Demand Response Technology Readiness Levels For Blocks Of Buildings

Dr Tracey Crosbie

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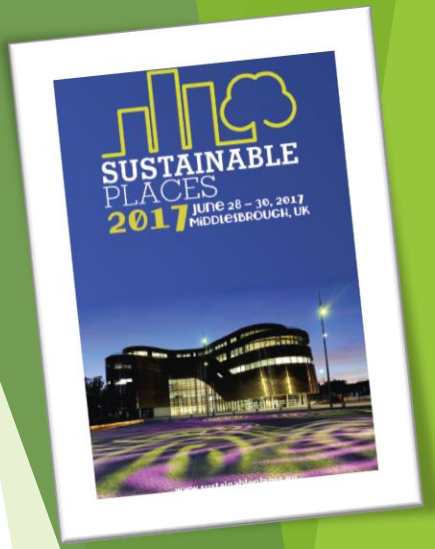
Teesside University

Demand Response in Blocks of Buildings
EU H2020 funded Innovation project
Mar 2016 – Feb 2019
10 partners 5 EU countries 4 demos



Teesside University UK Project Coordinator

Centre Scientifique et Technique du Bâtiment France

Siemens Energy Management Division UK

R2M Solution Italy

NOBATEK France

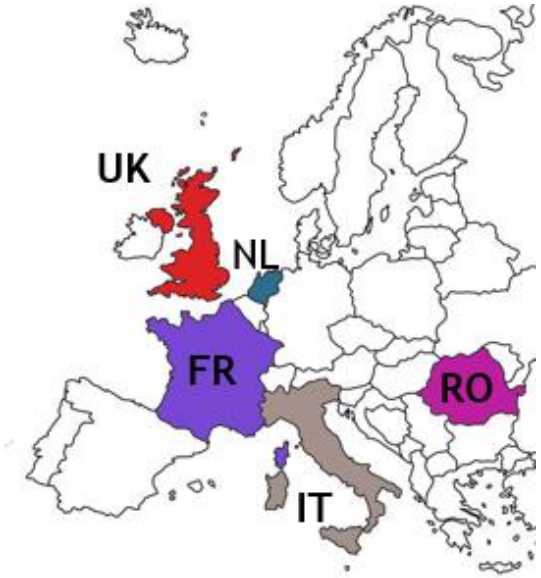
Grid Pocket SAS France

Duneworks BV Netherlands

Fondazione Poliambulanza Italy

Servelect Romania

Universitatea Tehnică din Cluj-Napoca



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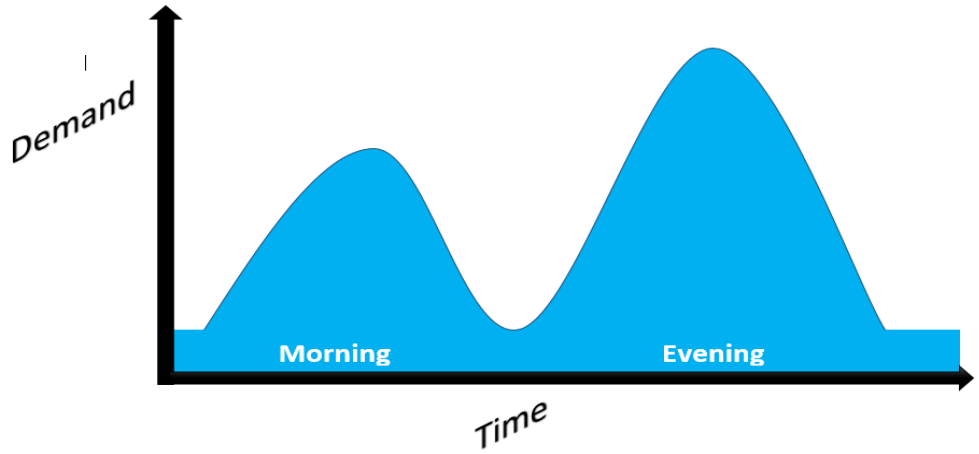
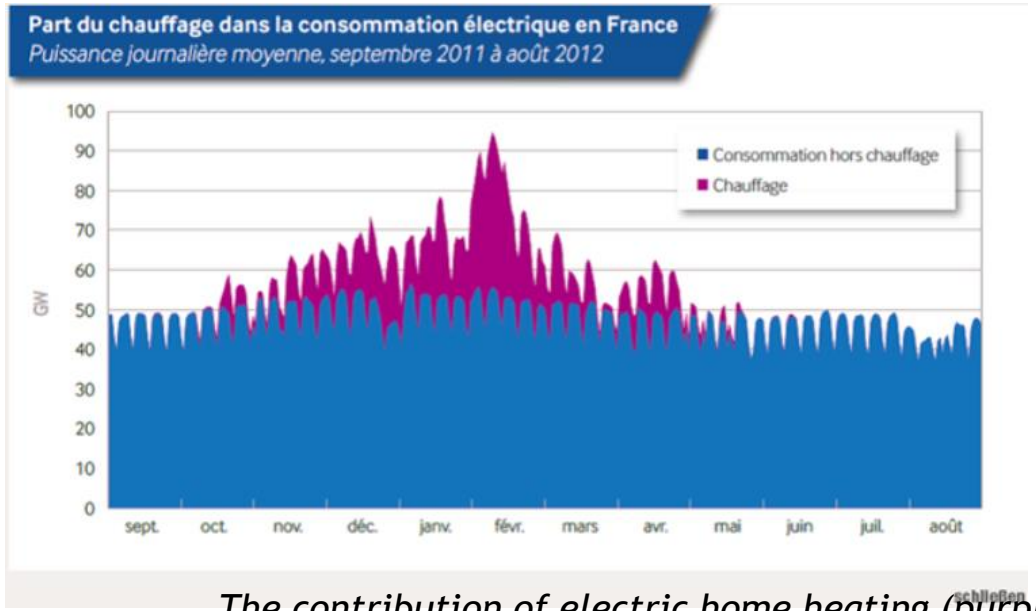
What is Peak demand ?





The contribution of electric home heating (purple) to French electricity demand, Sept 2011- Aug 2012, daily averages. Image from Renewables International

- Large peaks in demand are caused by lots of people using electricity at the same time
- *Peak demand* fluctuations occur on daily seasonal & yearly cycles

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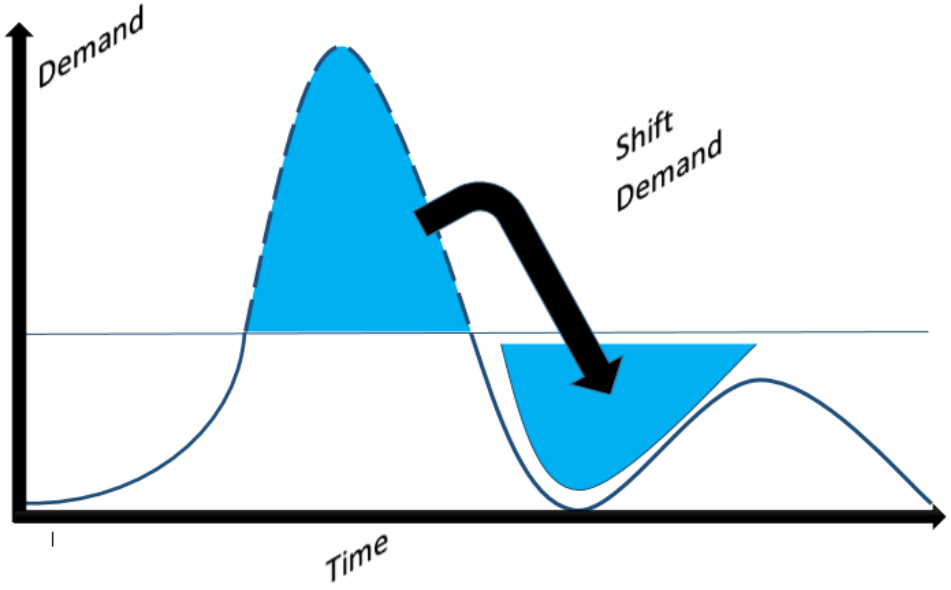
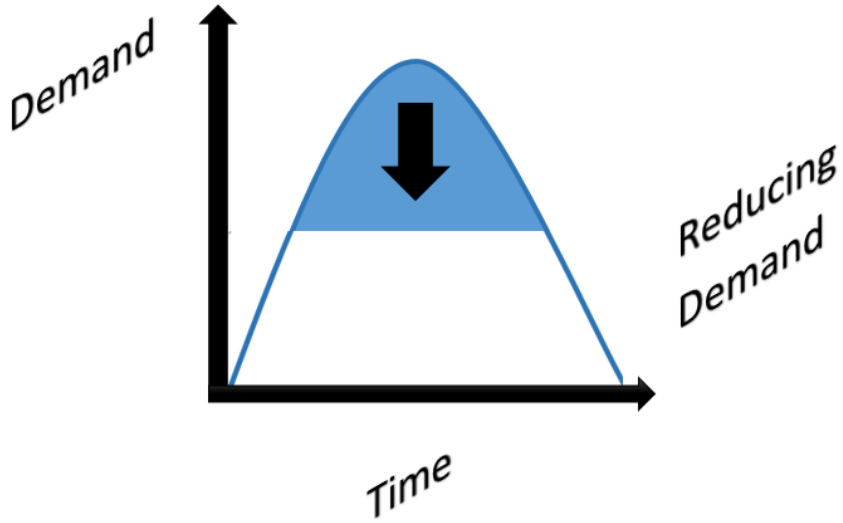
What is demand response ?





- Demand Response involves consumers reducing or shifting their electricity usage during peak periods in response to time-based tariffs & other financial incentives

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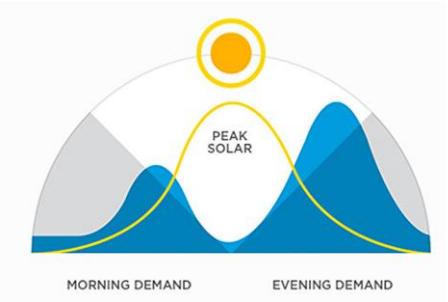
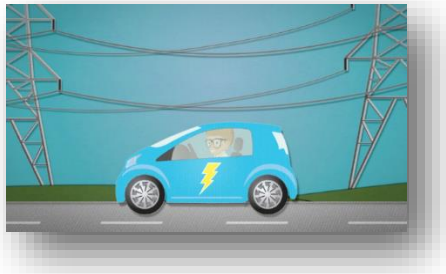
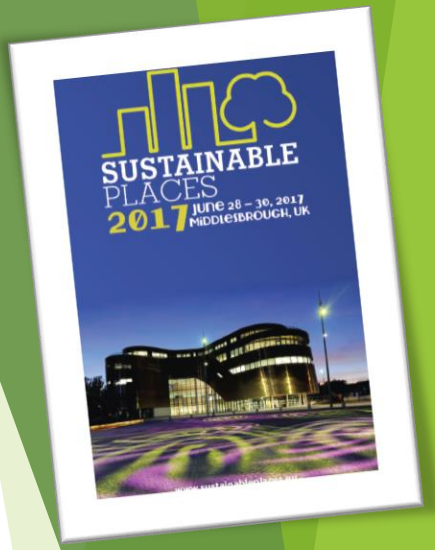
Why do we need new approaches dealing with peak demand ?





- Traditionally we matched electricity demand & supply by controlling the rate of generation to meet peak demand
- Renewable electricity decreases control
- Electric cars set to increase peak demand
  - Potential 40% increase in morning peaks & 60% increase evening peaks by in the UK by 2030



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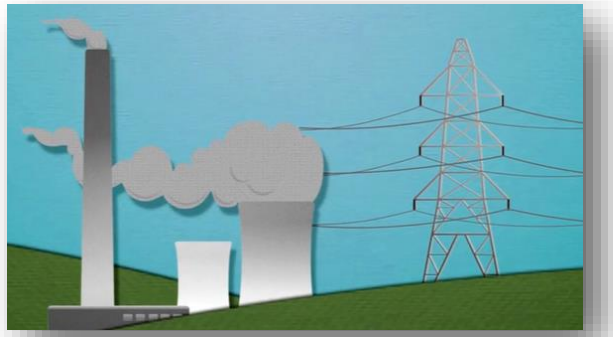
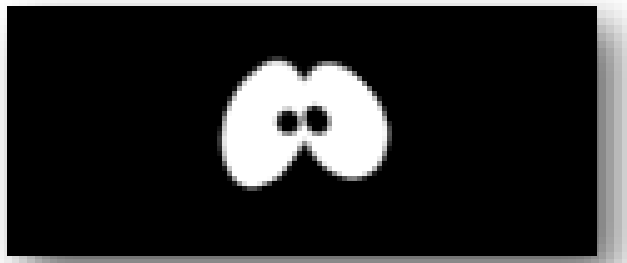
Why is peak demand is a problem





- High peak demand increases energy costs
  - Maximum demand even if it is reached only once a year dictates the size of generators transmission lines transformers & circuit breakers
  - Power generation which can be ramped up quickly often uses more expensive fuels is less efficient & has higher marginal carbon emissions
- If peak demand exceeds maximum supply levels it can result in power outages & load shedding

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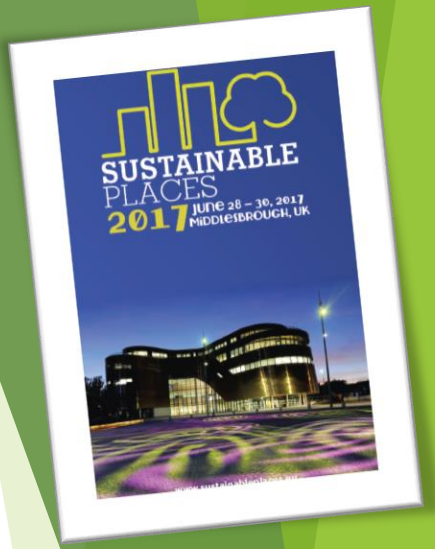
Why blocks of buildings ?

- Because blocks of buildings offer more flexibility in the timing of energy use than single buildings
- Most DR programmes aimed at small or medium scale customers have failed to meet expectations
- Therefore the value chain of DR service provision in blocks of buildings for the different actors involved has yet to be demonstrated



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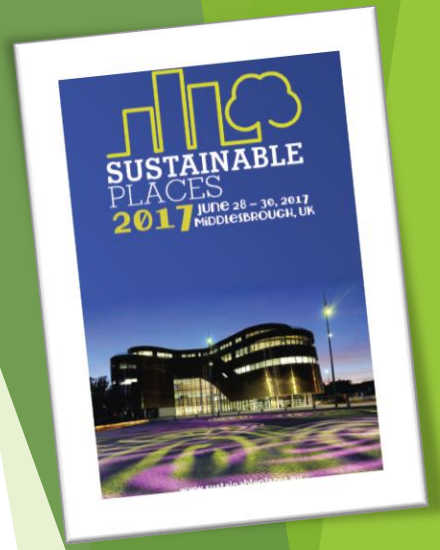
Aim of DR BOB



- To demonstrate the economic & environmental benefits of demand response in **blocks of buildings** for the actors required to bring it to market
- These actors include but are not restricted to
  - Distribution Network Operators (DNOs)
  - Energy Retailers
  - Transmission Service Operators (TSOs)
  - Energy Service Companies (ESCOs)
  - IT providers
  - Aggregators
  - Facilities owners & managers

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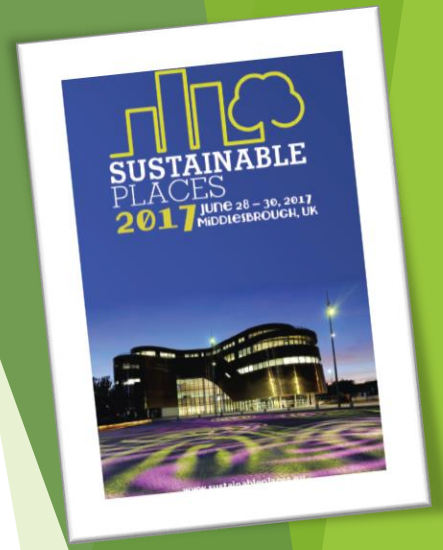
DRBOB Objectives



- Integrate **existing technologies** to form the **DR-BOB Solution ROI <5y**
- Demonstrate the DR-BOB Solution at **4 sites** in the **UK, France Italy & Romania** with blocks-of-buildings covering 274,665 m^2 with 47,600 occupants over at least 12 months
- Realise **up to 11% saving in energy demand, up to 35% saving in electricity demand & a 30% reduction in the difference between peak power demand & minimum night time demand** for building owners & facilities managers at the demonstration sites
- Provide & validate a method of assessing at least **3 levels of technology readiness (1-no capability, 2-some capability, 3-full capability)** required to participate in the DRBOB DR solution
- Identify revenue sources with **at least a 5% profit margin** to underpin business models for each of the different types of stakeholders required to bring demand response in the blocks-of-buildings to market in different local & national contexts
- Engage with **at least 2,000 companies** involved in the supply chain for DR in blocks of buildings across the EU to disseminate the projects goals & findings

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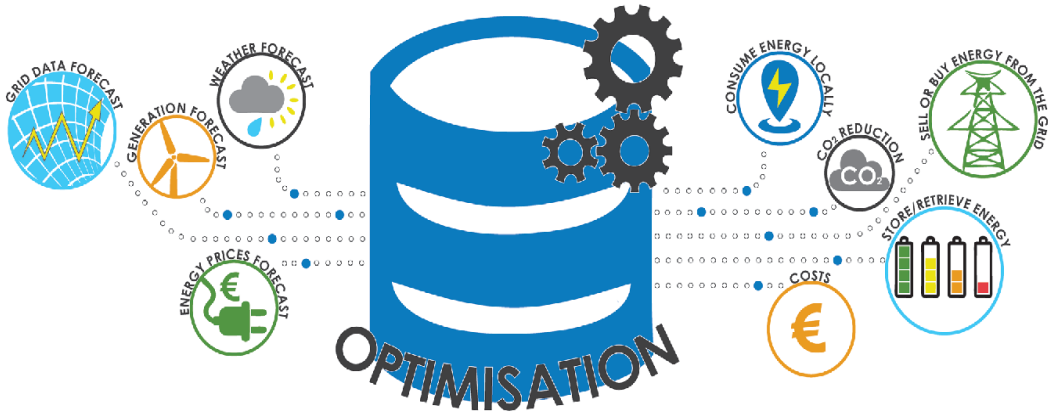
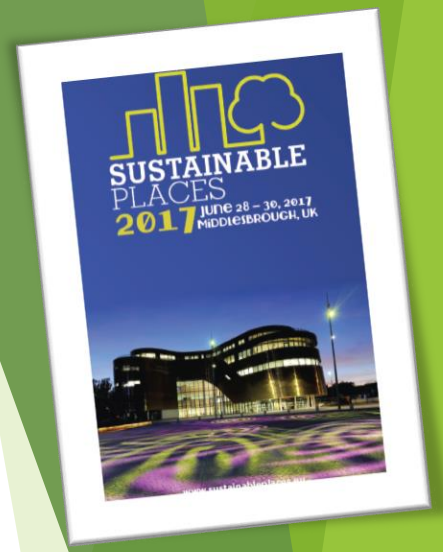
DRBOB solution key functionality

- Aggregation of DR potential of many blocks of buildings
- Real-time optimisation of local energy
  - production
  - consumption
  - & storage
- User adjustable optimisation criteria
  - to maximise economic profit
  - or to minimise CO2 emissions



- Automated intelligence adapts to
  - fluctuations in energy demand & production
  - changing weather conditions
  - dynamic energy tariffs



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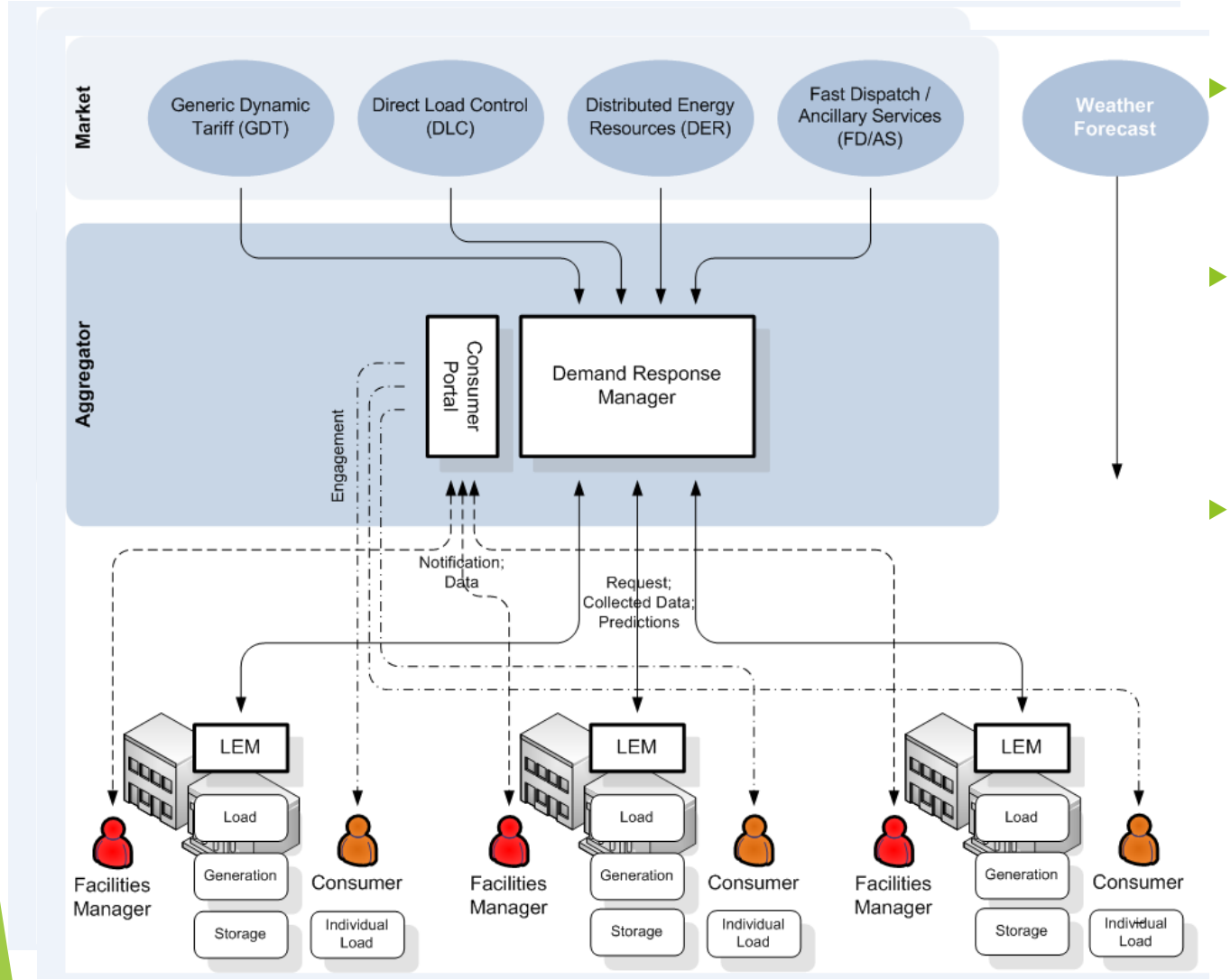
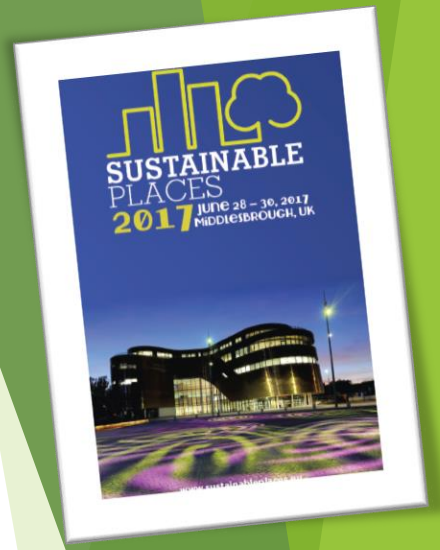
DR-BOB Architecture



- A scalable cloud based central management system
- Supported by a local real-time energy management solution
- Which communicates with individual building management systems & generation / storage
- Achieved by integrating
  - Demand Response Manager Siemens
  - Local Energy Manager (LEM) –Teesside University
  - Consumer Portal – GridPocket EcoTroks™



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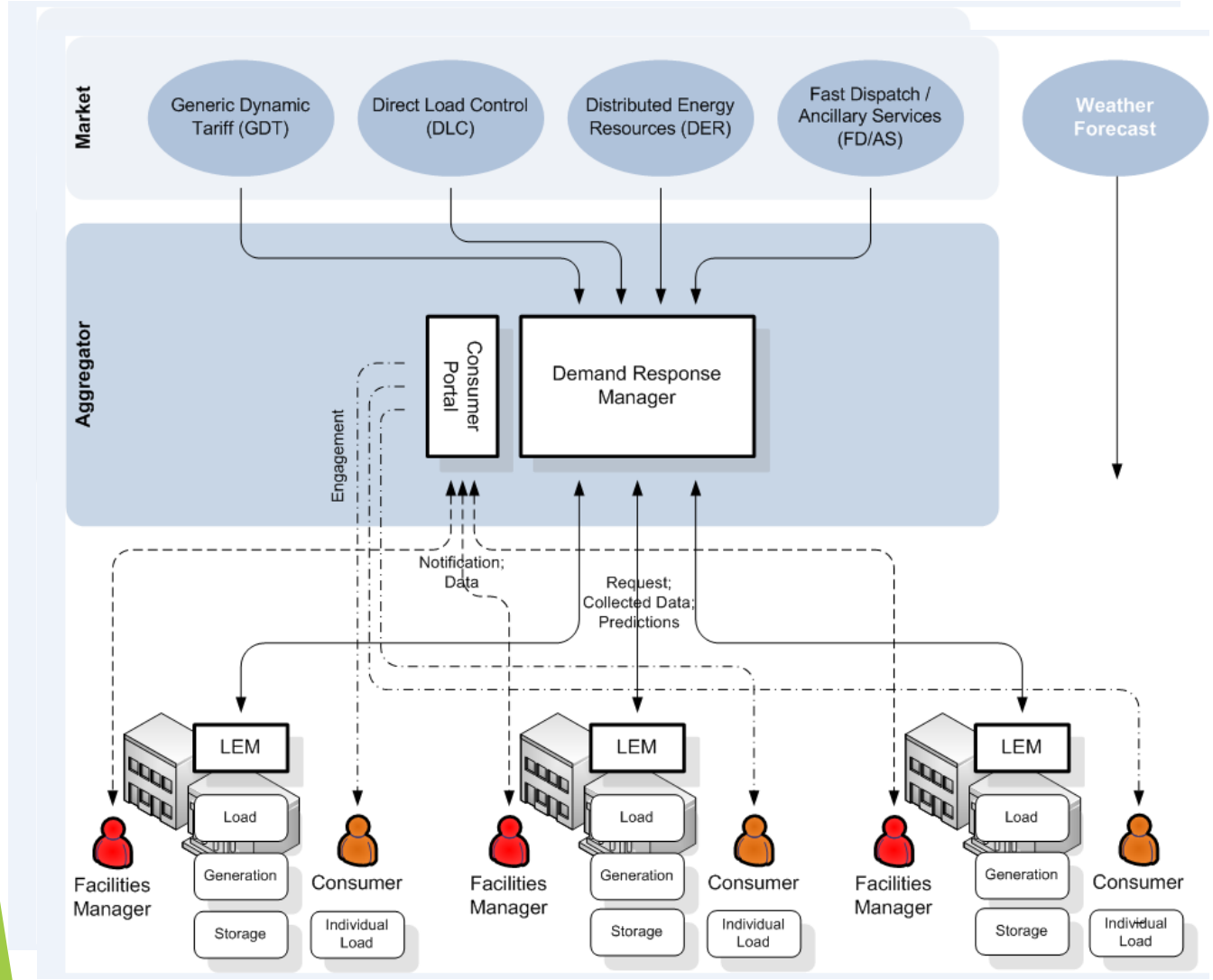
DR-BOB Architecture



- DRM – provides the ability to aggregate DR actions
- LEM provides energy management at the level of blocks of buildings
- EcoTroks™ Customer Portal provides user interfaces for energy management
- Applicable at all voltage levels
  - Directly for LV & MV
  - HV applicability is indirect from DR requests from the TSO

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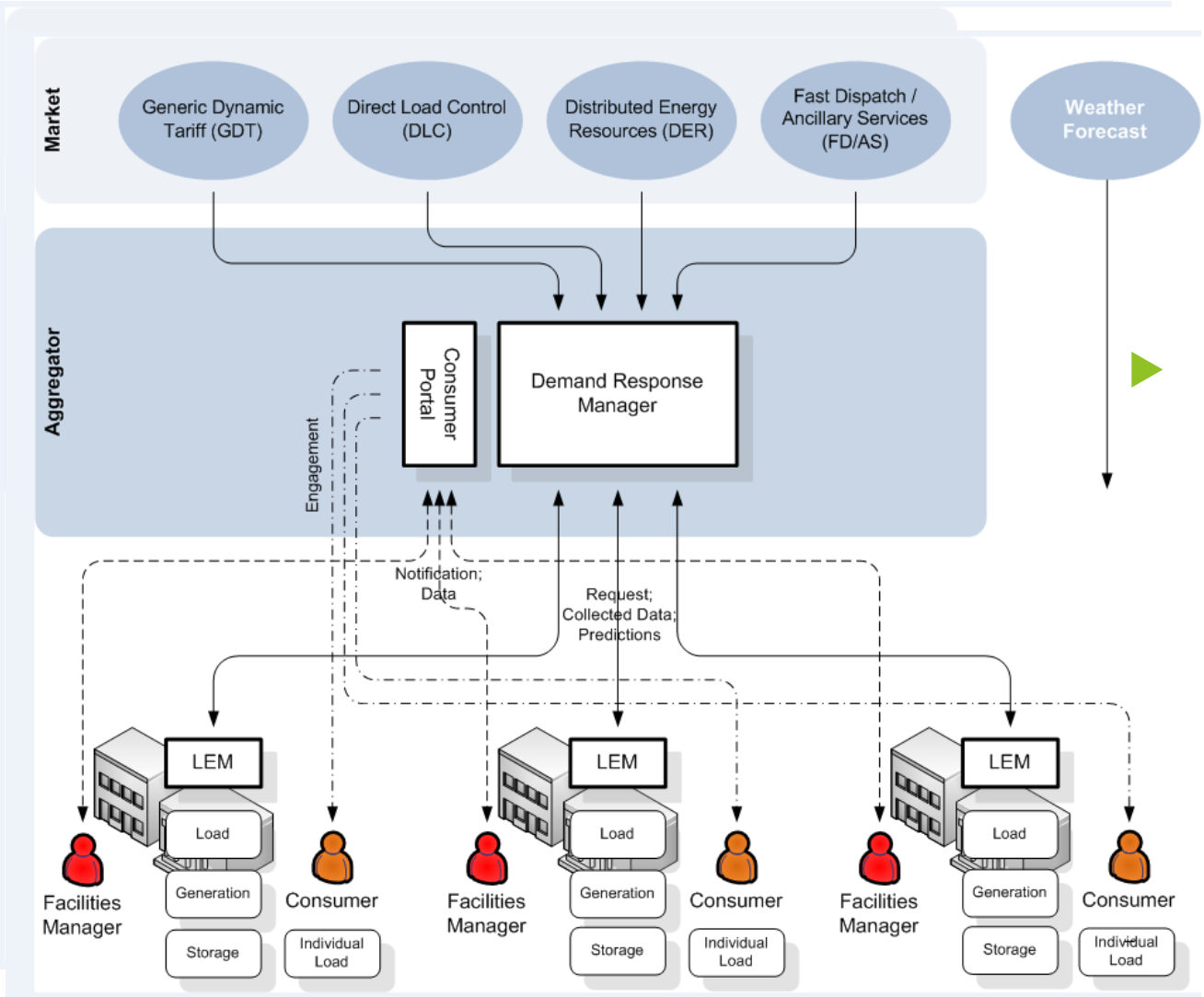
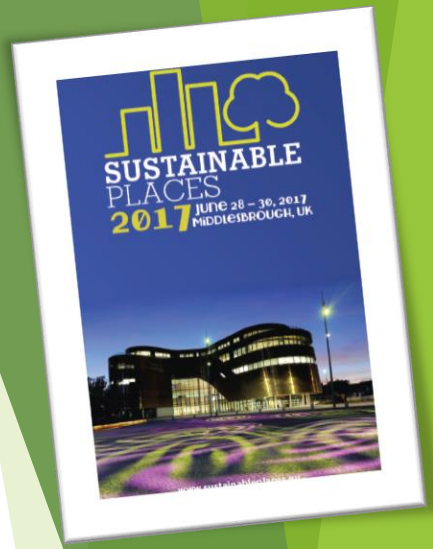
DR-BOB Architecture



- DRM provides
  - Macro-level optimised energy management to ensure the efficient use of aggregated assets
  - Central point for demand response events
- LEM
  - integrates with the local generation & storage assets & BMSs to manage micro level supply & demand
  - Keeping communications & centralised computing to a minimum
  - Improving reliability
  - & reducing costs



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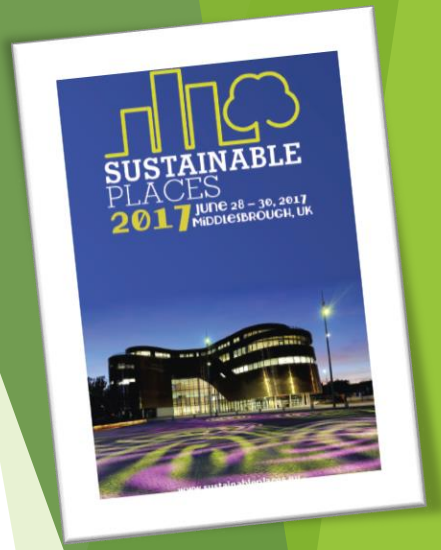
Configuration

- The DR-BOB energy management solution will allow energy management companies to provide varying levels of control
  - From the centralised macro-view
  - Through to localised complete control of the energy systems at the building level the micro-view
- The solution utilises existing standards such as IEC60870-5-104 & OpenADR
- the architecture enables new adaptors to be added to support new standards in the future



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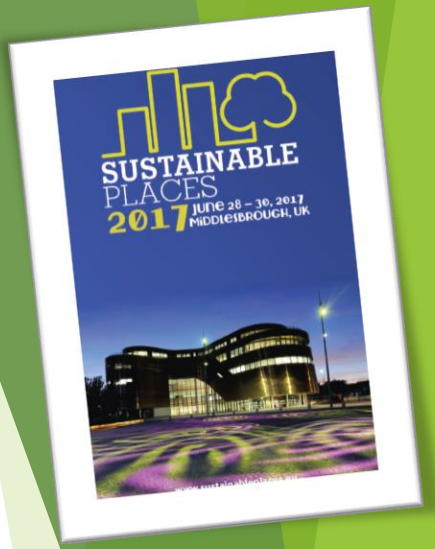
The applicability of DR BoB solution

- Depends on the technologies deployed in buildings and their BMS
  - the controllable assets within the buildings (including energy generation/storage)
  - the availability of wider communications interfaces to enable telemetry and telecontrol signals with the DR sponsor.



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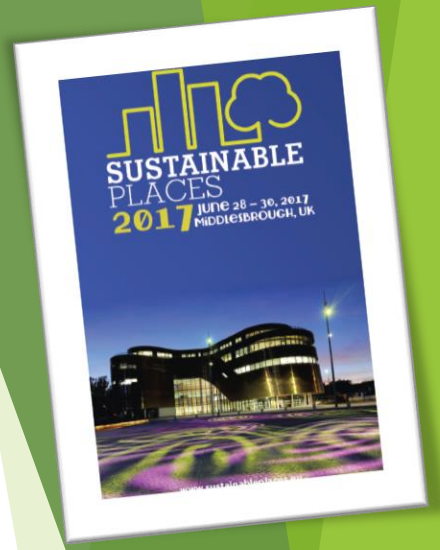
Assessing the applicability of DR BoB solution



- To enable building owners and managers to assess the applicability of the DR-BoB energy management solution to their buildings, a method of assessing and validating the technology readiness of building stock to participate in the DR-BoB energy management solution at any given site is under development.
- This work is in harmony with other ongoing initiatives within Europe.
- There is a project looking an EU project looking at Smart readiness indicators for buildings
- National projects
  - Nice Côte d'Azur Chamber of Commerce and Industry (2014) Recommendations for buildings smart grids ready: Guide for project owners (in French). URL http://oreca.regionpaca.fr

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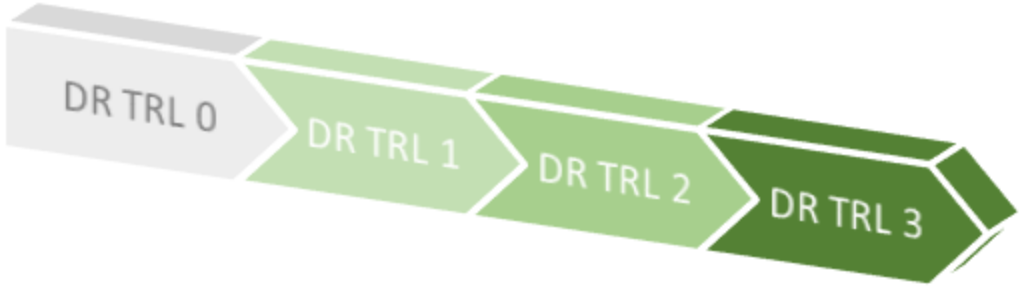
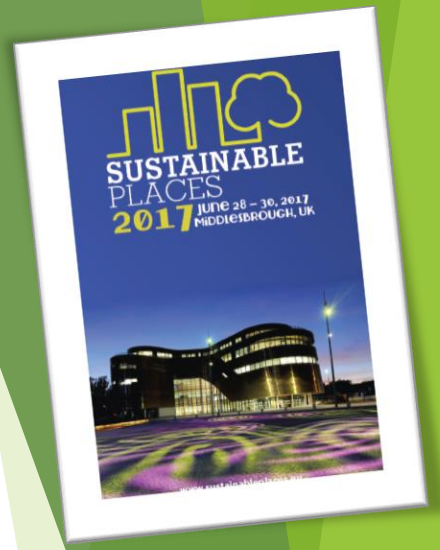
Demand Response Technology Readiness Levels





- DRTRLs to measure the technological readiness of a block of buildings to participate in a building-stock oriented DR program
- Borrows from the TRL concept developed by NASA in the early 70s. Essentially TRLs provide a "*discipline-independent, program figure of merit (FOM) to allow more effective assessment of, and communication regarding the maturity of new technologies*".
- Provides a scale which a facilities manager or building owner can use to conduct a technology readiness assessment (TRA) of the current energy and communications systems at their site, or sites, to support their decision to implement the DR-BoB energy management solution.

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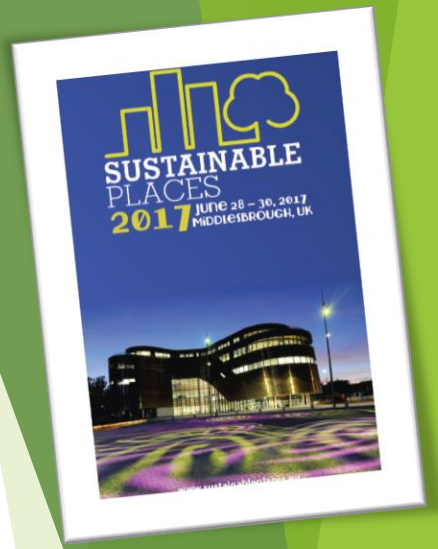
Operationalising DRTRLs for BoBs

- **Technology** refers to the building/site energy & communication systems
  - includes metering & telemetry flexible load local energy generation & energy storage plant
- **Readiness** refers to time
  - i.e. ready for operations at the present time
- **Level** refers to the extent of the capability of a block of buildings to take part in the DR-BoB energy management solution
- **Block of buildings** refers to a group of buildings that may or may not be in proximity to each other if under common governance



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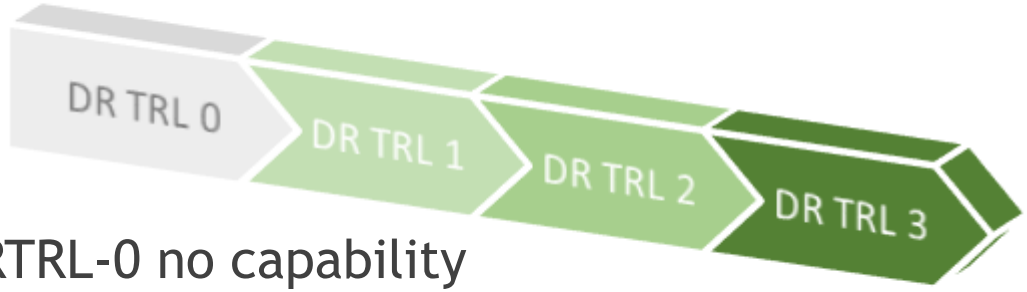

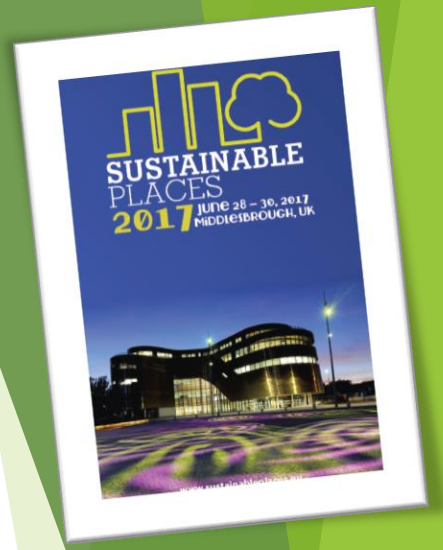

- DRTRL-0 no capability
  - a building/site does not have the technical capacity to enable the implementation of the DR-BoB solution;
- DRTRL-1 manual capability
  - a building/site has flexibility and can be controlled in a manual capacity by facility managers or end consumers making a direct intervention to apply control signals typically based on a recommendation notification such as an email
- DRTRL-2 partially automated capability
  - a building/site has the minimum technology required to partially enable some of the automated functioning of the DR-BoB energy management solution by directly responding to tele-command signals without manual intervention, but will still require manual intervention for the remaining functionality;
- DRTRL-3 full capability
  - a building/site has the technologies required to fully enable all of the automated functioning of the DR-BoB energy management solution through tele-command signals, without requiring manual application of control.

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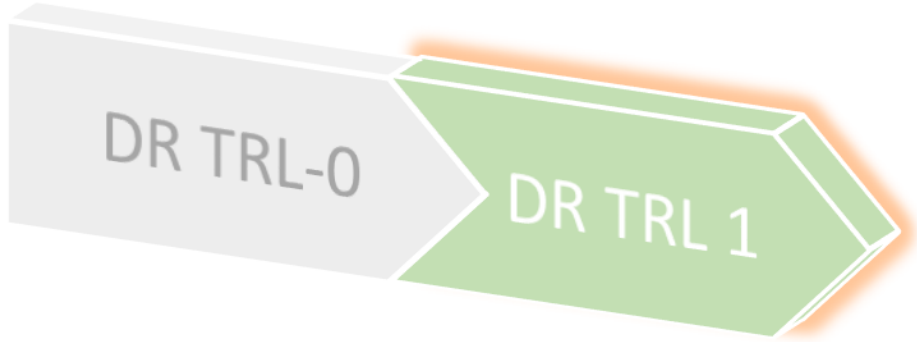

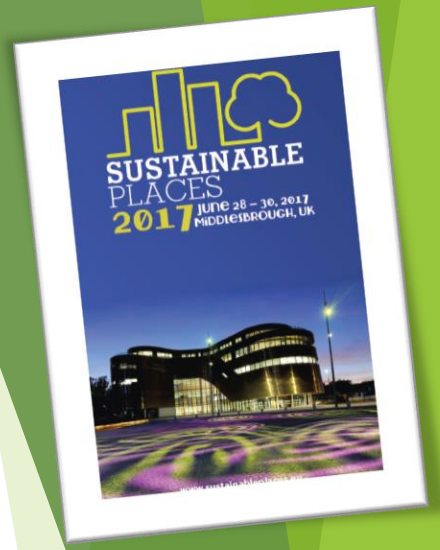

DR TRL 1 manual capability

- To meet DRTRL-1 a building/site must have
  - Consumption assets that can be deactivated for a short period by manual direct control without deleterious consequences
  - Wide Area Network (WAN) communications
    - dedicated network connection or relevant ports open in firewall for OpenVPN
  - Occupants with access to notification services
    - such as email twitter, intranet pop-ups etc.

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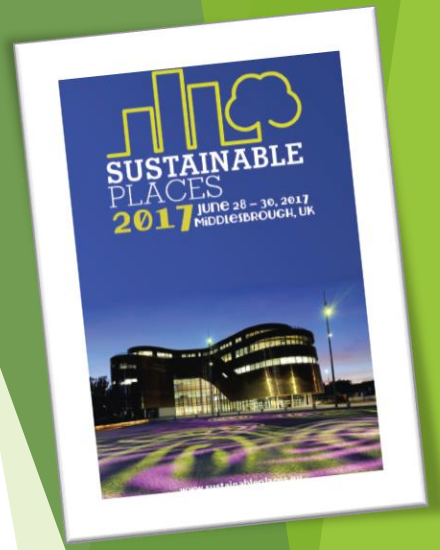
DR TRL 0 DR TRL 1 DR TRL 2



DR TRL-2 partially automated capability

- To meet DRTRL-2 a building/site must additionally have:
  - Automated energy metering at the building level (high frequency, <1hr) able to export data with low latency, <1hr;
  - Controllable assets, either dispatchable behind the meter (BTM) generation or turn-down demand, whose schedule can be altered for a short period by without deleterious consequences;
  - HVAC assets controlled by BMS accessible via an open or standard protocol

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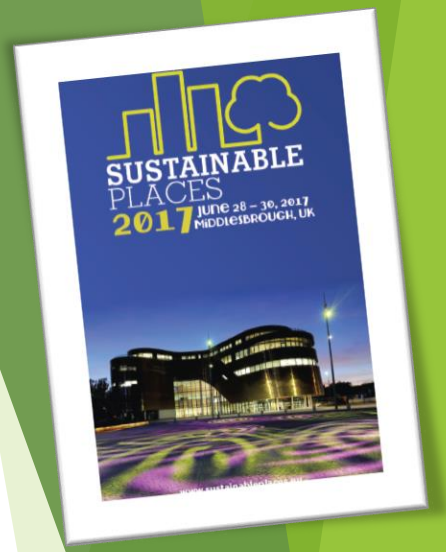

DRTRL-3 full capability

- To meet DTTRL-3 a building/site must additionally have
  - Automated, low latency (<15min), high frequency (<half-hourly) asset specific energy metering
  - HVAC assets under direct control via an open or standard or BMS protocol
  - Temperature sensors in areas served by HVAC assets under direct control.
  - Energy storage assets (electrical, thermal)
  - If the building/site under control has temperature sensors and close to real time energy metering then more effective optimisation is possible with feedback direct to the DR-BoB solution platform
  - The full capability of the DR-BoB solution is enabled if this is also coupled to energy storage assets that can be incorporated into dispatch schedules

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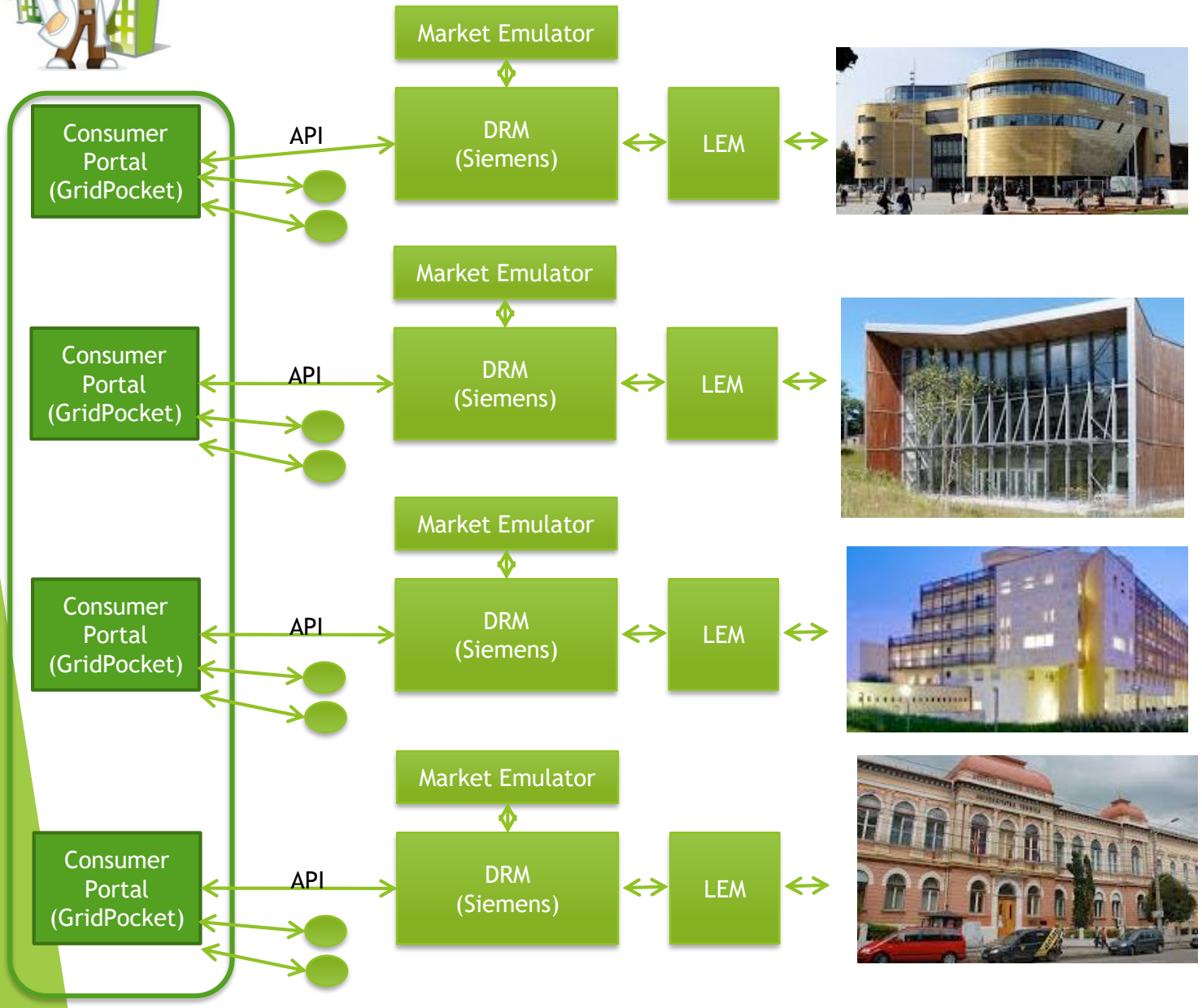
Architecture implemented at four pilot sites

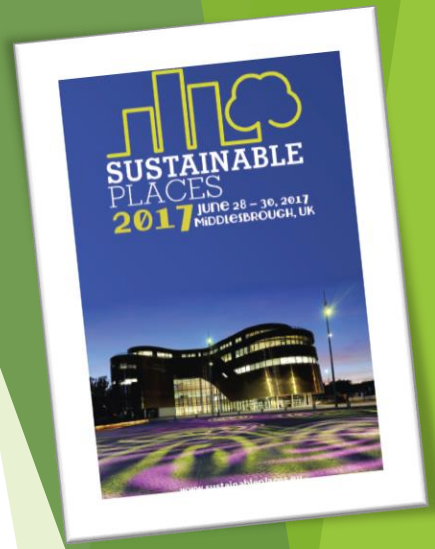


Campus at
Teesside University
In Middlesbrough UK

Business park in
Anglet France

A hospital in
Brescia Italy

Campus at
TUCN Cluj Napoca
Romania



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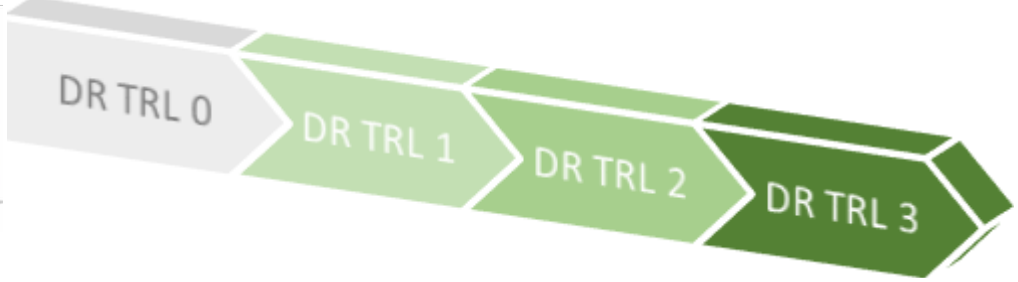
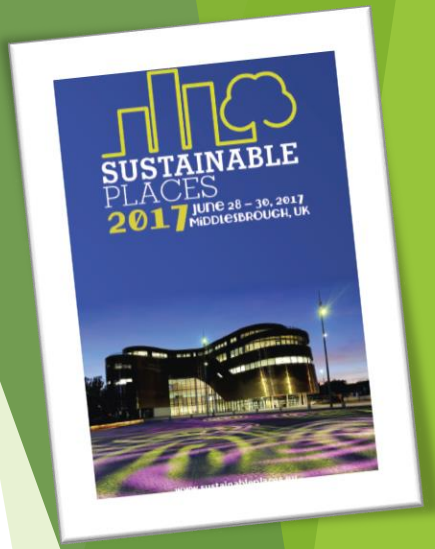
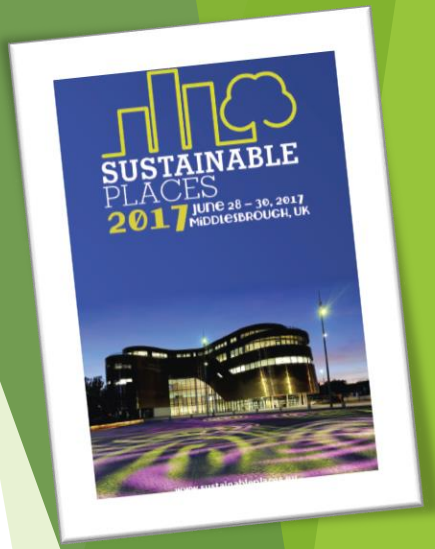


Pilot site DRTRL

	Building Uses	Controllable Assets	Initial DRTRL	Implemented DRTRL
	Teesside University campus Educational, office, catering + low rise residential	Chilled water system, fan coil units, EV charging stations, CHP, backup generator and UPS	1	3 - Metering system upgraded to reduce latency, BMS upgraded to enable control over standard (BACnet) protocol.
	Business Park, Workshop, training centre, office	Microgrid, heat pumps, RES (PV), electrical storage	1	3 - One additional meter required at FCMB workshop.
	Hospital Healthcare + office	Chilled water system, CCHP (trigeneration), food carts, laptops	1	2 - Metering system upgraded to improve resolution and reduce latency
	TUCN Campus Educational, leisure, office + high rise residential	Chilled water system, washing machines, swimming pool pumps	1	2 - Building Energy and Management System required to enable control over standard protocols and export of data.





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