Teesside University

School of **Computing, Engineering & Digital Technologies**
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# KPI Evaluation Framework and Tools Performance: A Case study of inteGRIDy project

**Dr Chris Ogwumike**, Dr Huda Dawood, Dr Tariq Ahmed, Mr Bjarnhedinn Gudlaugson, and Prof Nashwan Dawood

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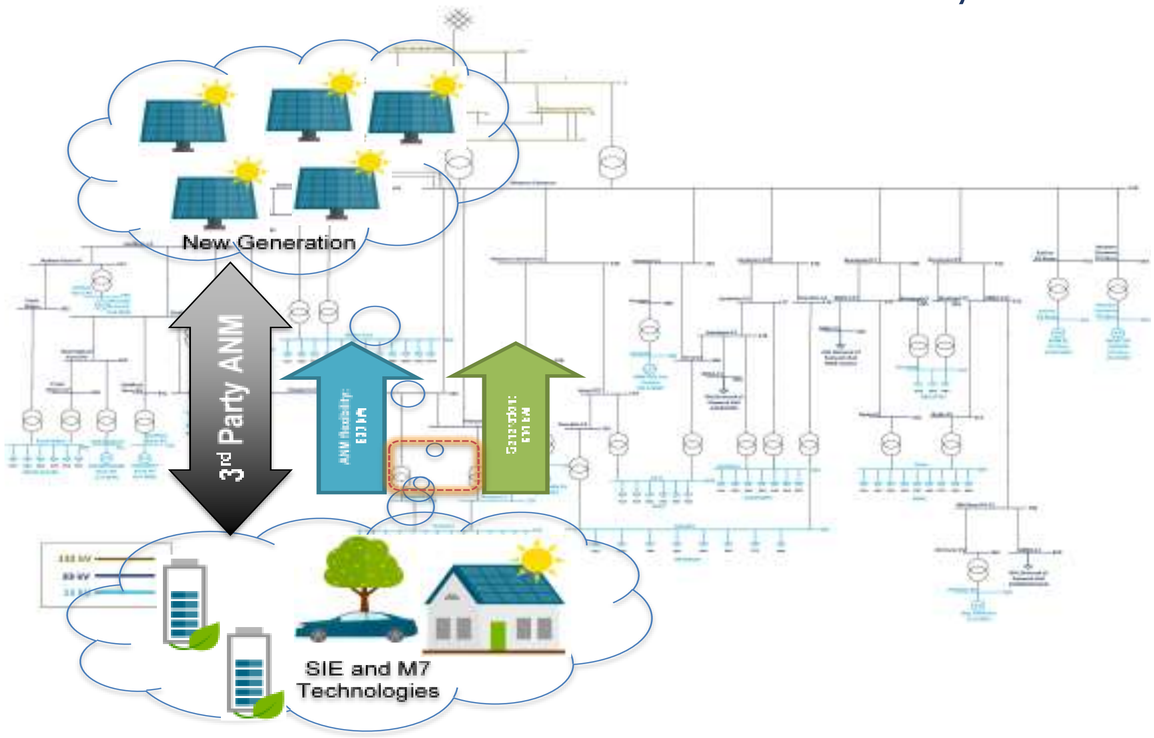
# Overview for today:

Some background/motivation, then focus on Isle of Wight (IOW) pilot Use Cases, KPI Evaluation, Results and Analysis




SIEMENS Ingenuity for life

Minus7 a heating revolution

inteGRIDy

# InteGRIDy

Integrated Smart GRID Cross-Functional Solutions for Optimized Synergetic Energy Distribution, Utilization Storage Technologies

- ❑ 28 partners
- ❑ 33 Use cases
- ❑ 4 main thematic pillars
- ❑ 4 domains
- ❑ 10 pilot sites

- inteGRIDy aims to:
  - **integrate** cutting-edge **technologies**, **solutions** and **mechanisms** in a scalable Cross-Functional Platform (**framework of tools**) of **replicable** solutions
  - **connect** existing energy networks with diverse stakeholders with enhanced observability of both **generation** and **consumption profiles**
- which will advance:
  - the **optimal** and **dynamic** operation of the DG,
  - fostering grid **stability** and **coordinating Distributed Energy Resources** (DERs), **Virtual Power Plants** (VPPs) and collaborative **Storage schemes**
  - within a continuously **increased** share of RES

# Isle of Wight Pilot Description of Action (DOA)

| inteGRIDy pillar | Aspects Addressed | Technologies | Use cases |
|---|---|---|---|
| **Demand Response** | - **Test** smart technologies regarding heat pump **remote control** hub and building **energy management** to enable load shifting.<br>- Develop a Power Systems Model and use it to identify constraints to 'autonomous' generation**.** | - VPP for Advanced Building Management System Control (using sensors and control)<br><br>- Heat Pump Control Hub. | - Building optimization to maximize efficiency and demand flexibility |
| **Energy Storage Technologies** | - Test **thermal storage** solution to enable load shifting and cost reduction for domestic users. | - Heat Pump Control Hub.<br>- (using Data logger /controller) | - Minus7 Energy storage system |

# KPI evaluation phases

1. Define and analyse the evaluation parameters

**Redefine goals, purposes and post conditions**

2. Select the appropriate evaluation methodology

**Combination of the available methodologies in the bibliography**

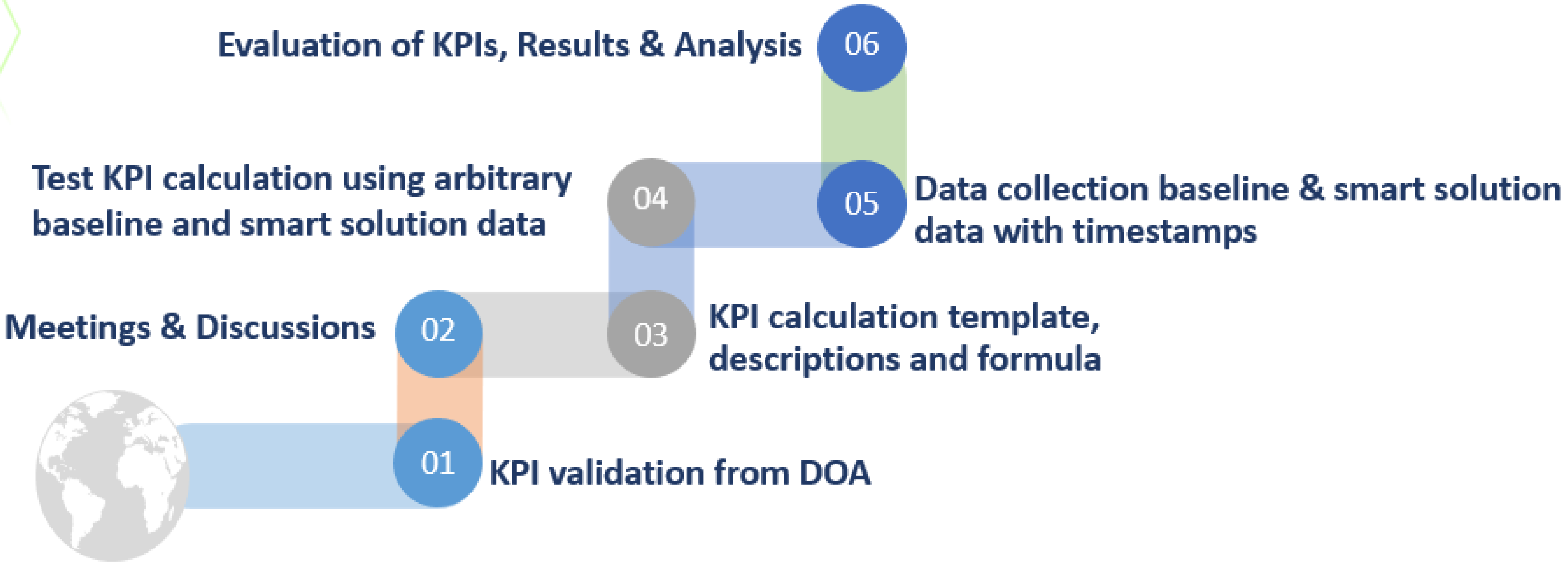
3. Mechanisms for data collection as needed for the evaluation process

**Technical and business (stakeholder / users oriented) mechanisms**

4. Evaluation process based on the collected data

**Evaluation process and analysis of the collected data**

# KPI evaluation methodology



# Building optimisation Use case

- This use case aims to maximize the grid efficiency and demand flexibility contribution to DSO triggered demand response services
- Demand response event schedules were grouped into three; increase, decrease and hold consumption (1, -1, 0).

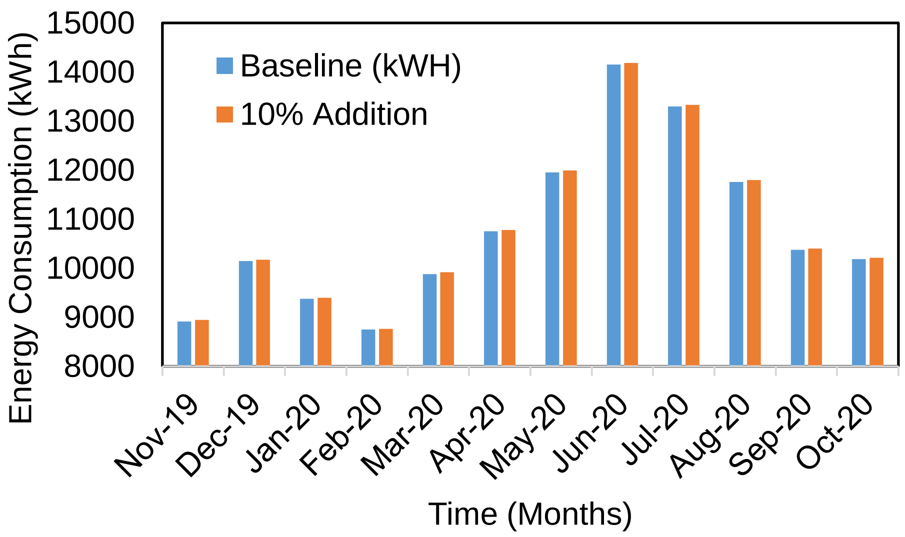



**Figure 1: Baseline and 10% increase in demand**

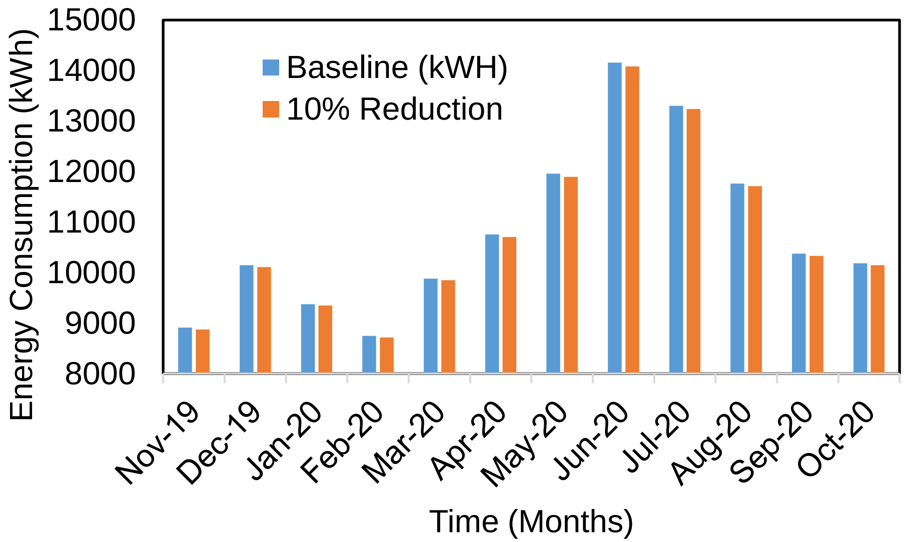



**Figure 2: Baseline and 10% decrease in demand**

## Table 1: Technical KPI Results for building optimisation use case

| KPIs | #ID | Baseline | 10% Increase | 10% Decrease |
|---|---|---|---|---|
| Energy Consumption | T.01 | 130973 | 131322 | 130415 |
| Peak to Average Ratio | T.02 | 140.48% | 140.46% | 140.31% |
| Energy Consumption Reduction | T.04 | | -349 | 558 |
| Demand Flexibility Ratio | T.05 | | -0.00266 | 0.00426 |
| Demand Flexibility Request | T.06 | | 130626 | 130409 |
| Demand Flexibility Baseline (Potential) | T.07 | | 130626 | 130409 |
| Demand Request Participation | T.08 | | 0.00267 | 0.00428 |
| Demand Request Enrolment | T.09 | | 0 | 0 |
| Peak Load Reduction | T.10 | | -35 | 77 |

## Table 2: Economic KPI Results for building optimisation use case

| KPIs | #ID | Baseline | 10% Increase | 10% Decrease |
|---|---|---|---|---|
| Retailer Cost of Energy | EC.01 | 17681 | 17728 | 17606 |
| Average cost of Energy Consumption | EC.02 | 1360 | 1364 | 1354 |

## Table 3: Environnemental KPI Results for building optimisation use case

| KPIs | #ID | Baseline | 10% Increase | 10% Decrease |
|---|---|---|---|---|
| CO2 Emission | EN.01 | 17812 | 17860 | 17736 |
| CO2 Emission Reduction (kg) | EN.02 | | -47.46 | 75.84 |

# M7 Energy Storage Use case

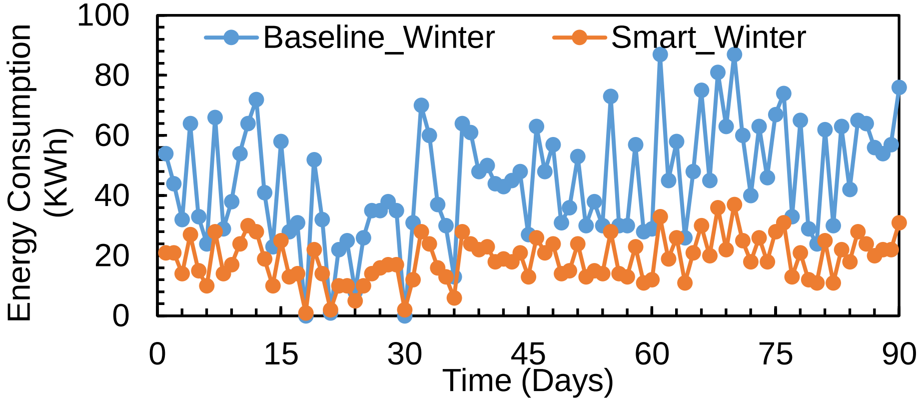



**Figure 3: Baseline and Smart Energy Consumption for Winter (Dec to Feb)**

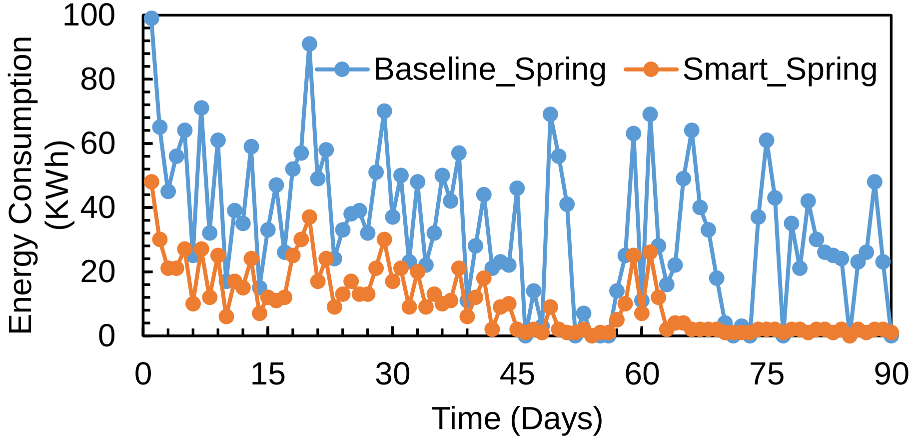



**Figure 5: Baseline and Smart Energy Consumption for Spring (March to May)**

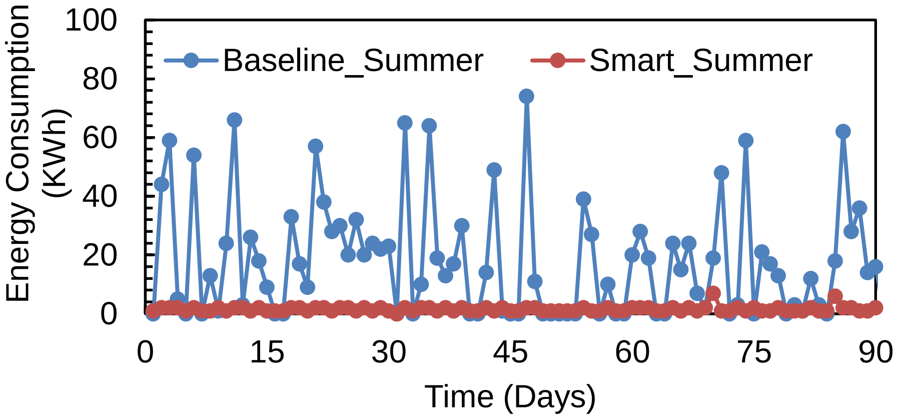



**Figure 4: Baseline and Smart Energy Consumption for Summer (June to August)**

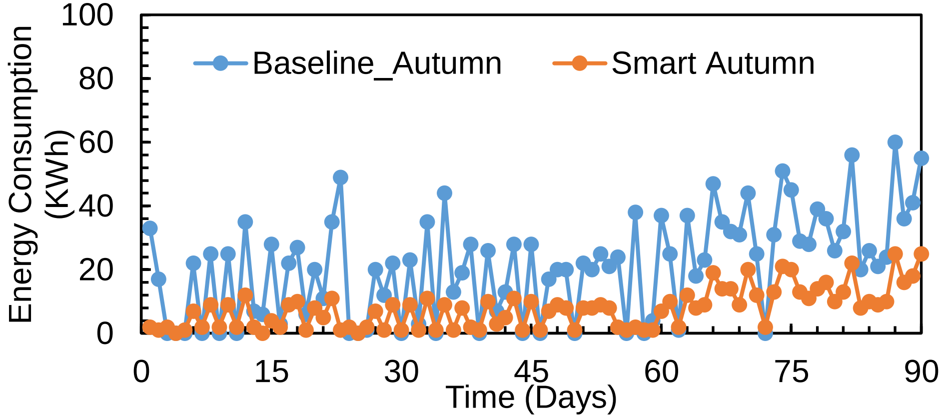



**Figure 6: Baseline and Smart Energy Consumption for Autumn (Sept to Nov.)**

# M7 Energy Storage cont.

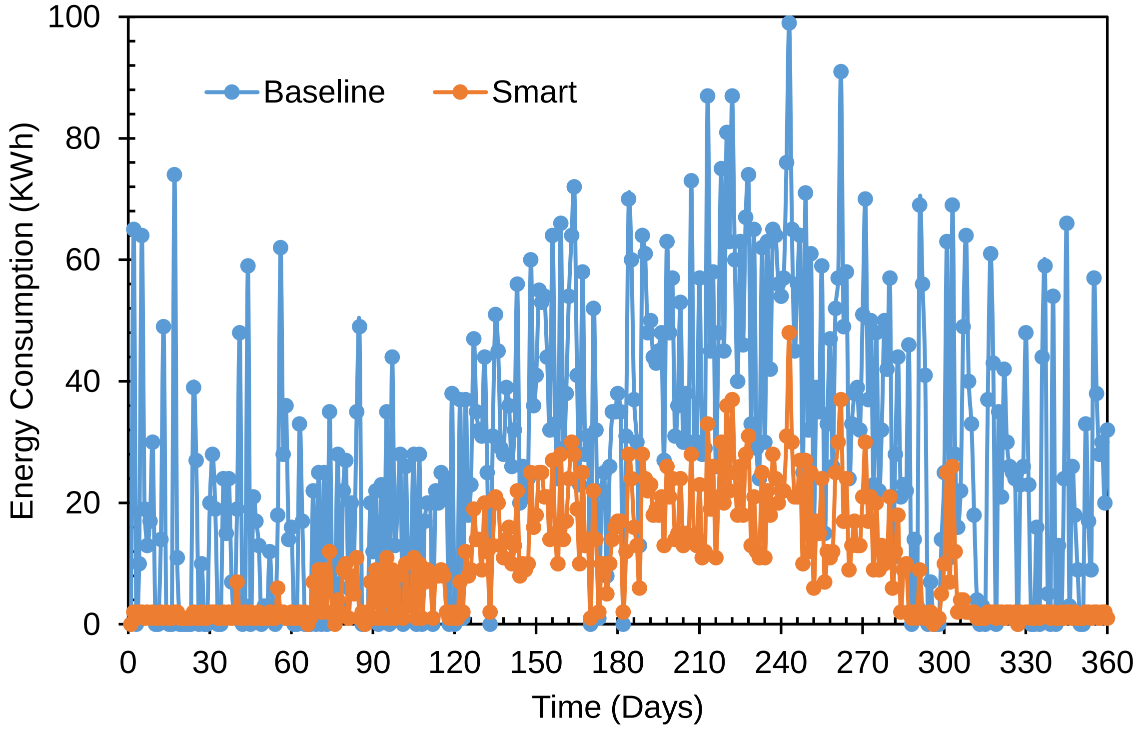



Figure 7: Overall Energy consumption (12 Months July to June)

Table 4: Technical KPI Results for M7 Energy Storage Use case

| KPIs | Unit | #ID | Baseline | Smart |
|---|---|---|---|---|
| Energy Consumption | kWh | T.01 | 691 | 48 |
| Peak to Average Ratio | % | T.02 | 296 | 129 |
| Energy Consumption Reduction | kWh | T.04 | 643 | |
| Demand Flexibility Ratio | | T.05 | 0.930535456 | |
| Peak Load Reduction | % | T.10 | 64 | |

Table 5: Economic KPI Results for M7 Energy Storage Use case

| KPIs | Unit | #ID | Baseline | Smart |
|---|---|---|---|---|
| Retailer Cost of Energy | £ | EC.01 | 1443.69 | 468.04 |
| Average cost of Energy Consumption | £/kWh | EC.02 | 3.97 | 1.29 |

Table 6: Environnemental KPI Results for M7 Energy Storage Use case

| KPIs | Unit | #ID | Baseline | Smart |
|---|---|---|---|---|
| CO2 Emission | Kg | EN.01 | 1454.38 | 471.51 |
| CO2 Emission Reduction | kg | EN.02 | 982.87 | |

# Conclusive remarks on IOW

| Pilot sites | Use cases | Demand Flexibility / Grid optimization | Energy Consumption Reduction / Cost optimisation / Retailer cost | Energy storage / EV / $CO_2$ Emission reduction |
|---|---|---|---|---|
| **IOW** | **UC01-** Building optimisation to maximise efficiency and demand flexibility, minimise costs and reduce environmental impact across the enterprise. | Grid efficiency and demand flexibility contribution to DSO triggered demand response services was based on 10% increase / decrease in demand considering contractual framework limitations that could potentially apply. This is applicable to both requested and potential energy consumption in demand flexibility. | For 10% increase in demand, the energy consumption was increased by 349 kWh. For 10% decrease, the energy consumption was decreased by 558kWh. The aim of stabilizing grid efficiency has been achieved. | |
| | **UCO3-** M7 Energy Storage system | The system appears to meet the requirements of the Third Party ANM flexible connection offer but the ability to test and report on this flexibility is reduced as no DNO is working on this project with the IOW | Minus 7 energy storage system stores heat during periods of low electricity cost, which typically correlates to a lower grid carbon factor as well as cheaper electricity cost. Overall energy reduction of 643 kWh was achieved. | There is a significant reduction of 982.87 kg $CO_2$ emission due to smart implementation in this use case. The percentage reduction of approximately 68% was obtained for the $CO_2$ emission. |

# Questions!