSUMERS TO NOTIFY OPERATOR OF OUTAGES

TECHNICAL LOSSES (Europe 2% - 10% - Turkey 60%?)

"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."

TOMORROW'S SMART GRID

A smart grid uses sensing, embedded processing and digital communications to enable the electricity grid to be:

- *observable (able to be measured and visualized)*
- *controllable (able to manipulated and optimized)*
- *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)

source World Economic Forum Smart Grid Investment report 2009

USA DoE Definition of Smart Grid

1. It is self-healing from power disturbances.
2. It enables active participation by consumers in demand-response programs (load control).
3. It operates resiliently against physical or cyber attack.
4. It provides quality power for 21st-century needs.
5. It accommodates all generation and storage options.
6. It enables new products, services, and markets to function.
7. It optimizes utility assets and operational efficiency with the use of sensors

Second mover Advantage ?

The case of Boulder Colorado

http://www.youtube.com/watch?v=f8ugivIg5kU

State regulators question prudence of Boulder's smart grid PUC decision will determine who has to pay for the project

Xcel Energy planned and implemented its smart grid project in Boulder outside of its normal budgeting process, which means the company did not conduct formal reviews of the project as costs increased, according to a financial analyst at the Colorado Public Utilities Commission.

The analyst, Harry Di Domenico, said it's also unclear whether capital costs will continue to rise for SmartGridCity -- the budget for which has nearly tripled to $44.8 million from the original estimate of $15.3 million -- given the project's history of "rapidly and apparently unanticipated increases.“

Typically, the Public Utilities Commission must grant such certificates before a large project -- such as building a new power plant -- is begun. The certificate is meant to ensure that the project is prudent and needed before ratepayers are asked to foot the bill.

When Xcel began building the smart grid in Boulder in May 2008, they did so without a Certificate of Public Convenience and Necessity because company officials believed the project -- which they saw as a large-scale lab for research and development of new smart technologies -- didn't require that kind of approval.

California smart meter deployment Revolt

Remember how an independent investigator said last week that the millions of smart meters being installed across Northern California by Pacific Gas & Electric were not malfunctioning and overcharging customers, even though a lawsuit against PG&E and over 1,300 customers claimed they were?

Now the San Jose Mercury News says it's collected dozens of complaints on its Action Line from readers who claim that the wireless smart meters interfere with their household electronics — cordless phones, crib monitors, patio speakers, wireless headsets and microphones, home security systems, motion detectors and remote-controlled garage doors

APPLICATIONS MODEL

GENERATION

- No longer centralised
- Distributed (connectivity)
- Renewable
- Electric Vehicles
- Storage

NETWORK

- Remote management
- Fault monitoring
- Self healing
- Islanding / Micro grids
- Demand Response

CONSUMER

- Metering
- Load management / pricing
- Generation export
- Building Energy efficiency
- Storage

GENERATION

Distributed Generation including CHP / Building Management

International Export / Import

Recharging EV network capable of export in to the grid.

Integration of large scale renewable generation

Network level Energy storage deployment

Nuclear

NETWORK

Wide Area monitoring / configuration of MV network to facilitate real time response to generation load and status information

Introduction of Micro grid management and potential of “Self Healing” at MV level – support EV charging network

Intelligent Substations / installation of transformer metering

Sensor network (LV and MV) delivering real time information on load, voltage, temperature etc. Auto switches / re closers / fuses

Distributed Generation requires Multi directional power flows

CONSUMERS

Smart Meter rollout leading to Demand Side Management

Distributed Generation – including EVs?

Integration of networked Building Energy efficiency applications

CONSUMER STORAGE!

Potential Demand Response / Aggregator role initially focused upon commercial and industrial customers

NB What customer usage / load data will distribution utility be able to access under Smart Metering proposals?

* GENERATION BROADLY DISTRIBUTED / DIVERSIFIED

* POWER DELIVERY WILL BECOME MULTIDIRECTIONAL

* CUSTOMERS WILL PARTICIPATE IN GENERATION MIX AND DEMAND MANAGEMENT

(Including Electrification of Transport and Heating)

By 2015 400 *million "Smart Meters" will be deployed - HOWEVER we don't yet know how* customers or utilities will use them? OR how this information will change usage, pricing, demand and supply?

Welcome to the dawn of the Smart Grid!

3 FIRST STEPS TO UK SMART GRID

Smart Meter rollout

Low Carbon Network Fund

The Thorny issue of EVs

A high concentration of plug-in electric vehicles poses a serious challenge to utilities. Plug-in electric cars could draw electricity equivalent to the amount needed to run one home, or up to three homes in certain places. You can see if you have three or five electric cars arrive in a neighbourhood, you're going to overload the local circuits, and that will lead to blackouts. So we see it as an opportunity but we also see it as a challenge of significant proportions.

Paris Autolib electric car hire scheme accelerates

The popular Velib bike hire scheme will also include friendly electric cars when a self-service car hire scheme gets underway autumn 2011 …. **3,000 electric vehicles,** with drivers able to pick up a car from one of the **1,000 stations** in Paris and its suburbs. The bubble-shaped Blue cars, designed by Italian partner Pininfarina, are powered by lithium polymer metal batteries produced by Bollore, and have a range of 155 miles in the city between charges, which will take about **four hours**.

UK OFGEM announced in Oct 2009

Over the next 10 years UK needs to invest up to £200bn in power plants and other energy infrastructure projects to secure energy supplies & meet climate change targets.

Ofgem proposed four scenarios:- “Green Transition”, “Green Stimulus”, “Dash for Energy” and “Slow Growth”.

Scenarios expected to deliver reductions in carbon emissions of between 12% and 43% (from 2005 levels)

Energy infrastructure investment required between £95bn and £200bn investment will increase UK domestic energy bills by between 14% and 25% by 2020 (above inflation and with respect to 2009 levels)

UK government unveils plans for every home in UK to be equipped with smart meters by the end of 2020

Smart meters allow suppliers to remotely record customers' gas electricity use, and let consumers monitor their energy usage

26m electricity and 22m gas meters at cost of between £7bn and £15bn …. biggest programme of work since British Gas converted appliances in 17m homes to natural gas in1970s.

£10bn of costs will be accounted for in cost savings by the suppliers. **Customer to pay for approximately £5bn**

Average consumer **projected to save up to 3%** off their energy use each year, and thus cut £25 to £35 off their annual bills

UK Government unveils plans for every home in Britain to be equipped with smart meters by the end of 2020

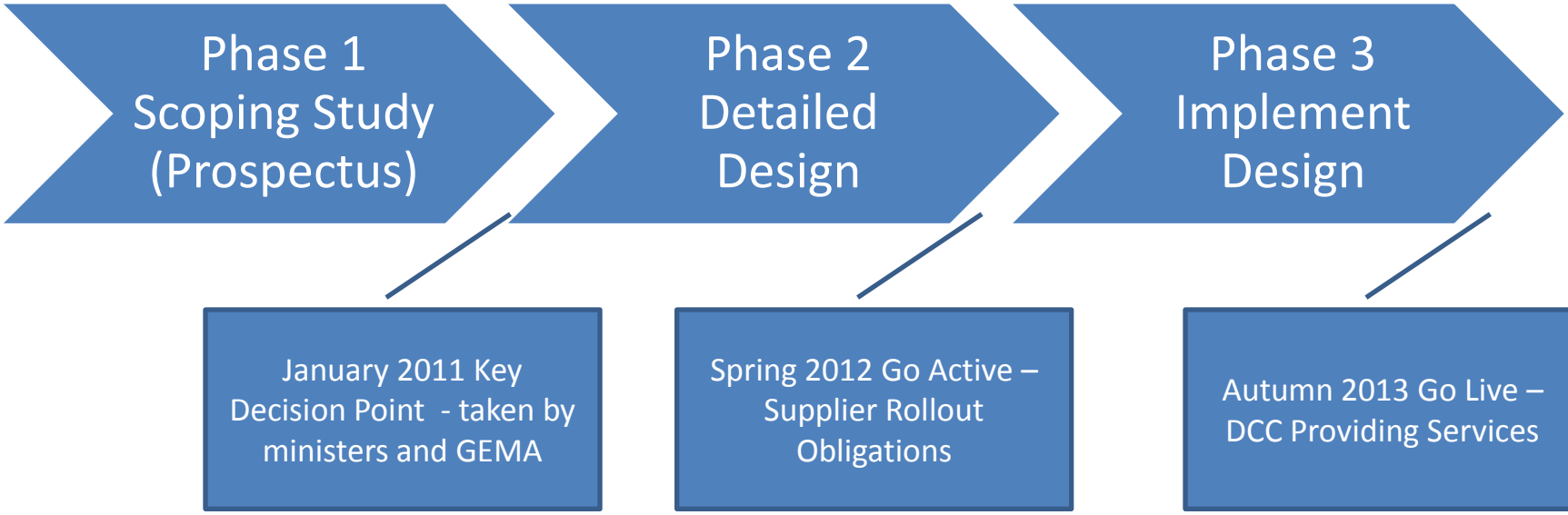
Supplier Driven Meter Deployment

Standard meter design currently in development through Ofgem consultation

New Central Regulated DataCommsCo (DCC) to operate centralised data and communications

DCC will provide two-way channel between smart meter and central communications hub to which smart meter data users will have access i.e. suppliers

SMART METERING TIMELINE



Huge potential carbon reduction available from Home insulation alone

£500m Low Carbon Networks fund for large scale trials of advanced technology and commercial initiatives

DNOs will have to share what they learn with all the other UK energy distribution network companies.

Up to 90 per cent of project finance covered by the fund with DNOs expected to provide the balance

£80 million of the fund allocated directly to DNOs to use for small projects

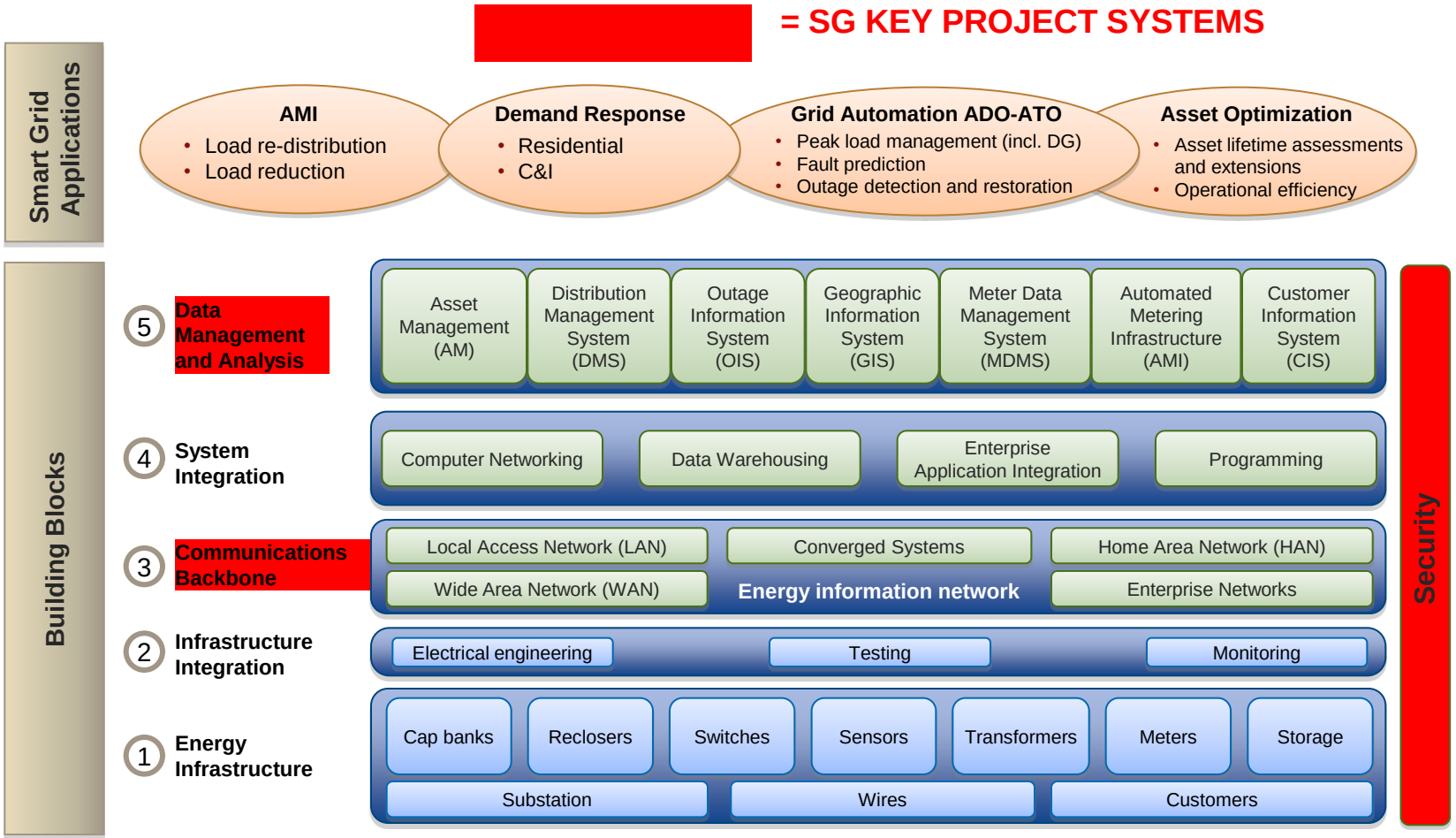
£100M of the overall £500M DPCR5 period fund will be kept for discretionary awards

DNOs compete for an allocation from the rest of £320m for flagship projects – annual award from OFGEM panel

SG applications areas specified by OFGEM for funding

- Projects that begin path that could lead DNO's to "full-blown smart grids"
- **Respond to shifting patterns of use / demand to keep systems in balance and to give consumers access to possibilities offered by new technology**
- Development of solutions to support Electric cars
- Reduce need for building more networks and enable DNO's to improve management of energy demand.
- Variable tariffs and payments also including home generation
- OFGEM referenced recent trial and specific applications
  - AMI – more effective payment for usage
  - Swifter fault location and repair
  - Better information for better DNO investment decisions
  - Communications Hub / Network - consumers can allow supplier to reduce their power consumption
  - Control of Distributed Generation

Smart Grid Project Architecture



AMI = advanced metering infrastructure, ADO-ATO = advanced distribution operations-advanced transmission operations, DG = distributed generation, MPL = municipal power and light, RF = radio frequency,

C&I = Commercial and Industrial, DG = Distributed Generation

Three key Elements for any Smart Grid project integrating Generation Network & Consumers

1. **Communications Architecture** - Likely that utilities will need to invest in access, intermediary and backbone communications systems

2. **Cyber security system** - Mission critical to maintain integrity of system and service

3. **SG Applications management / control system** - Essential to effectively co ordinate disparate management and operational applications including integration with legacy systems (**E.G. Meter / Load Data management system)**

1 Communications Architecture choice critical

Opportunity to fund 33kv substation fiber access expansion?

Real time monitoring / sensor network for 11kv OH network?

LV remote fuse / switches with remote connectivity & control

Meter interface (physical / logical)

HAN – integration of load management / generation / and energy application

SG Comms will involve integration of *IP Network* applications

1 Communications Architecture choice critical

REAL TIME / Low latency

Sub-Second Fault analysis

Real-Time Remote network control

Self configuring grid

Fiber optics, (Gb/s - Tb/s)

WiMax / BPL (10 - 200 mbs)

NON REAL TIME / High latency / Response Time R 1–10 mins

Remote connection, dis-/ reconnection

Optimize crew management

Automated meter reading

SMS, GPRS, Mesh Radio(1 – 170 kbs)

Non Time Critical Response Time over 10 mins

Remote consumer price signals

Remote meter configuration

Network reinforcement planning

Narrowband PLC (100bps - 5kbs)

2 Integrated Cyber Security system essential for end to end SG network

Growing focus on impacts of risks to electric power infrastructure

SG complexity through expanding inter-connectivity of systems and extension to new grid components / participants

Long-term investments and commitments being made in digitally-enabled field-accessible equipment

Legacy systems need to be secured along side newer, unproven technologies

ENSG "Critical Project Consideration" **Robust, thorough and embedded end to end security solution with a degree of ongoing centralised management and enhancement**

3 SG INTEGRATED Applications management system

Legacy Utility Operations

IBM, SAP, Oracle, Microsoft, Cisco
Middleware and Applications
Meter Data Mgmt, Billing, CRM

Back-Office Operations

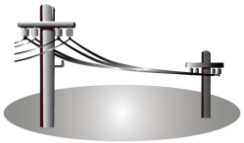
Grid Operations

Premises Controls

IBM, Microsoft, Google/GE
Web Portals, Energy Mgmt.

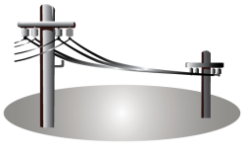
.SG APPLICATIONS MANAGEMENT PLATFORM

Substation

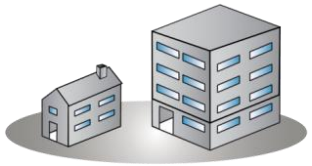


Distribution Grid

Distributed Renewable Generation & Storage



Distribution Grid



Residential and C&I Demand

4 ISSUES FOR UK Limited

- Regulatory Change
- Distribution
- Demand Aggregation
- Smart Grid in the North West

The need for Regulatory Change!

Performance Based Rate (PBR) Regulation

Industry performance between 1990 to 2005

- Distribution rates charged to UK customers **dropped by over 30%** in real terms.
- The quality of supply also improved - average annual interruption time per customer **fell by 39%.**
- Average EBITDA margins of distribution companies **up by 51%.**

However ….

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Performance Based Rate (PBR) Regulation

However……

Utilities driven to stretch value of capital investments as far as operationally possible.

Utilities must maximise profit margins for private shareholders with large scale outsourcing of network engineering support resources

Spending on R&D by the UK DNO's largely collapsed. At privatisation in 1990/91 average R&D investment by UK DNOs £6m p.a. In 2003/4 below £1m p.a. In 2006/7 OFGEM reported 5 of the 7 DNO's spent below half their IFI budget

Utilising grid for research, testing, development more difficult as this could have negative impact on Service Level Agreements.

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Status of UK Power Distribution Networks

- The chronic under investment by successive governments after major construction in the 1950's/early 1960's has been exacerbated by the impact of PBR regulation after privatisation in the 1990's.
- On top of this new Environmental and social policies are requiring the DNO's to rethink from the bottom up what short and medium term changes need to take place to address this new perspective of power distribution.

PROPOSED NATIONAL 2020 BINDING RES TARGETS

	RES in 2005	2020 RES Target%	Increase required
United Kingdom	1.3%	15%	13.7%
Average EU 27	**8.5%**	**20%**	**11.5%**

National statistics compiled by EU however show UK has to address greatest percentage increase of all EU 27 states, to meet the 2020 targets.

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Change in Energy Distribution

Can the present electrical distribution system deliver a low-carbon electrical future?

What happens if the UK achieves it's commitment to deliver:-

35% of electrical energy from renewables by 2020

100% of electrical energy from zero carbon sources by 2050

(in 2008:- 7% of electrical energy from renewables)

Expected that most of the "new" renewables will come from variable and difficult to predict wind generation

This in conjunction with less flexible "new-build" nuclear plants may challenge the ability of the UK to absorb low carbon energy

Can the present electrical distribution system deliver a low-carbon electrical future?

Requires significant investment in primary generation and network assets while reducing utilization of the assets

Problem further compounded by shifting significant amounts of energy demand from gas and petrol (heat and transport) to electricity

Can Generation capacity meet future peak demand?

Will require radical changes in UK power system control strategy

Also demand management will need to play a significant role in generation-demand balancing

Smart Grid will require a new market approach – The Distributed Energy Resource (DER) Aggregator

Distributed Energy Resources (DER) Virtual Service Aggregator role for ENW?

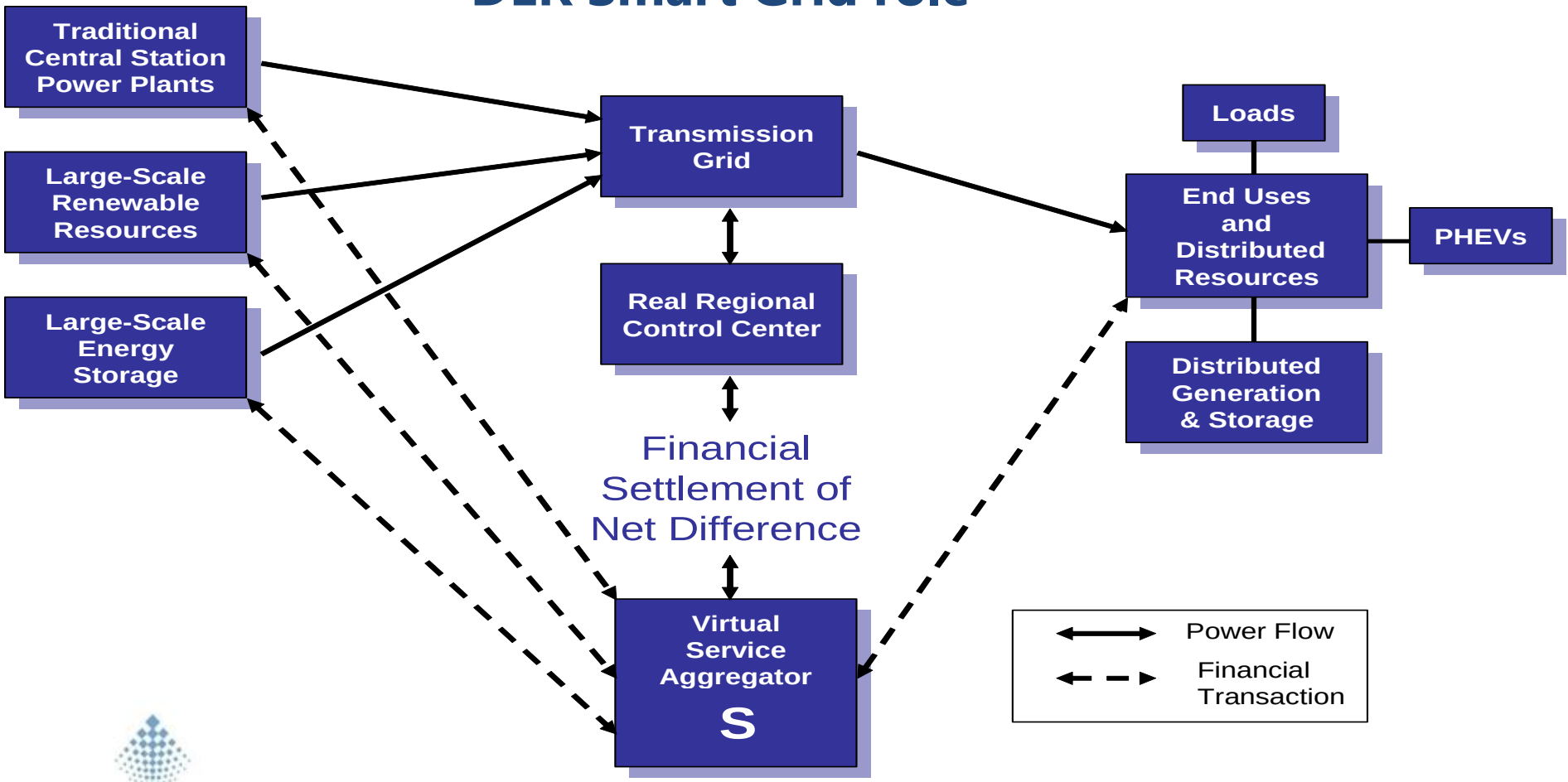
- Virtual Service Aggregators serving as Energy Balancing Authorities
  - Dispatch and control stochastic renewable generation
  - Dispatch and control (and own?) large scale energy storage capacity
  - Manage demand response proactively
  - Deploy / Manage smart electric vehicle charging

- Optimal end-to-end dispatch to optimise system reliability

- CO2 Cap-and-Trade Market Monitoring

AMI determination to further confirm opportunity?

DER Smart Grid role



DER Market will become critical to UK

- **DER Integrator Service Provider can deal directly with National Grid if their service size meets the minimum requirement**

- **Service Providers can also choose to use Agent or Aggregator**

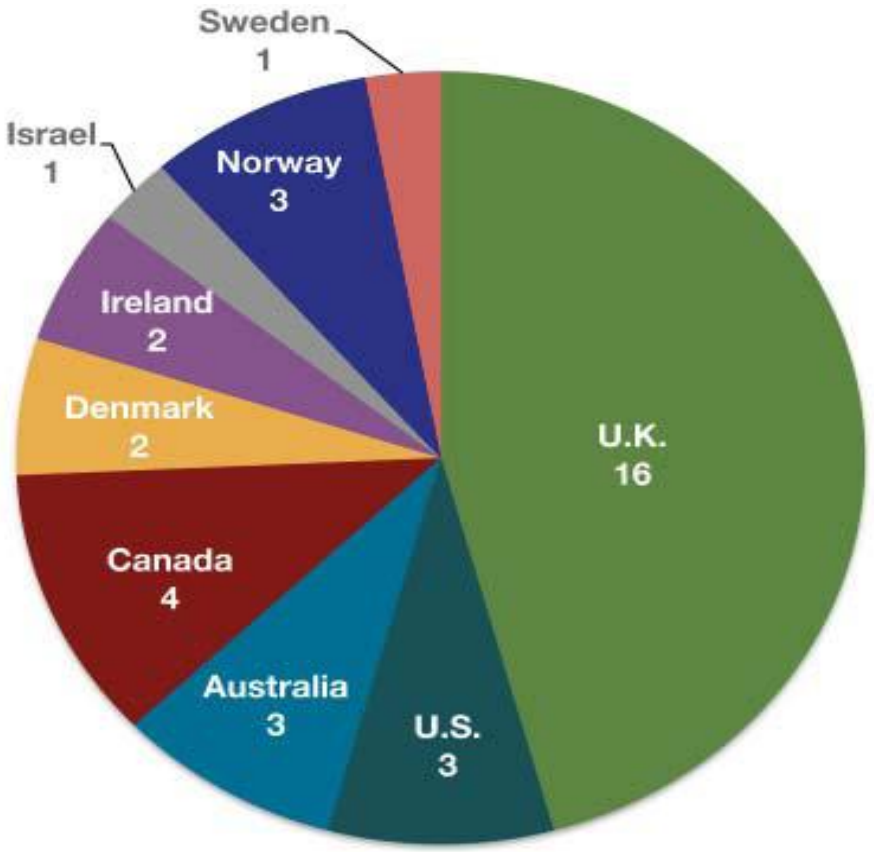
The following companies offer DER service

- **Flexitricity**
- **GDF Suez**
- **NPower Cogen**

Importantly ENERNOC has recently obtained license

Smart Grid in the North West

Will UK develop a Smart Grid Industry or import skills and product?



UK Smart Grid Development Centre in NW?

Smart Grid Development Centre:

- A unique facility in Manchester City Centre hosted by the University
  - A demonstration and test facility to support the roll-out of smart grid technologies
  - An educational environment for the provision of training
  - A showcase of smart grid technology used for engagement with smart grid stakeholders including consumers
- Project being developed by NG SSE ENW, Wipro Joule Centre, NWDA
- Initial deployment of equipment planned for q4 2011

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SGDC Summary:

- The Smart Grid Development Centre will be a world-class resource providing a test bed for smart grid technology in a live environment
- Opportunities will exist for companies (from SME to major corporates) to deploy, test and showcase smart grid technologies
- Supported by academia and industry, the SGDC aims to accelerate the development and deployment of smart grid technologies
- We will be inviting industry academia and governments to participate and collaborate with the SGDC founders

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Thank you!

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