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STORAGE & SYSTEMS CONFERENCE

21 JUNE 2017 **GLASGOW**

Scottish & Southern Electricity Networks

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areg
Aberdeen Renewable Energy Group

Opening Remarks:

Michael Rieley

Scottish Renewables

Delivering a Smart and Flexible Energy System

Chair

Keith Bell

ScottishPower Professor of Smart Grids

Strathclyde University

Paul Jordan

Head of Business Development

Energy Systems Catapult

Scottish Renewables - Storage and Systems Conference 2017

CATAPULT Energy Systems

Paul Jordan
Head of Business Development

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Our energy system is undergoing major transformation and the pace is quickening

CATAPULT Energy Systems

Clean energy's dirty secret

Wind and solar power are disrupting electricity systems

But that's no reason for governments to stop supporting them

Stem CTO: Lithium-Ion Battery Prices Fe
70% in the Last 18 Months

"There are new markets opening up because of what we've seen in battery pricing."

by Stephen Lacey
June 28, 2016

Smart energy technology 'stymied by current policy'

Policy Exchange says policies boost growth in dirty diesel, arguing a smarter power grid could cut costs and curb emissions

Smart meters can be installed in homes to monitor energy usage in real time.

Driving towards an energy dilemma: the inexorable rise of EVs

20th March 2017 4:58 pm

Will smart home technology systems make consumers more energy efficient?

With a push from Lowe's, Home Depot and Staples, home automation systems are gaining traction. But the force behind real change lies with the consumer

Wireless Charging: Coming Soon to an Electric Vehicle Near You

Mercedes is bringing Qualcomm wireless charging technology to market with the S550e. Other models and automakers soon to follow.

by Julia Pyper
October 27, 2016

News › Business › Business News

Why the poorest will pay the most to upgrade ageing infrastructure

Public Accounts Committee chair Margaret Hodge is concerned cash-strapped consumers will not be able to afford bills

Sources: Economist, Guardian, Independent, Green Tech Media, Telegraph

Market Opportunities, but key issues still need to be addressed for the UK to capitalise

Drivers

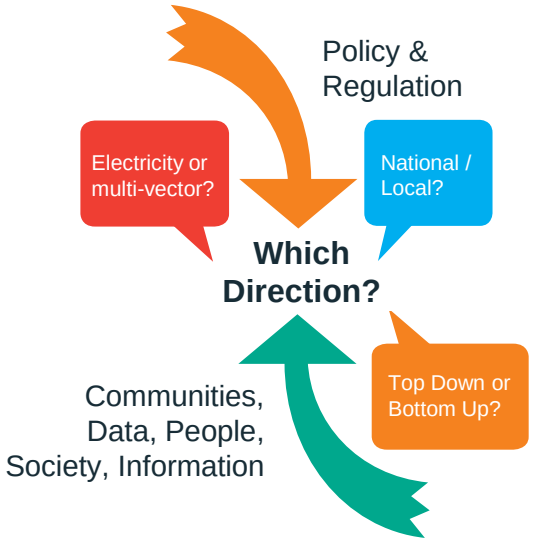
- Energy trilemma and ageing infrastructure
- Societal changes and growth in electrification
- New technology and digitalisation solutions

Opportunities

- New markets (domestic and overseas)
- New Products and Services (up to £46bn of UK GDP impact*)
- Reduction in cost of infrastructure and consumer bills (up to £27bn in efficiency savings*)

…but

- No clear UK trajectory to 2050 decarbonisation goals
- Gaps in long-term planning and system integration
- Market failures for innovators trying to commercialise



*Sources: Low Carbon Innovation Coordination Group (LCICG) TINA (Technology Innovation Needs Assessment) Reports, NIC 2016 report "Smart Power"

Unleashing the energy opportunity – 3 Catapult strategic priorities

We are working with innovators to address three key capabilities that are currently lacking in the UK energy innovation landscape:

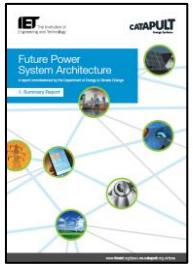
- **A ‘whole systems’ view of the energy landscape**: to help innovators understand how their product fits into the energy transition and how best to accelerate its exploitation
- **Expertise in integrated energy systems**: to help innovators overcome the systems integration barriers (social, technical and economic) of integrating their products into a highly complex energy system
- **Development of real world demonstration and scale-up environments**: to help innovators and policymakers transition future integrated energy system solutions to business as usual

Capabilities include: systems and solutions architectures, smart and multi-vector energy systems, building physics, local area planning, AI and machine learning, data science, consumer insight, systems engineering and integration, market modelling and analysis, technology-specific knowledge.

Catapult is supporting innovators through a range of programmes, platforms and collaborations

Whole Energy Systems Analysis
- Report on system need for Industrial Strategy
- New platforms (Percypt) to collate thinking
- Suppliers selected for methodology support
- Discussion advanced with ETI about SAF transfer

Energy Knowledge Exchange
- Platform to perform knowledge discovery, community development and data analytics
- Working with existing info. providers to develop a 'widget' that will sit on providers' sites



Future Power Systems Architecture
- Phase 1 report delivered in July 2016 with IET
- Rigorous System Engineering approach and 35 new or significantly enhanced functions
- Phase 2 to develop enabling framework and identify follow-on projects to address functions, launch planned for 23rd June 2017

Multi-Vector Test and Demonstration Studies
- Assessment of UK test facilities and their potential to evolve into Multi-Vector test facilities
- 14 facilities identified with an element of m-vector
- Review of market drivers, use-cases and gaps ongoing and discussions with test sites

ENERGY INNOVATION CENTRE

EIC Collaboration and SME barrier investigation
- EIC supports SMEs and links to DNOs/GDNOs
- Investigations carried out into SME barriers as well as Network Operator innovation needs
- Working together to implement SME initiatives

Smart Systems and Heat Programme
- Delivering for ETI (Phase 1) and BEIS (Phase 2)
- Tools for local area energy planning, system simulation and delivery of new energy services
- Consumer insights and generic business models
- Completion of 30 home trial of home energy mgmt. system and development of new 100 home trial

ESC & EIC – SME barriers insights report, launched on 23rd May 2017 at UtilityWeek Live

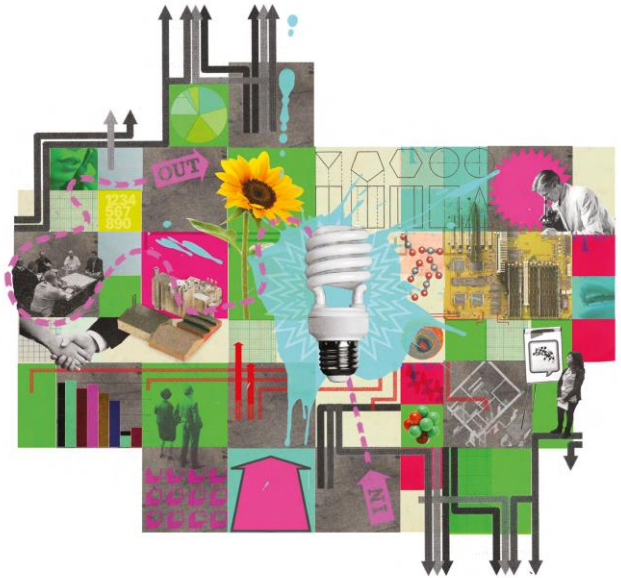
https://es.catapult.org.uk/wp-content/uploads/2017/05/CollectiveFuture-Insights-report.compressed.pdf

Continued support for innovators through existing and new programmes

- Direct support to innovators, particularly SMEs:
  - With EIC, implement recommendations from barriers report
  - PNDC (Power Networks Demonstration Centre) MOU, pilot programme to provide access to test time and research support
  - Trial EKX with SMEs and assess user journeys

- Smart Systems and Heat:
  - 100 home trial of customer energy service value propositions
  - Engagement with Energy Service Providers for further trials
  - Large-scale demonstration – discussions with Levenmouth
  - Investigate fuel poverty options – Fair Future project

- FPSA:
  - FPSA2 – progress the 35 functions, launch event on 23rd June
  - FPSA3 and beyond – Enabling Frameworks and develop projects to demonstrate specific elements of potential future architecture



Thank you!

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Contact us:
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CATAPULT
Energy Systems

Andy Burgess

Associate Partner

Ofgem

ofgem Making a positive difference for energy consumers

Delivering a Smart and Flexible Energy System

Andy Burgess
Associate Partner
Energy System Integration

21 June 2017

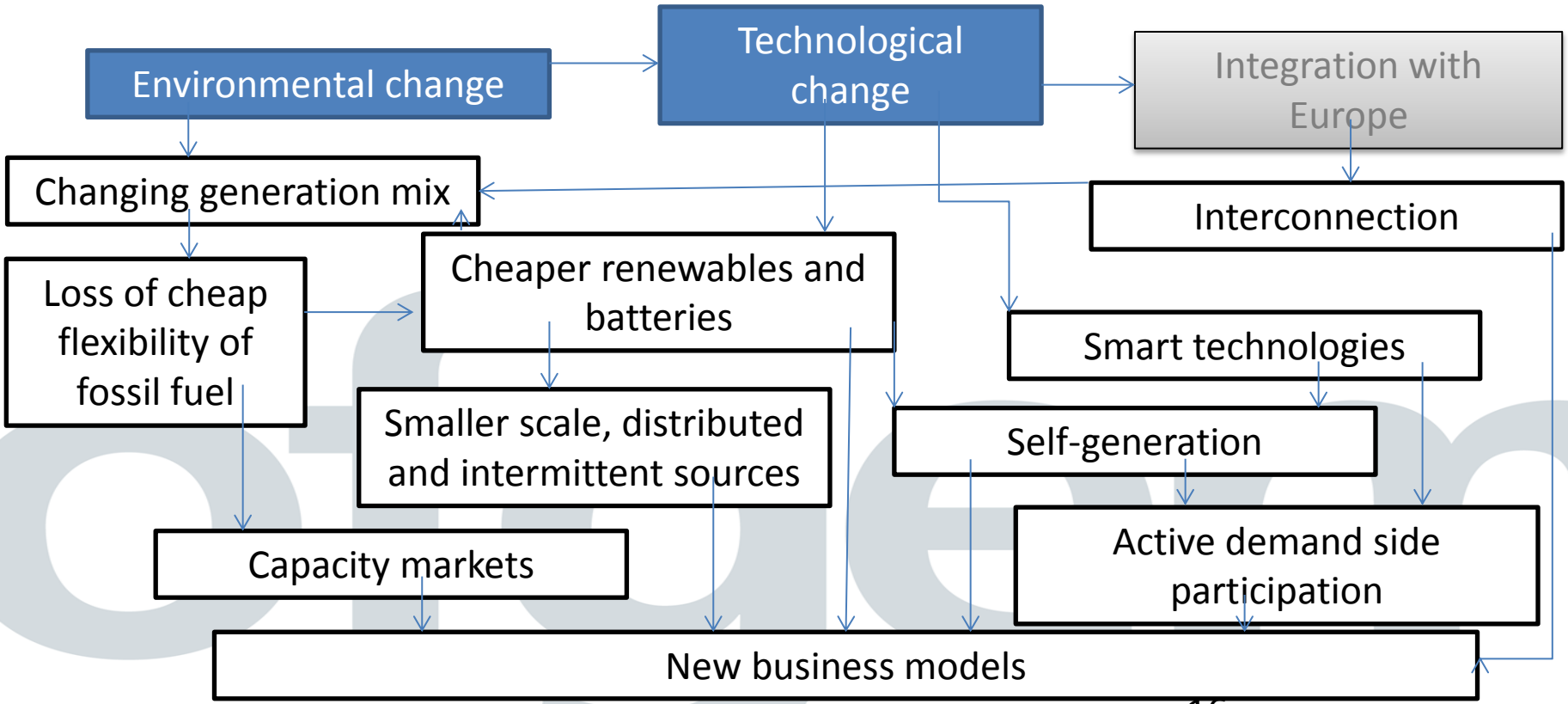
ofgem Making a positive difference for energy consumers

Ofgem's role

- Protecting current and future consumers
- Regulating monopolies
- Access to the system
- Making markets work for consumers
- Overseeing regulatory and commercial arrangements
- Being independent – thinking long term, providing stability

THE CHANGING WORLD

ofgem Making a positive difference for energy consumers



Ofgem's future facing work

- RIIO framework for network regulation
- Non-traditional business models
- Future retail regulation
- Flexibility and the joint call for evidence with BEIS on a smart, flexible energy system
- Targeted charging review
- Future insights
- Innovation link
- Future Energy Systems and Networks Strategy

Joint call for evidence

Contents

- **Removing policy and regulatory barriers**
  - Enabling storage
  - Clarifying the role of aggregators
- **Providing price signals**
  - System value pricing
  - Half hourly settlement
  - Smart tariffs
  - Smart distribution tariffs
  - Other government policies
- **A system for the consumer**
  - Smart appliances
  - Ultra low emission vehicles
  - Consumer engagement with DSR
  - Consumer protection
  - Cyber-security
- **different parties in system and network**
  - The impact of system changes
  - The need for immediate action
  - Further future changes to arrangements
- **Innovation**

Principles underpinning approach

- Market based, wherever possible
  - Using market and network charging arrangements to send price signals that users are capable of responding to;
  - Enabling flexibility providers to get access to the existing suite of markets, alongside new markets and being able to stack value across them
- Levelling the playing field between flexibility providers, including removing barriers and distortions
- Setting expectations of the roles and responsibilities of the monopoly network and system operators.
  - Expect them to make efficient use of flexibility providers as alternatives to traditional approaches
  - Enabling competitive markets to develop for these services
  - Playing an increased role in delivering the best outcome for the whole system

ofgem Making a positive difference for energy consumers

What this means

- Exciting changes
- More difficult decisions
- Allowing for different possibilities and different entities and being alive to change
- Priority remains consumers but with even greater diversity in consumer engagement
- Changing roles especially for network companies, but also for suppliers / intermediaries
- Keeping industry rules and charging regimes under review

Anna Kynaston

Head of Low Carbon Support Unit

Scottish Government

Storage and Systems Conference

21 June 2017

Anna Kynaston

Low Carbon Unit

Scottish Government
Riaghaltas na h-Alba
gov.scot

Scotland's Draft Energy Strategy

Setting the Context

Scottish Government
Riaghaltas na h-Alba
gov.scot

Smart, local energy systems

2050 Vision

- Scotland is a leader in the development of local energy systems, providing local solutions to local needs with improved consumer benefit
- Expertise in the management of local energy systems, coordinating the supply, storage and use of many devices, has developed to become a significant export industry
- Local communities play an active part in the delivery of innovative, low carbon energy systems, have the opportunity to influence energy planning from the outset, and receive community benefit (in various forms) from energy generation
- Local energy plans, drawing on best data on energy supply and use, are drawn-up in collaboration with local authorities in every region of Scotland, acting as a commercial investment prospectus and coordinating an area-based approach to public investment

Aims for energy policy

Scottish Energy Strategy

‘Whole-system’ view

- Integrated approach to heat, power and transport
- New 50% ‘all energy’ 2030 renewables target
- Renewed focus on energy efficiency and energy demand reduction

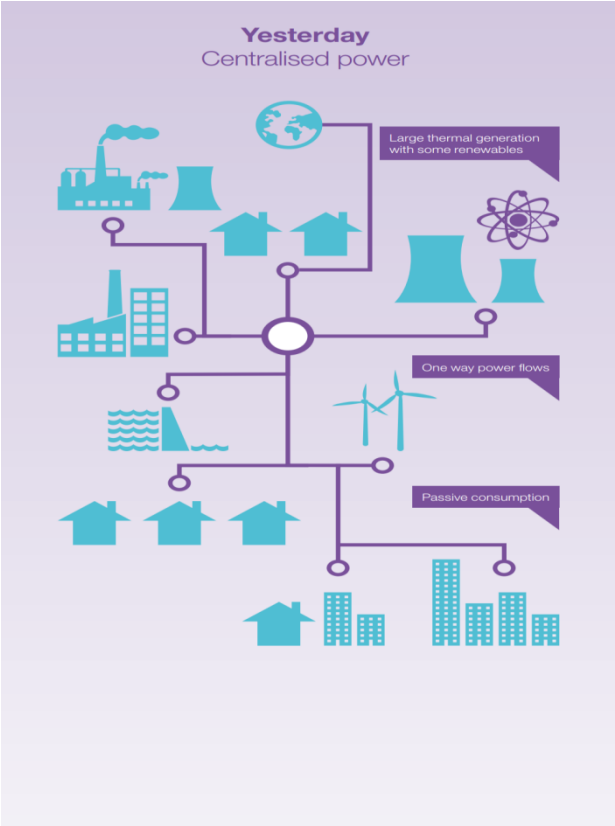
Stable energy transition

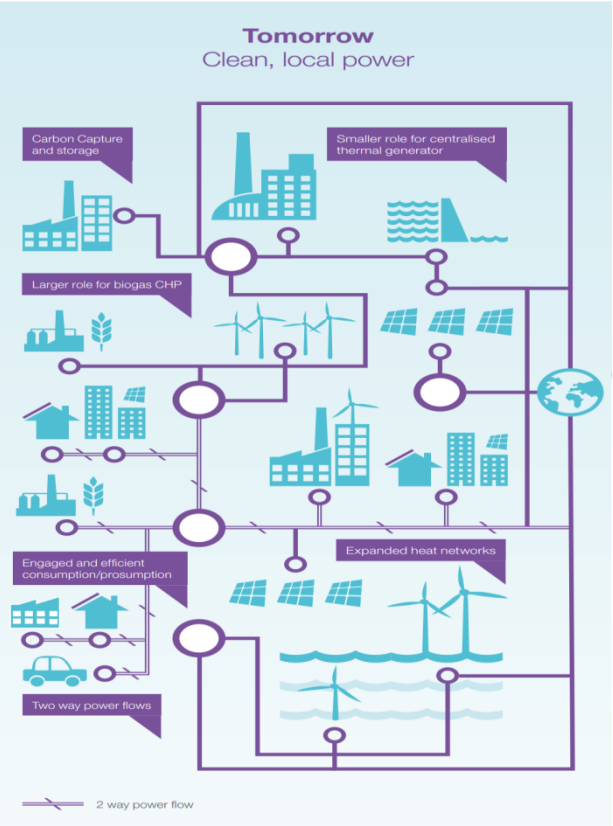
- Long-term plan, consistent with requirements of Climate Change Plan
- Flexible to future changes in technology and patterns of energy use
- Managed transition of energy supply

A smarter model of local energy provision

- Encouragement for new localised models of energy supply and use
- Enhanced role for local planning and partnership delivery
- New economic opportunities of energy storage and ‘smart’ energy solutions

Smart Local Energy Systems





Smart Local Energy Systems

Supporting the demonstration and growth of innovative projects

- Low Carbon Infrastructure Transition Programme;
- Local Energy Challenge Fund;
- CARES Infrastructure and Innovation Fund;
- Renewable Energy Investment Fund;

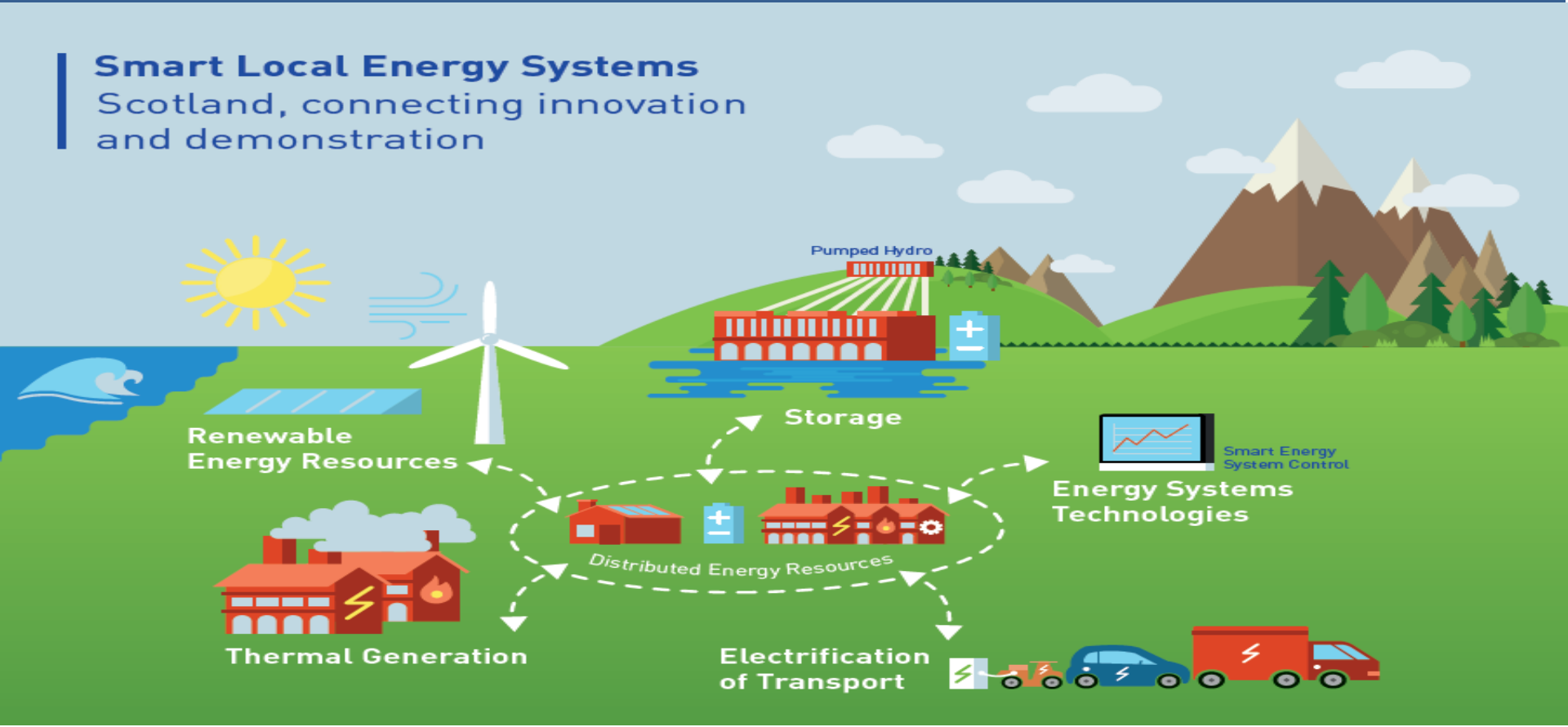
Partnership between communities, private and public sectors

- Develop strategic approaches to local energy systems;
- An enhanced role for local authorities and to deliver new local energy systems;
- Explore potential for a government owned energy company;
- Explore the creation of a Scottish Renewable Energy Bond;
- Consult on the development of a regulatory framework for local

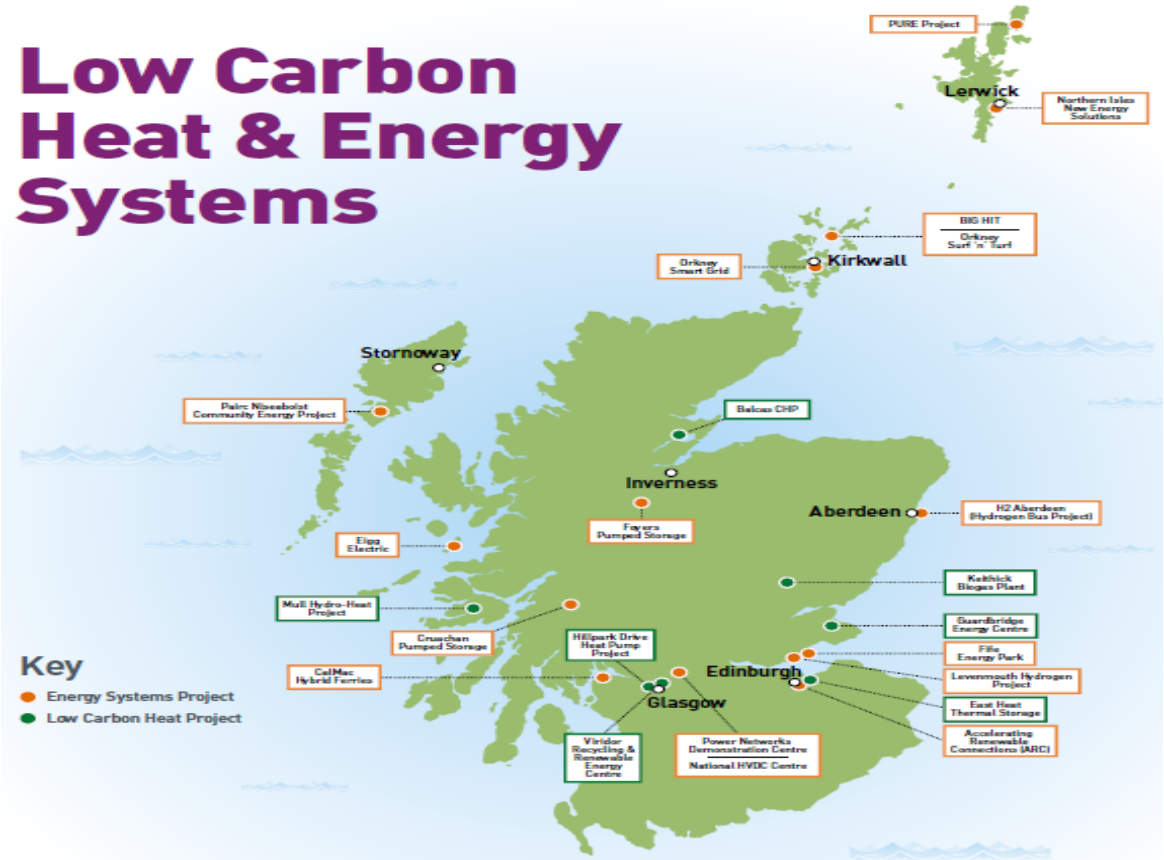
Smart Local Energy Systems

- Broad characteristics set out in draft Energy Strategy;
- Holistic response to energy;
- Local Energy very distinct from Community Energy;
- Decentralisation of generation;
- About the better use of all energy at point of generation, reducing price for consumers; and

Optimised Local Energy System Schematic



Projects in Scotland



What next

- Consultation closed;
- Responses to be analysed and will inform development of final Strategy;
- Building the narrative and being clear about the outcomes required to support Climate Change Plan ambition;
- Need to understand any untended consequences.
- Keen to hear of existing working systems across the country/world – what can we learn from these.

Storage in Scotland

Energy storage: the rationale

- Increased electricity demand – 30%

- More flexibility in our energy system,
  - ➢to manage intermittency of renewables; and
  - ➢to enable electricity grids to operate more efficiently and cost effectively

- Diverse set of storage technologies exist, but SG is technology neutral: our focus is on how storage can benefit the energy system, the energy industry and the energy consumer

Energy storage: the potential

- A 2016 study funded by UK and Scottish governments and utilities found that, if market barriers are removed, energy storage could save the UK up to £2.4 billion annually by 2030, saving households £50/year on bills;

- Scotland is well placed to capitalise on the benefits of storage given its vast renewable energy resources

- We are already home to a number of innovative storage projects – from mature pumped hydro to newer battery and hydrogen projects

- Results of recent energy strategy consultation should highlight the distinct opportunities for Scotland

Questions and Discussion

Thank You

Contact us at lcitp@gov.scot

http://www.gov.scot/lowcarbon

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Anthony Legg

Director, Head of Power & Utilities

EY

Flexible solutions

Scottish Renewables Storage & Systems Conference

21 June 2017

Anthony Legg – Head of Power & Utilities,
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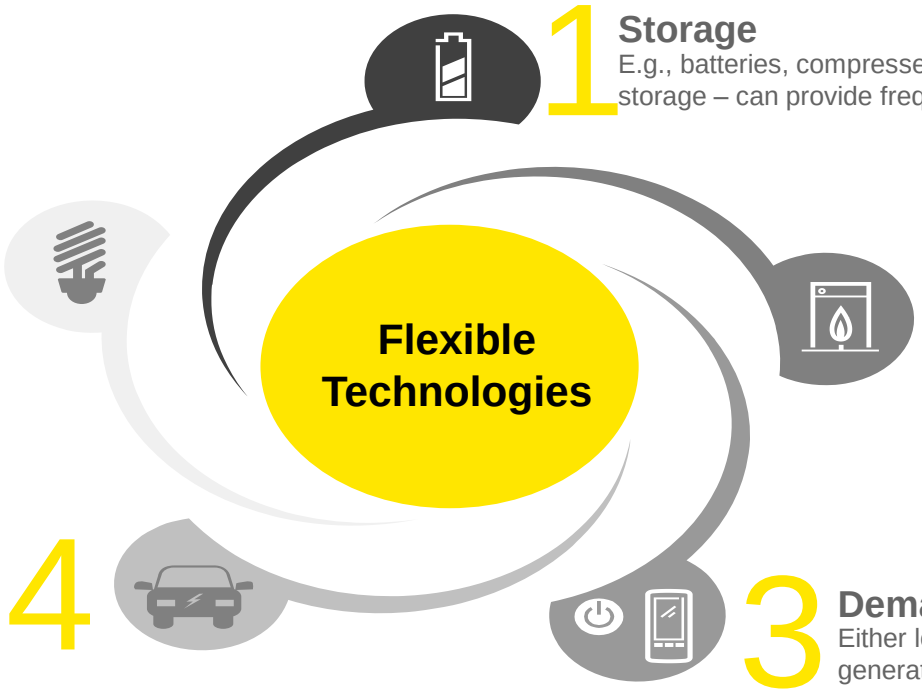
EY
Building a better working world

1. Overview of technologies which can provide flexible solutions



1 **Storage**
E.g., batteries, compressed air and pumped storage – can provide frequency response

2 **Embedded generation**
E.g., gas & diesel reciprocating engines – provides reserve capacity and cost avoidance at times of peak demand

3 **Demand Side Response**
Either load turn-down or BTM generation

4 **Electric Vehicles**
Use of EVs as battery storage to offer into system.

5 **Energy Efficiency**
Services to promote energy efficiency and incorporation of smart technology that responds to system needs

2. What do investors in flexible solutions need in order to go ahead and invest?

In order for flexible solutions to be brought forward, developers need to be able to create a credible business case based on revenue streams derived from clear and stable markets and mechanisms

What the system needs – technical requirements

- Electricity supply
- Reliable capacity
- System inertia
- Frequency response
- Reserve
- Voltage Control
- Black Start
- Locational services

What developers of flexibility need – commercial requirements

- A fair (expected) rate of return, compensation for risk
- Stability and predictability of revenues and costs to give confidence that the required rate of return will be achieved
- Clarity on the product(s) being purchased
- Clear rules on eligibility criteria
- Transparent and fair procurement process to create a level playing field
- Published results and prices of procurement process
- Predictable/stable pricing
- An appropriate number of markets to buy specific products, large enough to be competitive
- Compatible markets

3. How does the market remunerate flexible solutions today?

Capacity revenues

Capacity Market revenues for contributing to **security of supply**

Ancillary services

Revenues from **ancillary service schemes** run by National Grid and DNOs, including for **operating reserve** and **frequency response**

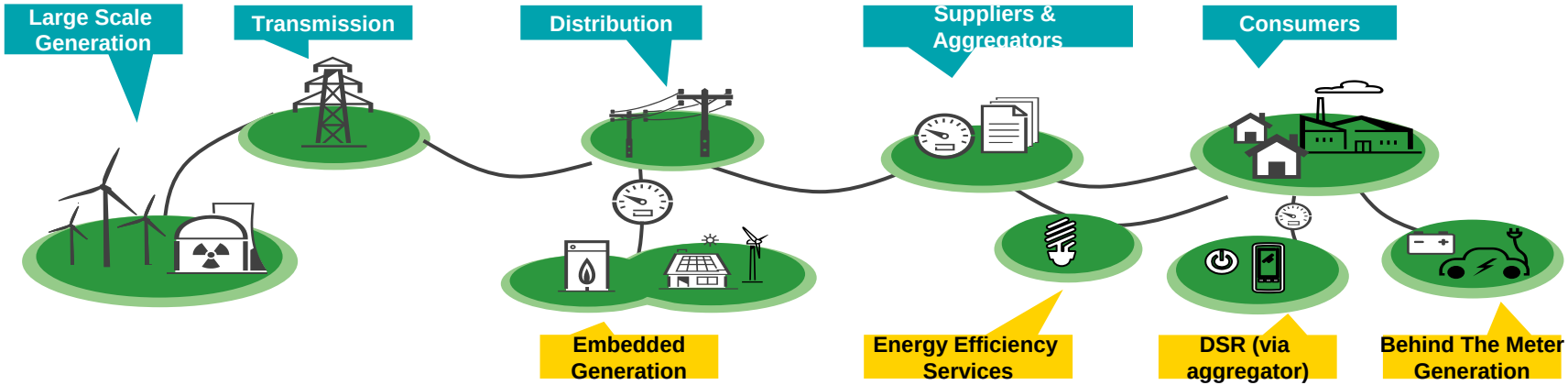
Energy revenues

Revenues for **energy generation** – either in forward markets or participation in **Balancing Mechanism**

Network services

Energy bill reduction from **DUOS and TRIAD avoidance**

4. Illustrative business models for flexible solutions



	Capacity Market Revenues	Avoid Capacity Market Charges	Ancillary Services Revenues	Energy Market revenues	Avoid Energy Charges	Avoid Network Charges
Embedded Generation	✓	✗	✓	✓	✗	✗
Energy Efficiency	✗	✗	✗	✗	✓	✗
Demand Side Response	✓	✗	✓	✓	✗	✗
Behind The Meter	✗	✓	✗	✗	✓	✓

NB this is an indicative assessment: Revenue eligibility may depend on regulatory decisions (embedded benefits, targeted charging review, ancillary service reforms), as well as participant technology and market access.

5. What is the size of the market for flexible solutions?

Market drivers:

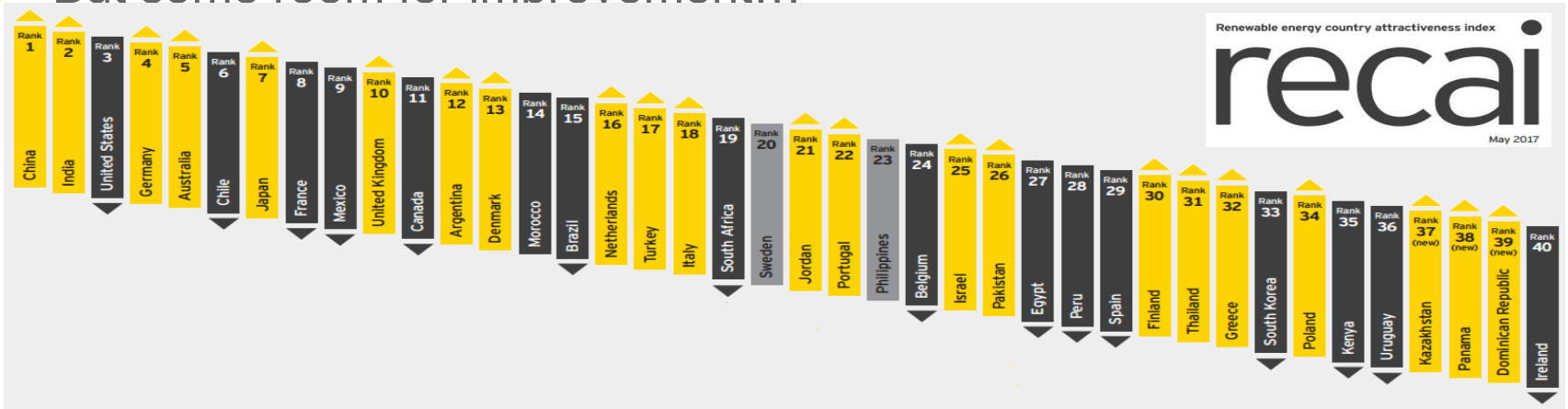
- **Regulatory** – Introduction of Capacity Market and incentives for network innovation
- **Centralised generation decline** – retirement of existing fleet of large thermal plant and replacement with smaller embedded generation
- **Renewables penetration** – increasing intermittency on the system as UK decarbonises
- **Nuclear** – increased inflexible nuclear generation expected after the pre-approval of Hinkley Point C
- **Tightening Reserve Margin** – should lead to higher prices and potentially higher volatility
- **Technological improvements –** decreasing technology costs and short lead times of flexible generation
- **New business models** – Increasing role for aggregators and small VI developers supplanting traditional utility role

Market size:

- Total spend of UK companies who use more than 6,00MWh of electricity per year is estimated currently to be £11bn
- Distributed capacity set to increase by around 40% over next decade
- Volumes to be procured in the BM expected to double by 2030
- Increasing proportion of total energy costs to come from outside the wholesale price

6. How competitive is the UK for investment in flexible solutions?

- UK is a mature market for energy, capacity and ancillary services
- Investment in renewables and nature of GB market as an island creates strong role for flexible generation
- But some room for improvement…



7. What are the barriers to investment in flexible solutions today?

Market complexity:

- Fragmented and complex market for ancillary services with many products
- Lack of pay-as-clear BM or ancillary service procurement
- Cost and complexity of acceding to BSC to participate in BM

Incentives for Flexibility:

- Imbalance prices set for 30 minute periods and strip out actions taken for short term balancing
- Capacity Market does not recognise extra value of flexible generation
- Lack of locational price signals in energy or capacity markets

Access to revenues:

- Mutually exclusive revenue streams prevents revenue stacking
- Lack of long term contracts for ancillary services and absence of secondary markets

Policy and Regulatory Risk:

- Uncertainty about commitment to decarbonisation or to future technology mix
- Volume of major changes currently affecting investment case:
  - Embedded Benefits Review
  - Targeted Charging Review
  - Ancillary services procurement
  - Government Industrial Strategy for smart energy

8. What kind of changes could help unlock investment in flexible solutions today?

- Longer term contracts available for ancillary services
- Faster planning process and approval
- Secondary markets for flexibility products
- Clarity on future technology mix
- Simplify ancillary services procurement
- Reduced regulatory risk
- Sharper incentives for flexibility in Capacity Market and Balancing Market
- Support for least-cost renewables
- Removing barriers to revenue-stacking
- Use of Pay As Clear principle for procurement of flexibility services

EY | Assurance | Tax | Transactions | Advisory

Ernst & Young LLP

ED None

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Aberdeen Renewable Energy Group

Putting Policy Into Practice

Chair

Paul Gardner

Segment Leader, Energy Storage

DNV GL

Adam Sims, SO Flexibility Manager, National Grid

Steve Atkins, Lead Commercial Contract Manager, Scottish & Southern Electricity Networks

Graeme Cooper, Executive Director, Fred Olsen Renewables

Marc Smeed, Principal Consultant, Xero Energy

John Tindall, Commercial Analyst, SSE

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The Changing Role of the Customer

Chair

Gillian Hurding

Access Project Manager

Community Energy Scotland

Paul Reynolds

Partner

Everoze

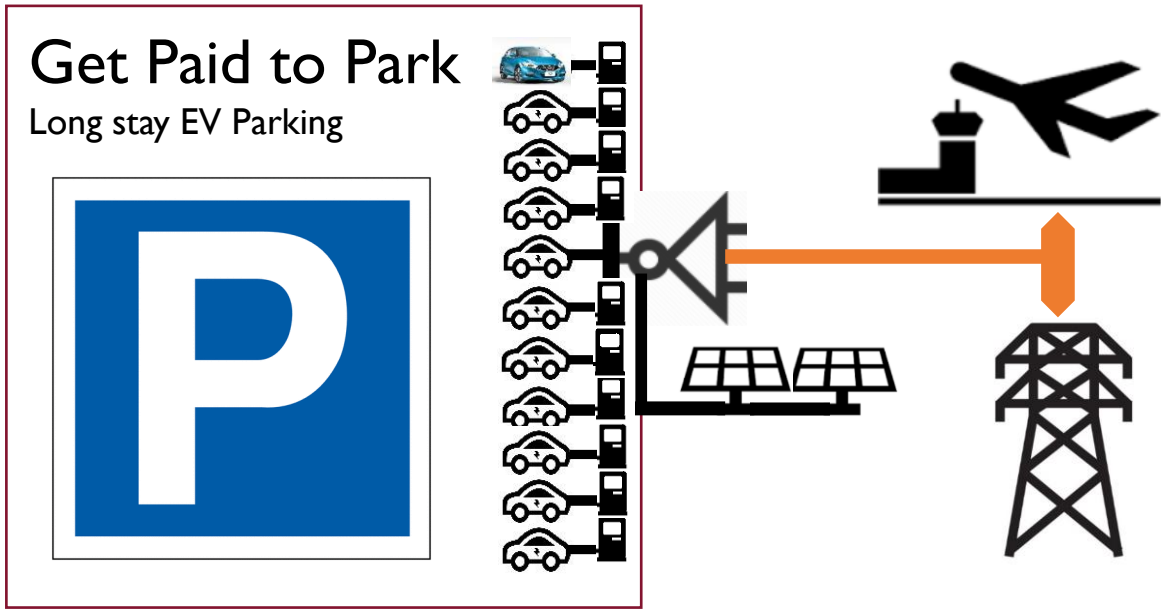
everoze

Paid to park: an introduction to V2G

Paul Reynolds
21/06/17

experts | evolving | energy

Its Feb. 2022…



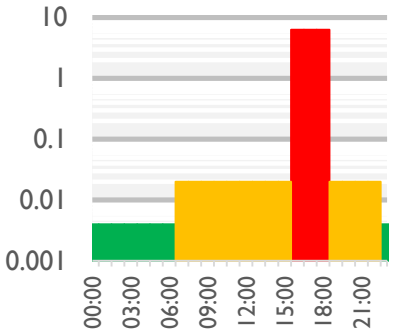
everoze

As I am on holiday…

My car is a flexible resource being used for..

Frequency response

Reduce energy charges for airport



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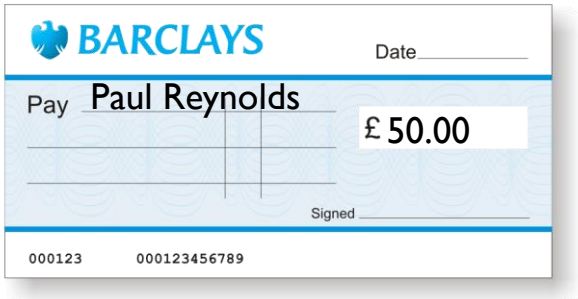
When I return,
I collect my car
& my money…



Which is…

- ✓ **Efficient** – better use of underutilised asset (car)
- ✓ **A huge resource** – by 2025 could have 15GWh of batteries on the road
- ✓ **Low cost** – battery capex paid for by need to drive – grid services are upside

Welcome to the world of vehicle to grid (V2G)

everoze

CONTENTS

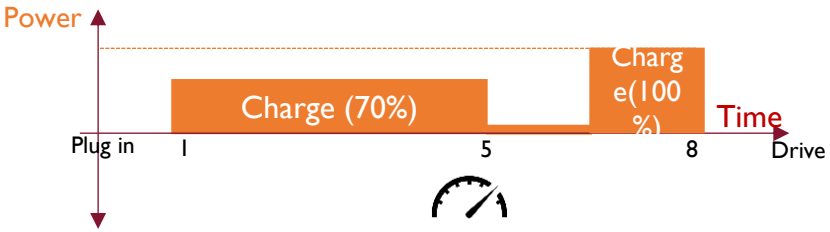
everoze

1 V2G vs Smart Charging

DEFINITIONS

Smart Charging

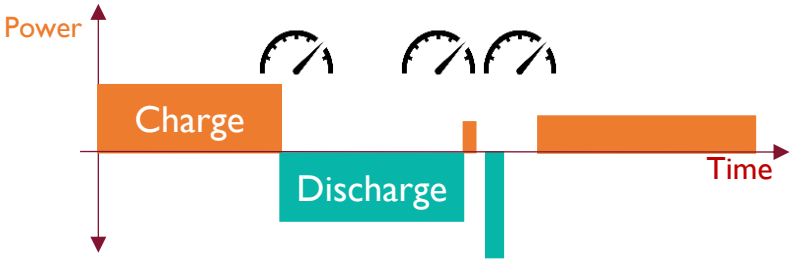
- The rate and time at which an EV is charged is varied, according to market or grid signals (one-way flow of energy)



- Form of demand response
- Minor modification – just control and comms system to standard charger

V2G

- Variable, two way flow of energy from and to the car (bi-directional)



- A battery storage system – which can drive
- Requires special chargers & car to be V2G enabled.

V2G is higher cost, but higher value

everoze

2 V2G now

UK

Off-the-shelf LEAF providing services to micro-grid in Birmingham

everoze

UK

First commercial installation now commissioned

Source: Marc Trahand, NUVVE, "V2G deployments & Nuvve" - V2G conference, Amsterdam

everoze

DENMARK

Nuvve seeking to roll out

Source: Marc Trahand, NUVVE, "V2G deployments & Nuvve" - V2G conference, Amsterdam

NETHERLANDS

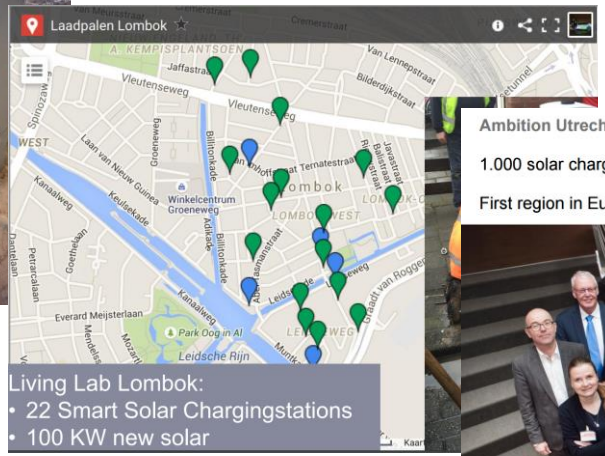
June 9th 2015:

First solar-controlled, V2G public AC charging station in the world

44 KW grid connection

LomboXnet

WE DRIVE SOLAR



Ambition Utrecht Region 2018/2019

1.000 solar chargers, 1.000 shared EV's, 10.000 new solar panels, 100.000 users

First region in Europe with clean energy- and mobilitysystem based on solar

1000 V2G chargers!

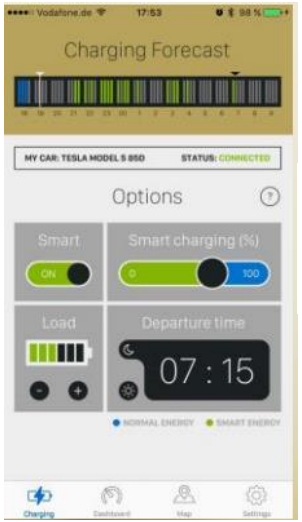
Source: Robin Berg – LomboXnet - "We drive solar" - V2G conference, Amsterdam

3 Challenges and solutions

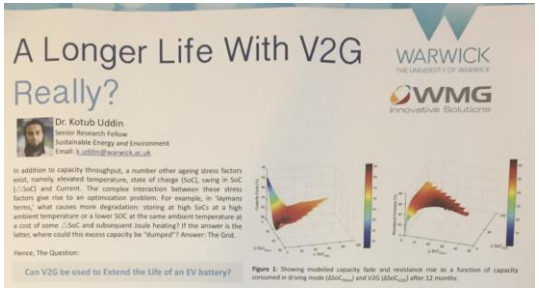
CHALLENGES & SOLUTIONS

Are V2G EVs available? What about degradation?	Will it affect my driving?	Will I make any money?

Zero Emission



JEDLIX



Technically proven – challenge is commercialisation and scaling up

everoze

Sources: i) Nissan; ii) Uddin, Kotub, et al. "On the possibility of extended lifetime of lithium ion batteries through optimal V2G facilitated by an integrated vehicle and smart grid systems" Energy 2017; iii)Taco van Berkel – Jedlix 'Beneficial smart charging with connected cars

Next steps

Increasing revenue through improved market access

Lowering cost of chargers and improving capability of EVs

Supportive regulatory environment

Not an EV…

everoze

Thanks for listening

Talk to us

contact@everoze.com

everoze.com

@everozepartners

experts | evolving | energy

Jenny Carson

Analyst

Delta-ee

Delta Energy & Environment Ltd
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Registered Office: Floor F, Argyle House, 3 Lady Lawson Street, Edinburgh, EH3 9DR, UK

Emerging business models

Scottish Renewables – The Changing Role of the Customer

21st June 2017

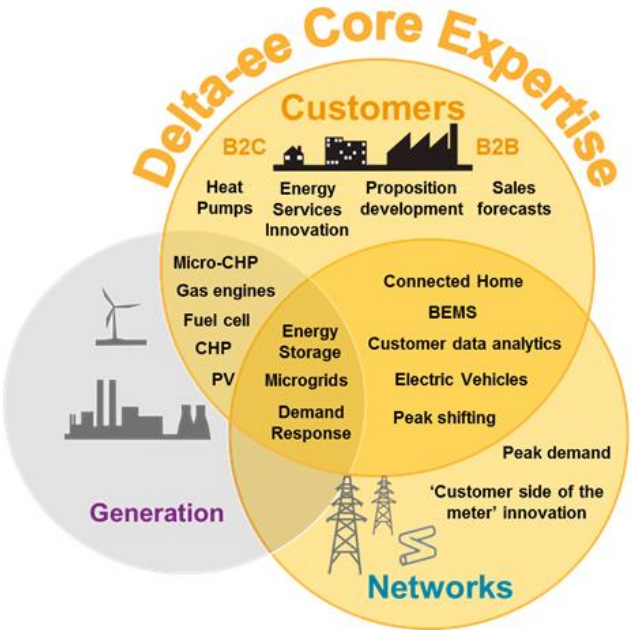
Jenny Carson, Analyst
Jenny.Carson@delta-ee.com
+44(0)131 625 3336

Agenda

- Key trends/themes in ‘New Energy’ business models
- Focus on storage & DSR → 3 emerging approaches
- What this means for the customer

DELTA Energy & Environment

Advisory services to succeed in the transition from ‘old’ energy to ‘new’ energy.



‘Old’ energy		‘New’ energy
Centralised	⇨	Distributed
Carbon intensive	⇨	Low carbon
Commodity sales	⇨	Service-orientated
Meter points	⇨	Customer centric
Value is upstream	⇨	Value is downstream

Selected clients:

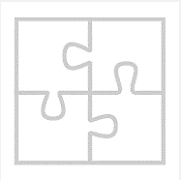
EDF, GE, Scotia Gas Networks, E.ON, electric Ireland, Danfoss, British Gas, ENGIE, BAXI, CALOR, JABIL, RWE, DAIKIN, BOSCH, VIESMANN, CATERPILLAR, nationalgrid, Lubrizol, ENN, electricity north west, Panasonic, OSAKA GAS, SAINT-GOBAIN, SHV Energy, iea, International Energy Agency, MITSUBISHI ELECTRIC, GrDF, Vaillant, ARISTON THERMO GROUP

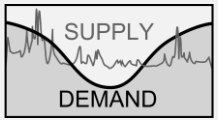
6 key categories of ‘New Energy’ business models

Marketplace operations

Energy as a service

Bundling





Time-of-use optimisation

Efficient consumption

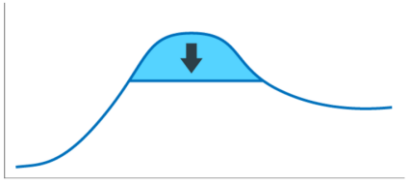
Lifestyle products

The race to re-invent: six types of business models are shaping the future – whitepaper & podcast

x3 Time-of-Use (ToU) Optimisation approaches

Lowest cost energy supply via shaping customer's demand profile

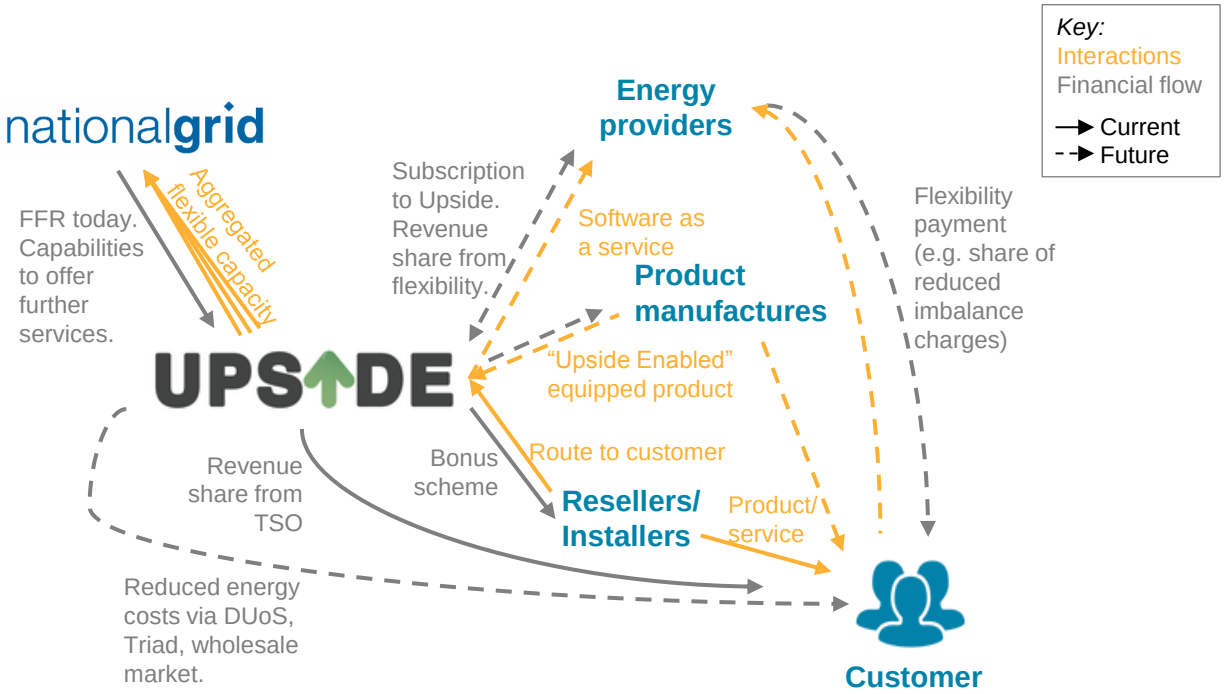
On-site flexibility to generate revenue



Empowering customers to optimise their own timing of consumption

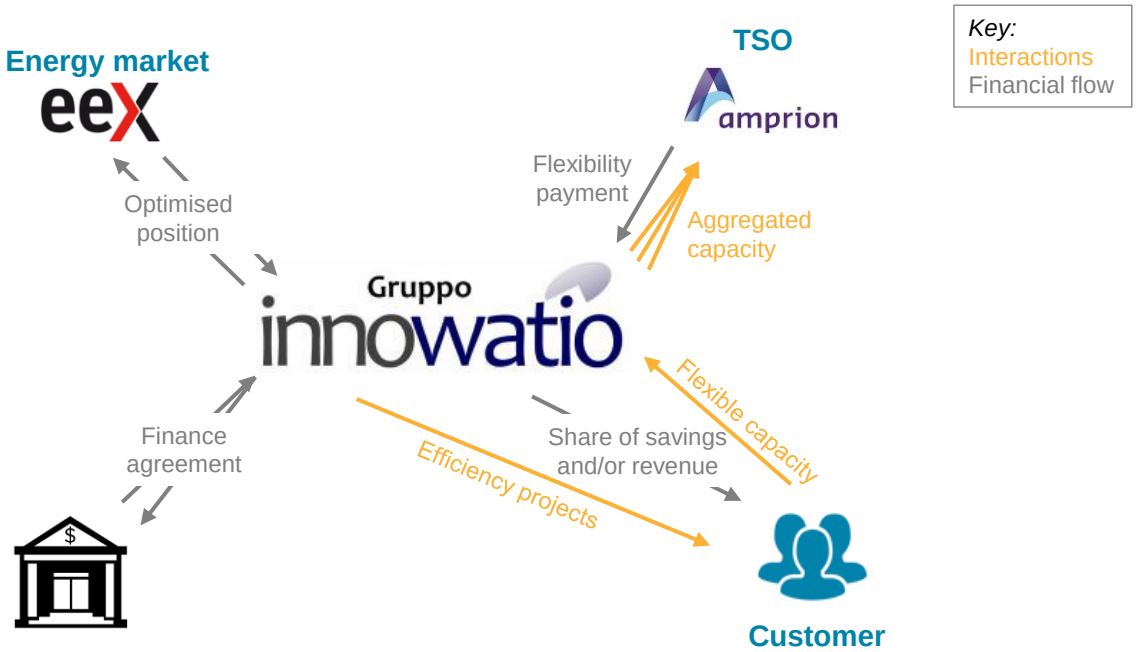
Example innovations – Upside Energy

Harnessing flexibility from small, distributed assets by energising the current supply chain and embedding demand response capabilities.



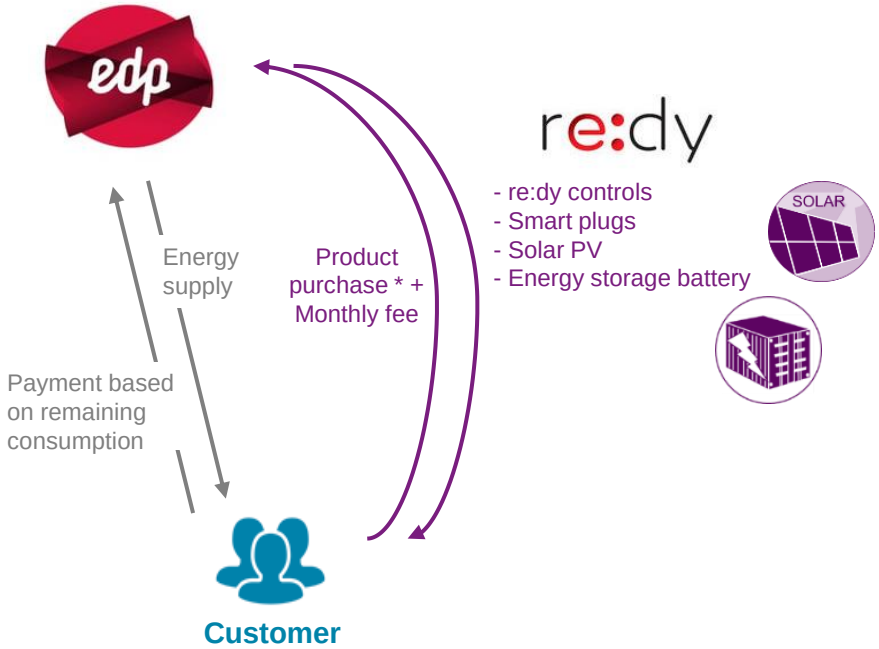
Example innovations – Innowatio

Hybrid ESCO-energy supplier forms **one-stop shop for customers** – offering site optimisation, energy efficiency, access to the wholesale market and participation in ancillary services all from one provider.



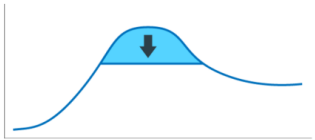
Example innovations – EDP re:dy

Smart controls coupled with PV & battery - empowering residential consumers to manage their own energy position and take the first steps to reduce their reliance on the electricity grid.



*either re:dy or re:dy bundled with PV and/or battery

x3 Time-of-Use (ToU) Optimisation approaches

	Lowest cost energy supply via shaping customer's demand profile	On-site flexibility to generate revenue	Empowering customers to optimise their own timing of consumption
			
Level of customer involvement	Typically **low**	Typically **medium**	**High**
Customer outlay	Typically **zero**	**Low**	**Yes**
Exposure to 'flexibility' values	**Zero - low**	**Low - medium**	**High**
Control of assets	Typically **3rd party**	**3rd party** (customer override possible)	Typically with **customer**

Delta Energy & Environment – contact us!

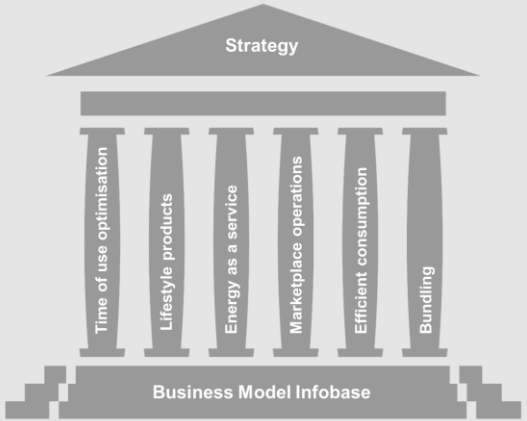
Contact us for more information about Delta-ee's:

- 'New Energy' Business Model Service
- Flexibility Multi-Client Study and Bespoke Research
- Energy Storage Research Service

presentation.

- **We'd be delighted to talk with you** by phone or in person – at our Edinburgh, Cambridge, Netherlands, or Denmark offices, or at your offices.
- For more information visit: www.delta-ee.com

Our 'New Energy' Business Model Service:



Thank you for your attention

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Founder/CTO

Power Migration Partners

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21 JUNE 2017 **GLASGOW**

Scottish & Southern Electricity Networks

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Aberdeen Renewable Energy Group

Technology and Project Speed Update

Chair

Stephen-Mark Williams

Director

Energy Technology Partnership

Alan Mason

Principal Consultant

TNEI

tnei

A specialist energy consultancy

CATAPULT Offshore Renewable Energy

Battery Co-location and Wind Turbine Auxiliary Power

Alan Mason

21st June 2017

Overview

- ORE Catapult uses its open-access 7MW Levenmouth demonstration research turbine to help UK companies de-risk and demonstrate innovative technologies.
- The wish is to understand the parameters for potential battery black-start projects.

CATAPULT Offshore Renewable Energy

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Objectives

- Consider the auxiliary power requirements for the 7MW Levenmouth demonstration
- Investigate the capacity and location of battery storage system required to provide standby power for 24 hours.

CATAPULT Offshore Renewable Energy

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Approach

- Carry out an audit on the power requirements of the turbine electrical subsystems.
- Determine the optimum size and location for the battery storage system.

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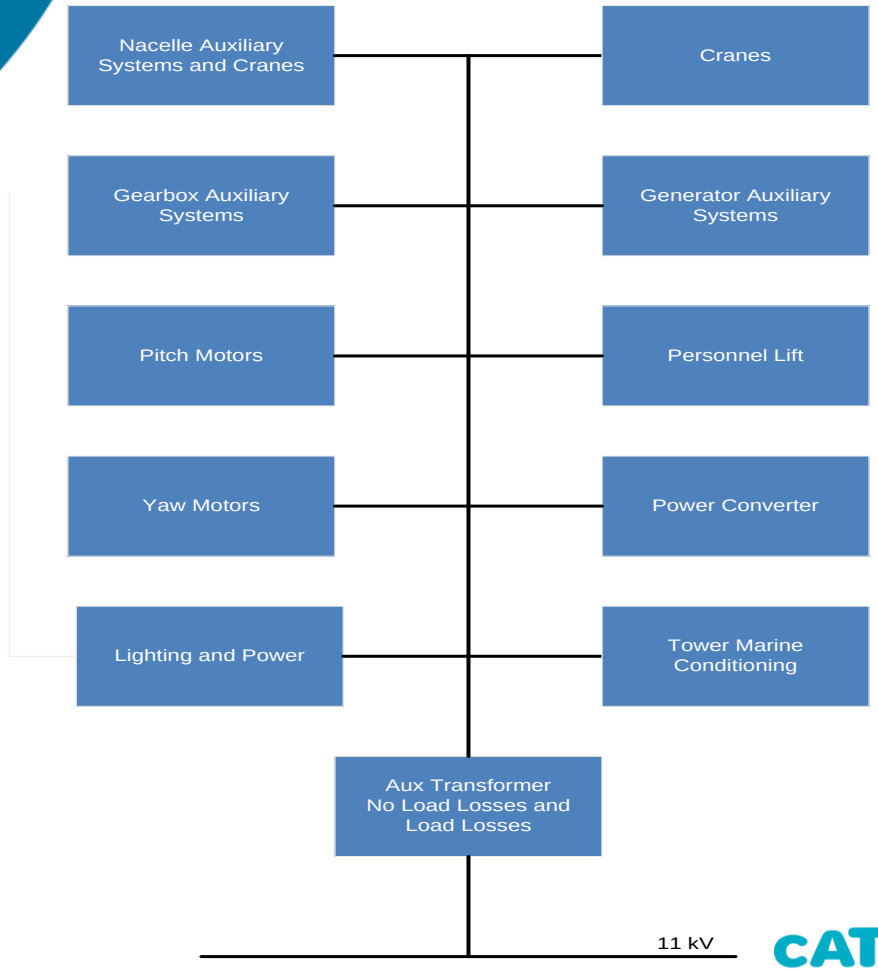
Nacelle Auxiliary Systems and Cranes
Cranes
Gearbox Auxiliary Systems
Generator Auxiliary Systems
Pitch Motors
Personnel Lift
Yaw Motors
Power Converter
Lighting and Power
Tower Marine Conditioning
Aux Transformer No Load Losses and Load Losses
11 kV

Total standby power requirements

Loading factor	Total energy (kWh)
Standby	883
BSS self-power	309
Total	1142

Overall power output is small, so low density batteries can be used. The batteries will be required to run down to zero, so LI-Ion is the preferred chemistry.

CATAPULT Offshore Renewable Energy

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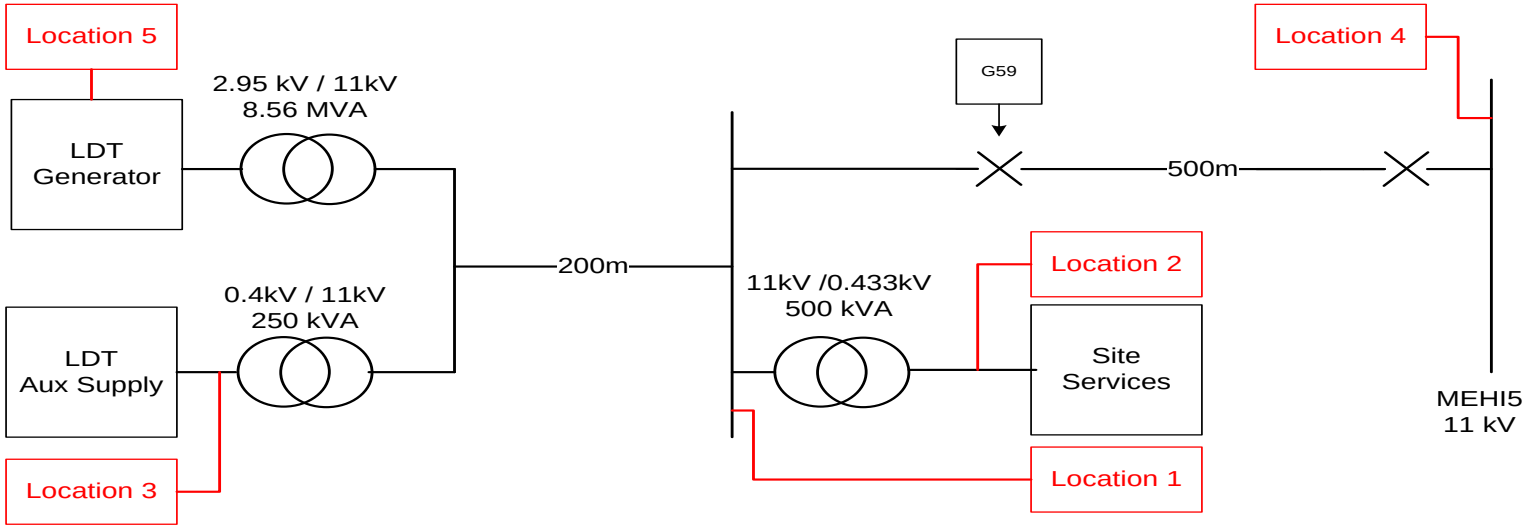
Location of battery storage system



Levenmouth
Demonstration Turbine

Site Substation

SPEN Primary Substation

CATAPULT Offshore Renewable Energy

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Lessons learned

- Transformer losses can be substantial for the larger transformers.
- The battery storage system would be housed in a modified FEU (forty foot equivalent unit).
- Li - Ion is the preferred chemistry.

CATAPULT Offshore Renewable Energy

tnei

Find out more

- TNEI: Alan Mason
  alan.mason@tneigroup.com

- ORE Catapult: Ander Madariaga
  ander.madariaga@ore.catapult.org.uk

CATAPULT Offshore Renewable Energy

tnei

Lynda Mitchell

Manager

ASLEE

ALGAL SOLUTIONS

For Local Energy Economy

LOCAL ENERGY SCOTLAND

Greener Scotland Scottish Government

THE CHALLENGE FUND

Using intermittent renewable energy to grow microalgae – a demand side management and grid balancing project

Lynda Mitchell, ALIenergy

VCHARGE Turn It On

Xanthella Illuminating algae

WOOD GROUP

fai

University of Stirling Innovation and Excellence

ALIENERGY Argyll, Lomond & the Islands Energy Agency

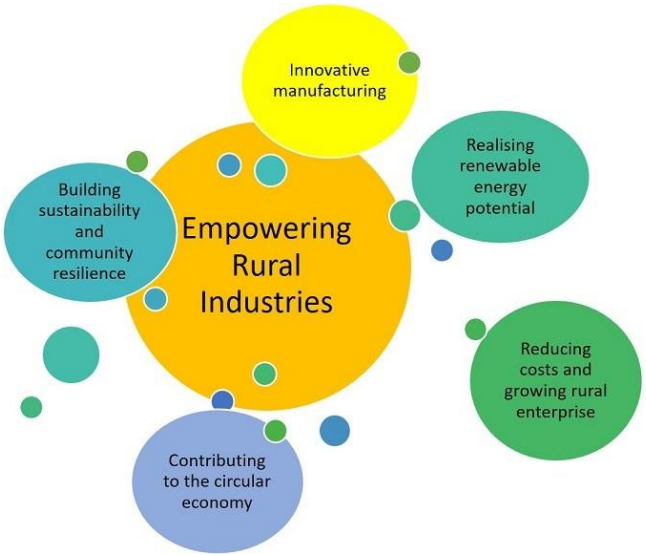
UWS UNIVERSITY OF THE WEST of SCOTLAND

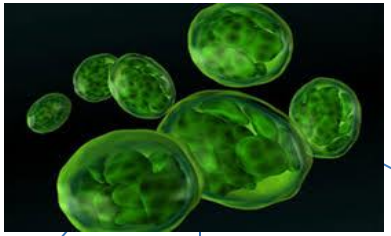
ARDNAMURCHAN ESTATES

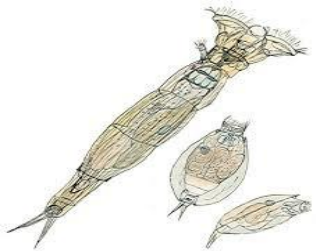
- How far can we address the issues of grid balancing and renewables while enabling economic algal production?
- Can we produce systems that are viable at industrial scale and suitable for rural use?
- How much does intermittency matter in producing algae?
- What is the smallest economic scale; what is the potential for upscaling?

product market: aquaculture

-Feed for rotifers used in wrasse production: (currently met by importing algae pastes from Japan or USA by air)
-Feed for juvenile oysters
-Salmon feed supplement - omega3s







Circular Economy

David Aldrich

Sales and Marketing Manager

Denchi Power

Les King

Director – Technology, Policy and Liaison

Doosan Babcock

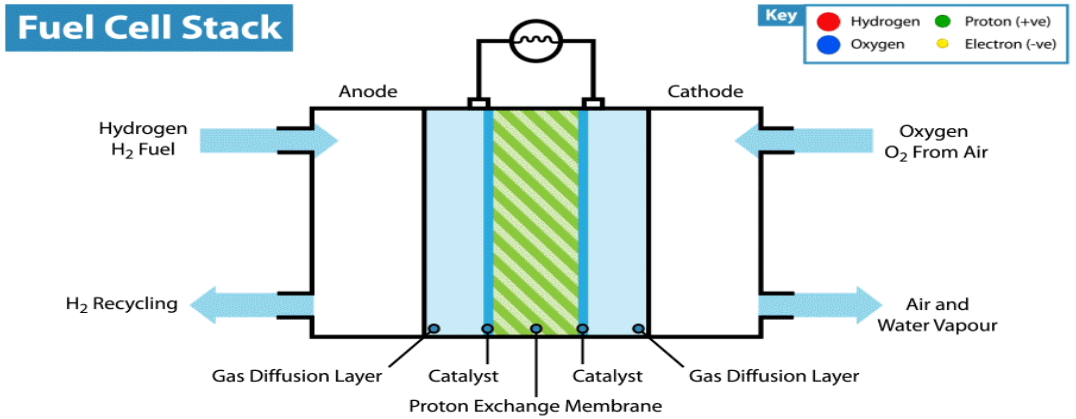
Stationary fuel cells:
Clean efficient point of use generation of heat and power

Scottish Renewables Storage and Systems Conference Glasgow 21st June 2017

Doosan Babcock

Production of Electricity and Heat at the Point of Use

- A fuel cell is an electrochemical device that combines hydrogen and oxygen to create electricity, heat and water
  - No combustion, no moving parts

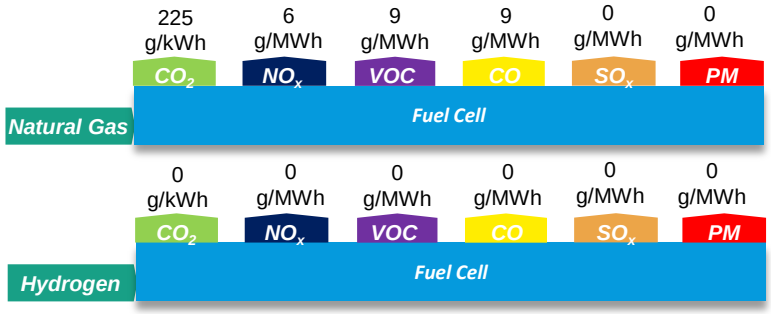


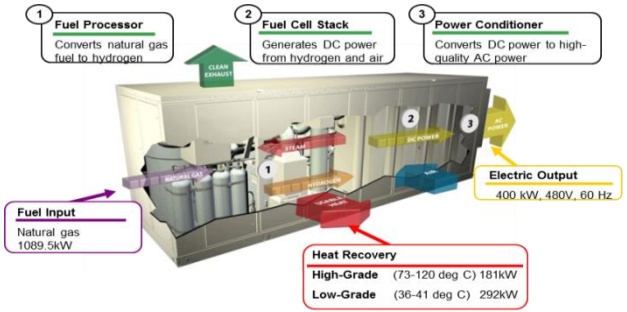
- Fuel cell principle invented in 1839 by Sir William Grove, round about the same time as Faraday discovered electro magnetism

- Fuel cells are an environmentally friendly, efficient, versatile, clean, flexible, reliable technology and complement other technologies such as conventional batteries, wind turbines, solar panels etc.

Fuel Cell Deployment

- Stationary fuel cells provide a clean future proofed approach to energy efficiency and CO2 reduction in the electricity and heat sectors in a range of applications ..stand alone and integrated…..with state of the art air quality performance





50 years of fuel cell experience	110 MW Installed reference
460kW electricity	500kW heat
>400 units sold	90% System efficiency
12 million hours of field operation	98% Availability
98% fleet availability	6mg/KWh NOx Zero particulates
Load following Small footprint	Low Noise No Vibration

Aberdeen Energy and Conference Centre

Innovative Energy Centre Solution integrating power, heat, cooling and transport networks

- Energy Centre including 3 fuel cells providing heating, cooling and electricity to the hotels and conference centre.
- Innovative solution including hydrogen production for H_2 bus fleet. Future proofing for potential hydrogen economy

3 x PureCell fuel cells, heat store, cold store, electrolysers, peaking CHPs

'Quad' - generation – cooling, heating, power and hydrogen

Connected to the transport network – hydrogen buses

20 year fuel cell life

Scottish Water and Stirling Council

Installation and integration of a decentralised innovative Energy Solution to improve air quality

Project Aim

- Replace individual carbon intense energy systems to produce the optimal mix of low carbon emissions, best energy efficiencies with the lowest impact to localised air quality

Solution

- Integration of a fuel cell CHP and heat pump at a waste water treatment plant, allowing excess waste biogas to be recovered from the AD plant and utilised to power and heat the local community

Over 1,000 Tonnes CO_2 Saved Per Year

5.6GWh of Waste Energy Recovered

2.2GWh annual reduction in energy consumption

Significant reduction in NO_x, SO_x and PM

15% Saving on Heating Bills for District Heating Network End Users

Konstantinos Pierros

Sales – Grid Integration

Enercon

Energy Storage

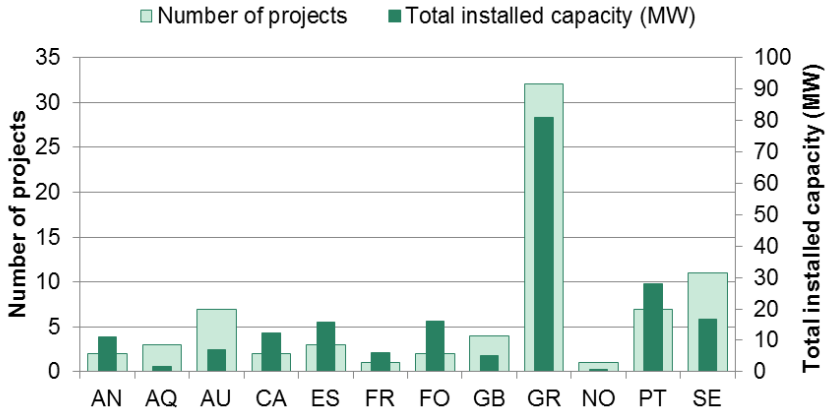
Konstantinos Pierros
Sales – Grid Integration

ENERCON
ENERGY FOR THE WORLD

Scottish Renewables Storage and Systems Conference 2017

Track Record in Isolated Systems

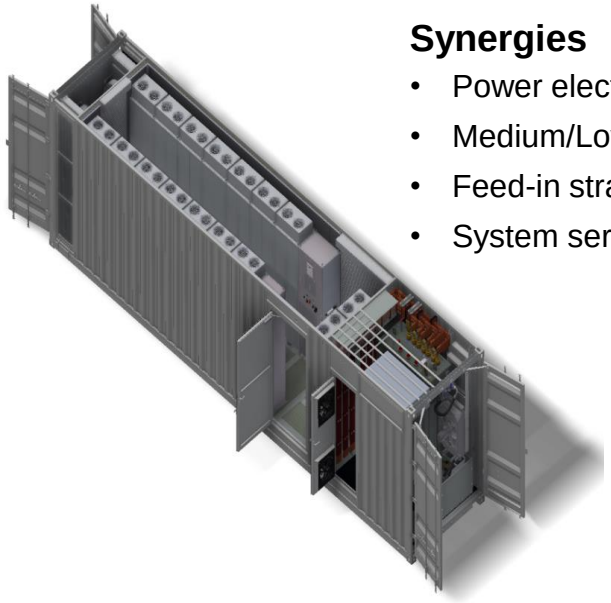
- Number of projects 75 (69 in operation)
- Number of WECs 251
- Total installed capacity (MW) 201
- Number of isolated systems 38
- Number of countries 12



ENERCON SMART Container

ENERCON Technology Platform

- Modular power electronics
- FACTS supply control
- Highly sophisticated feed-in technology



ENERCON SMART Container

Synergies

- Power electronics
- Medium/Low voltage technology
- Feed-in strategies
- System services for the grid

Not in scale!

Húsahagi, Faroe Islands

ENERCON Charging Solution

ENERCON Technology Platform

- Modular power electronics
- FACTS supply control
- Highly sophisticated feed-in technology

Synergies

- Power electronics
- Feed-in strategies
- System services for the grid

ENERCON Charging Solution

Not in scale!

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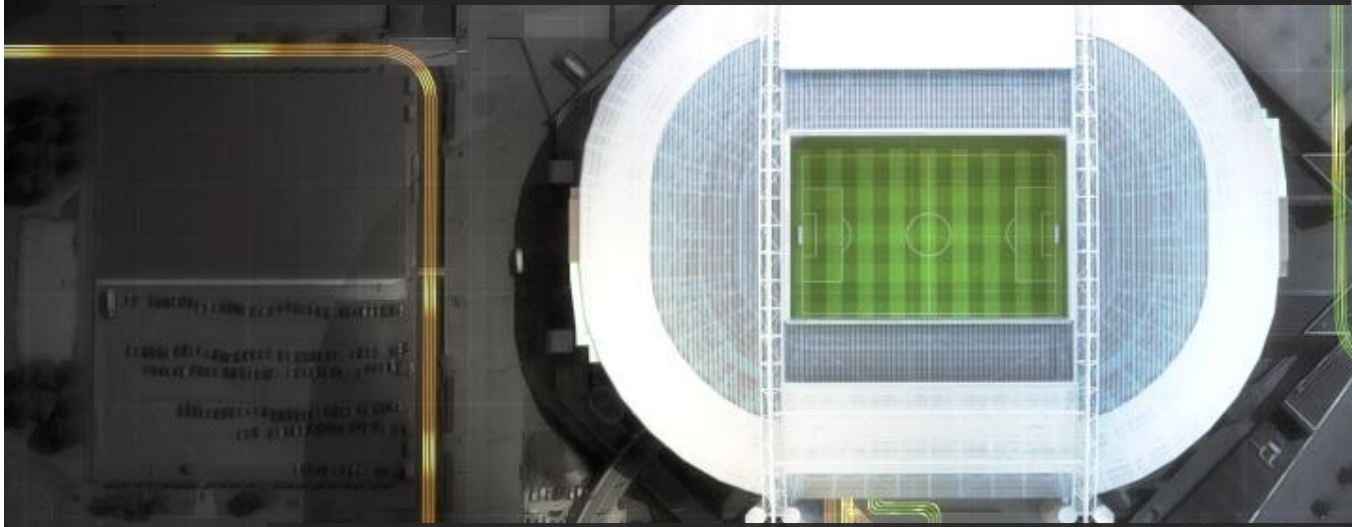
Dreekamp 5 | D-26605 Aurich
Telephone: +49 4941 927-0 | Fax: +49 4941 927-109

Richard Molloy

Business Development Manager – Energy Storage

Eaton Electric Ltd

WHEN ENERGY STORAGE PROVIDES VALUE TO THE AMSTERDAM ARENA AND ITS NEIGHBOURHOOD



Richard Molloy, Business Development Manager, Energy Storage, Eaton

Powering Business Worldwide

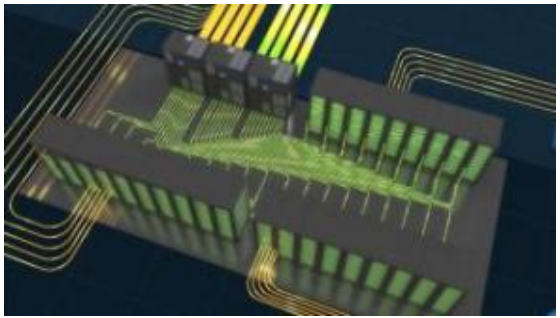
Eaton

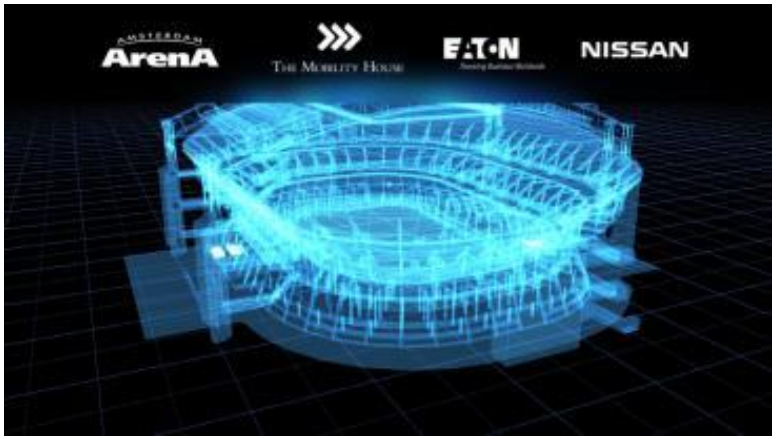
Powering business worldwide for over 100 years

- Electrical, fluid and mechanical power management
- $19.7bn turnover in 2016
- 95,000 employees
- 4 key sectors

Powering Business Worldwide

xStorage Buildings
Eaton Nissan energy storage solution for buildings





Utilizing both new and second life EV Batteries

EATON
Powering Business Worldwide

Case Study: Amsterdam Arena

Multiple services facilitated by energy storage

Recycling and recirculation or raw material

Assembly of new battery

Integrating Nissan batteries into power protection and energy storage solutions

Production of Battery Electric Vehicle

The Mobility House

Technology and operations

- ArenA PV integration
- Peak Shaving
- Backup Power
- Grid Services
- EV Car Sharing
- Vehicle-to-Grid

- Largest commercial building storage in EU
- 4MW, 4MWh 2nd use battery system (~290 car batteries, 400 households for 1 day)
- 2,3m EUR investment
- 10 year contract
- ~116 ton/CO2 reduction
- Further integration to energy hub, V2G

- PV2G for net balancing
- Energy exchange through V2G
- 100% compliant to UEFA/FIFA
- Pre order parking with special rate power charging offers

Powering Business Worldwide


EATON
Powering Business Worldwide

Q & A

Closing Remarks:

Michael Rieley

Senior Policy Manager

Scottish Renewables

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