2nd International Conference on Smart Energy Systems and 4th Generation District Heating
Aalborg, 27-28 September 2016

Innovative Delivery of Low Temperature District Heating System in Nottingham, UK

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4DH
4th Generation District Heating
Technologies and Systems

REMOURBAN Project

Project acronym: REMOURBAN

- **RE**generation **MO**del for smart **URBAN** transformation

- The project integrates energy, transport and ICT sectors through lighthouse (large scale demonstration – first of the kind) cities.
- The project aims at the development and validation in three lighthouse cities of a sustainable urban regeneration model that focus on convergence of energy, mobility and ICT sectors by the deployment of innovative technologies to significantly increase energy efficiency, improve sustainability of urban transport and reduce gas emissions in urban areas.
- The urban renovation strategy is **focused on citizens** who will be making a smart city a reality.

REMOURBAN Project

- Integration of:
  - Energy
  - Transport
  - ICT
- Three EU cities:
- Valladolid (Spain)
- Nottingham (UK)
- Eskisehir (Turkey)
- Two follower cities:
- Seraing (Belgium)
  - Miskolc (Hungary)
- 6M Eu for Nottingham over 5 years

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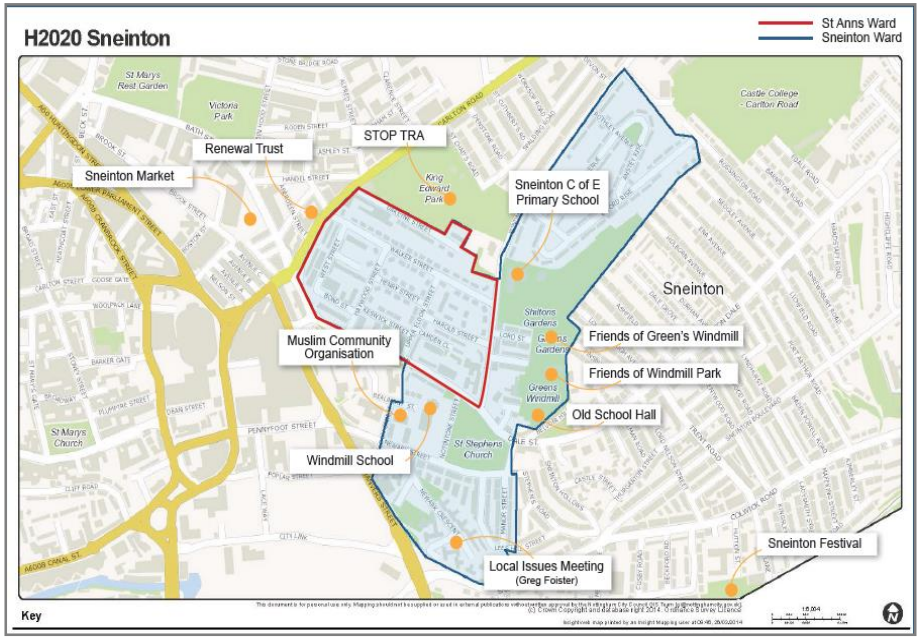
REMOURBAN Project area



- The area around Sneinton Road, Sneinton, Nottingham is considered as the most appropriate for the development of the REMOURBAN (DEMO site).
- The site is very close to the existing district heating. The pipe line is reaching the Bio City which is very close to Sneinton Road (100 – 200m).
- A large number of the properties (65%) in the area are social housing, owned by Nottingham City Council (NCC) and managed on their behalf by Nottingham City Homes (NCH).

Nottingham District Heating network

Nottingham's existing extensive Energy-from-Waste (EfW) district heating network, currently supplying 4,900 homes close to the Demo site, means that there is an opportunity to supply the blocks with an efficient and low-carbon heating supply.

It is proposed that a branch emanating from the return pipe of the primary mains is created to use low temperature heating from the *return* the first time on this system and maybe in the UK.

Eastcroft incinerator

- The heat energy mainly comes from the annual incineration of around 170,000 tonnes of municipal waste at Eastcroft incinerator
- The Nottingham District Energy Network is comprised of approximately 68km of insulated pipework carrying pressurised hot water around Nottingham City Centre satisfy the heating and hot water requirements of circa 4,900 dwellings and over 100 commercial premises
- It is a Combined Heat and Power (CHP) Plant, the steam is also run through a generating turbine to produce 60,000MWh of electricity annually.

Key environmental benefits

The key environmental benefits are as follows:

- Energy-from-Waste (EfW) largely removes the requirement for Nottingham and surrounding Boroughs to landfill refuse;
- The Combined Heat and Power (CHP) plant integrates the production of both usable heat and power (electricity) into one single, highly efficient process.
- Enviroenergy participates in TRIAD avoidance, helping the National Grid meet periods of high demand;
- The District Energy Scheme offsets approximately 27,000 tonnes of CO_2 emissions annually that would otherwise be produced by alternative use of gas.

Enviroenergy Nottingham LTDH network planning map

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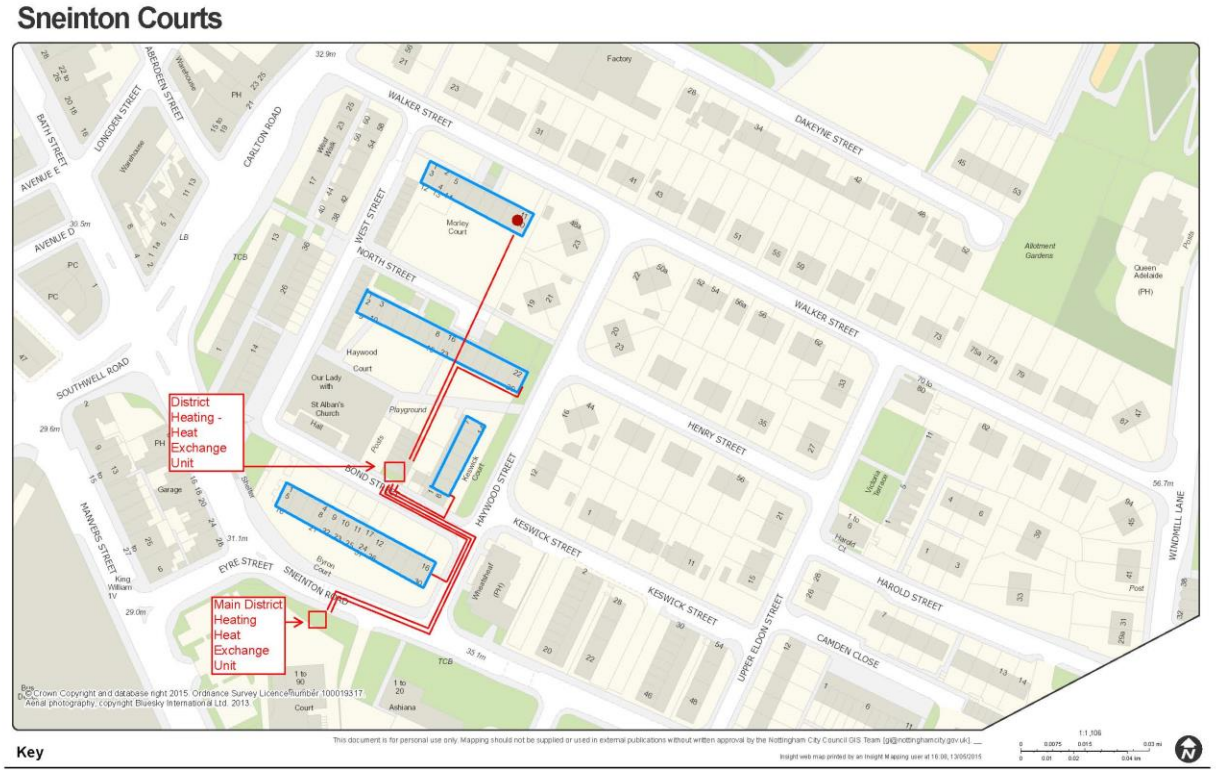

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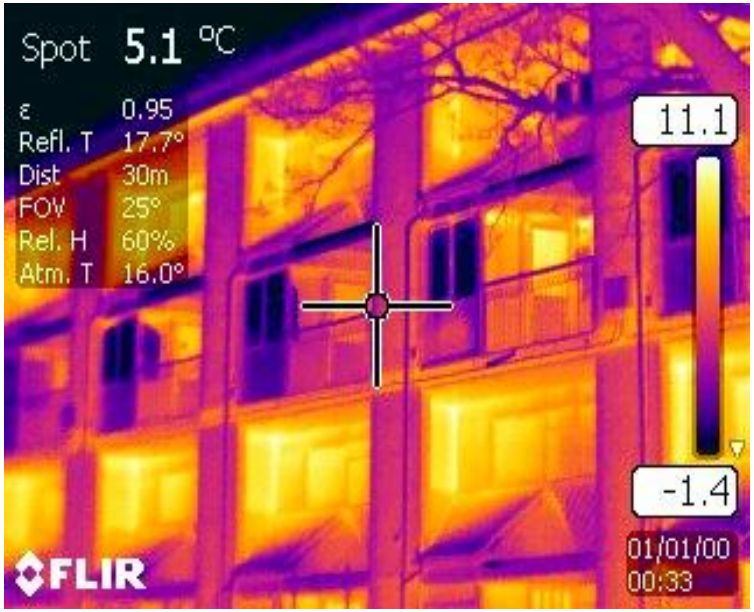
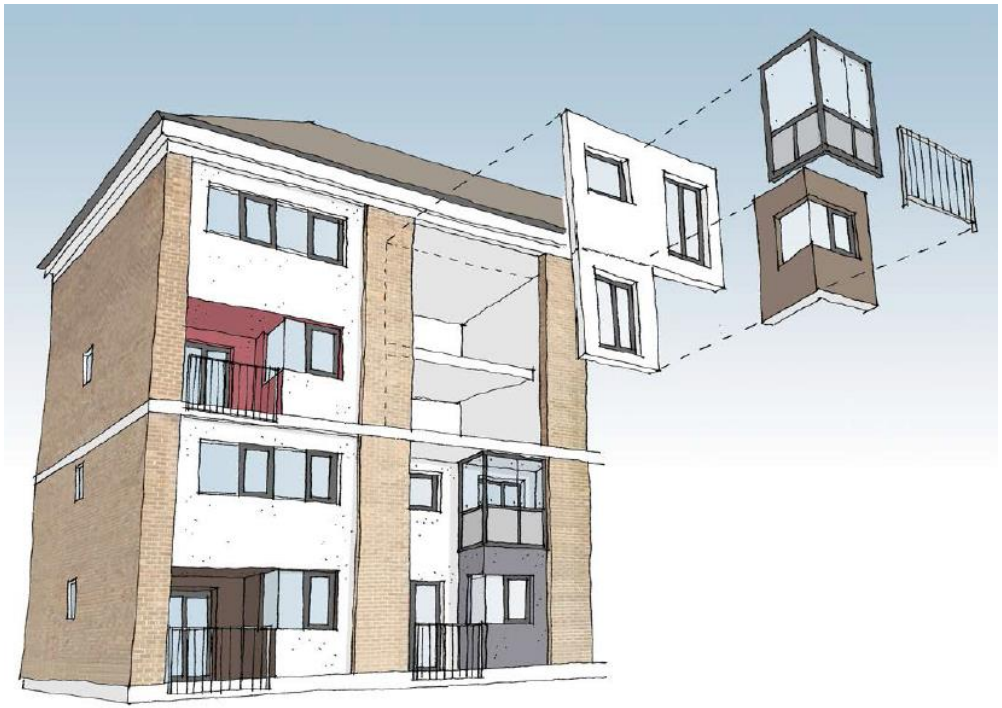
Maisonettes at Morley Court



Application of pre-fabricated panels to a system built construction



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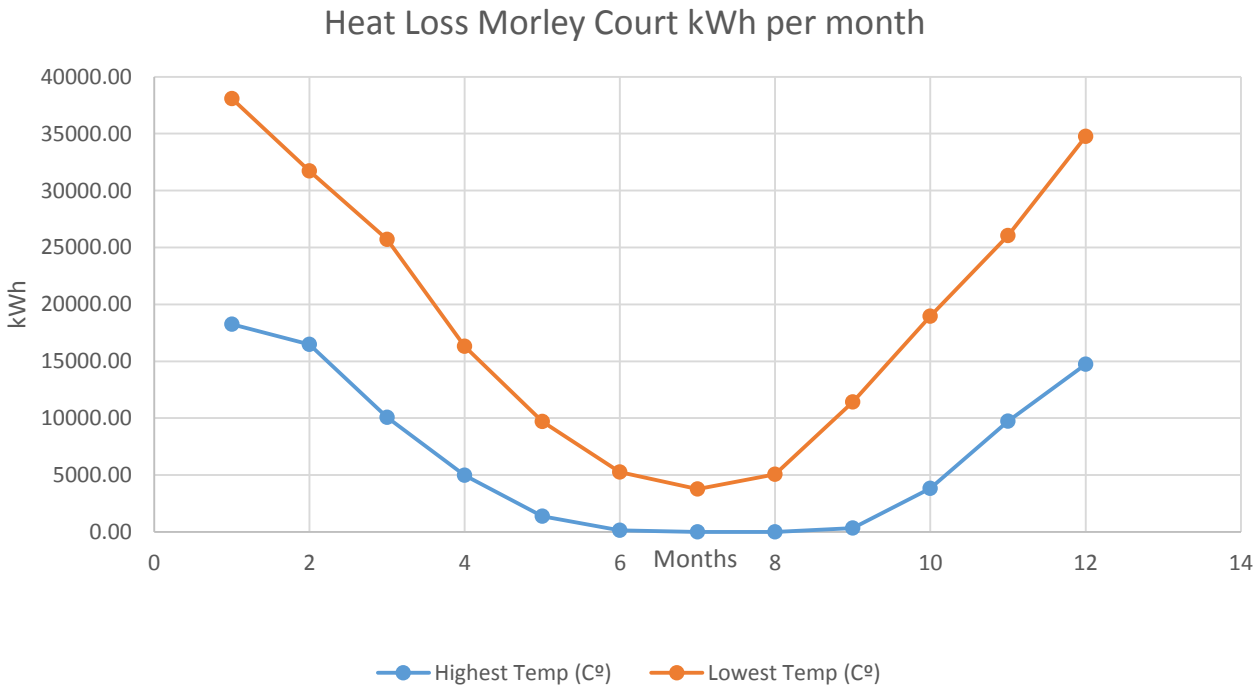
Heat loss calculations



Heat loss calculations

Conclusions for All 4 Courts - 94 flats

	Byron	Haywood	Keswick	Morley	Totals	
Space heating max power before retrofit =	145	146	75	99	465	kW
Space heating annual energy before retrofit =	406,381	411,073	210,220	277,995	1,305,669	kWh
Space heating max power after retrofit =	91	93	46	61	**291**	**kW**
Space heating annual energy after retrofit =	226,071	231,995	115,638	153,345	**727,050**	**kWh**
Space heating power reduction =	37.5%	36.3%	38.2%	38.0%		
Space heating energy reduction =	44.4%	43.6%	45.0%	44.8%		
DHW - Power for single Normal dwelling =					34.51	kW
DHW - Diversity fraction =					0.088	
DHW - Max power =					**286.17**	**kW**

EE Monitor

- The EE Monitor is smart and adaptable multi-functional device for use inside each home to show how much heat energy is being used and what it costs.
- The monitor is simple to install and easy to retrofit, with an Ethernet and a GSM solution available.
- The monitoring and credit control services have been developed with the needs of landlords in mind that debt exposure is minimised and where there is existing debt this can be recovered gradually through a debt recovery service

Intelligent Control System

The intelligent control system in each retrofitted property:

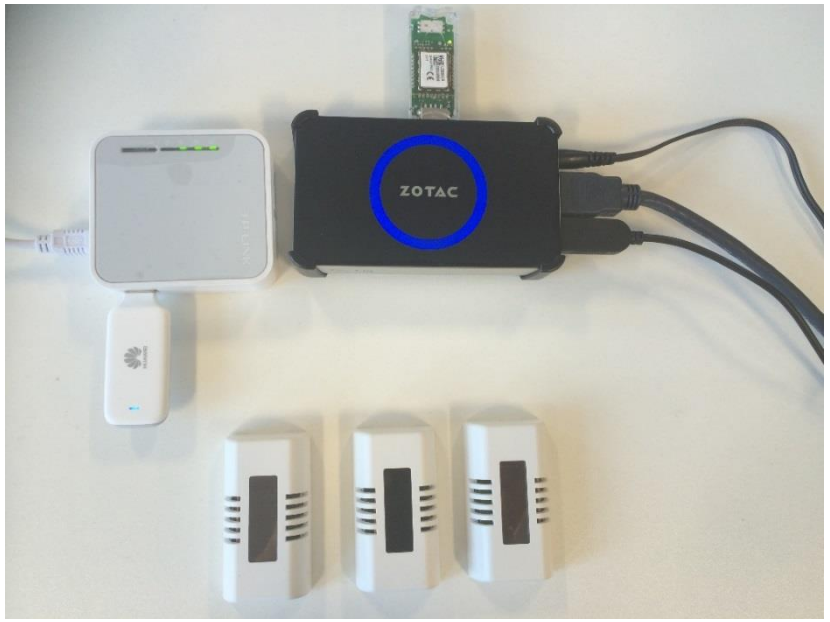
- optimise energy use and storage to suit predicted demand profiles
- allow provision of alerts and alarms for assisted living for vulnerable tenants
- energy consumption feedback for all tenants

Data capture and display

EnOcean® Pressac Mini Temperature and Humidity sensor

EnOcean® Pressac CO_2 Temperature and Humidity sensor

Open Energy Monitor® raspberry pi3 based Emonpi



Data acquisition test using laptop, Pressac® sensors, compact PC and portable wireless Router

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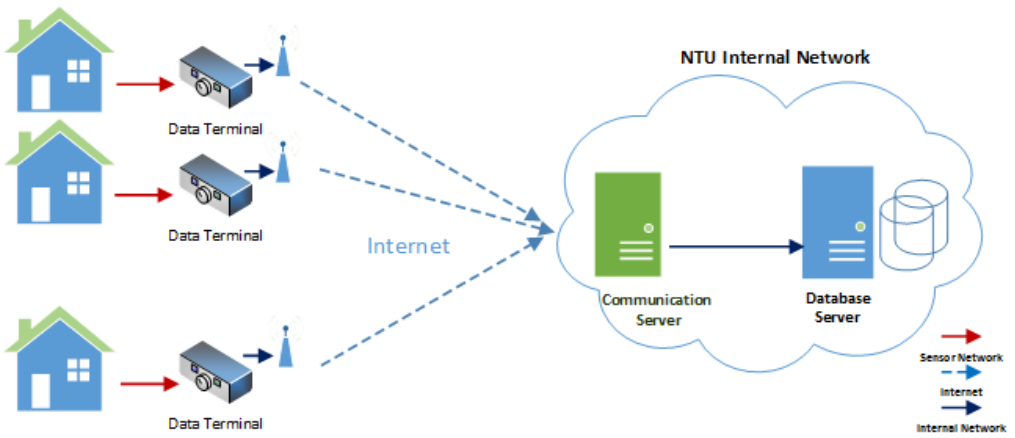
Data capture and display

Architecture



Communication Server

Software: Java, TCP communication

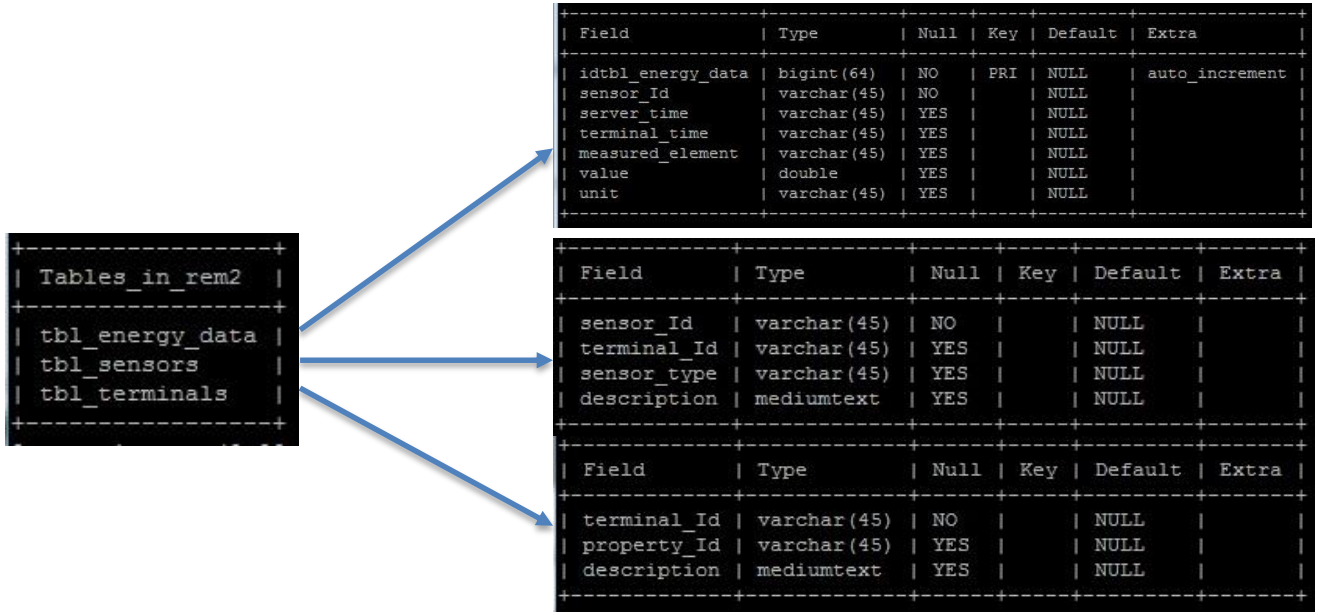
Data Format: JSON, easy to implement and can support multiple technologies (e.g. integration of Enocean and OpenEnergy devices)

{"time_stamp":"14-2-2016 10:41:30", "terminal_id":"215648", "temperature":[{"sensor_id":"536425","value":"23.0"}, {"sensor_id":"536441", "value":"22.0"}], "humidity":[{"sensor_id":"636425", "value":"32"},{"sensor_id":"736441", "value":"29"}], "co2":[{"sensor_id":"736425", "value":"123.0"},{"sensor_id":"836441", "value":"122.0"}], "electricity":[{"sensor_id":"936425", "value":"230"},{"sensor_id":"936441", "value":"220"}], "gas":[{"sensor_id":"136425", "value":"124"},{"sensor_id":"136441", "value":"122"}]}

Responsiveness and Tests: availability and efficiency of the communication software has been tested with a multi-threaded client software which simulate the access to the server from all data acquisition system at the same time (the worst case scenario).

Database Server

Data Structure



```
+------------------+
| Tables_in_rem2   |
+------------------+
| tbl_energy_data  |
| tbl_sensors      |
| tbl_terminals    |
+------------------+
```

```
+------------------+-------------+------+-----+---------+----------------+
| Field            | Type        | Null | Key | Default | Extra          |
+------------------+-------------+------+-----+---------+----------------+
| idtbl_energy_data | bigint(64)  | NO   | PRI | NULL    | auto_increment |
| sensor_Id        | varchar(45) | NO   |     | NULL    |                |
| server_time      | varchar(45) | YES  |     | NULL    |                |
| terminal_time    | varchar(45) | YES  |     | NULL    |                |
| measured_element | varchar(45) | YES  |     | NULL    |                |
| value            | double      | YES  |     | NULL    |                |
| unit             | varchar(45) | YES  |     | NULL    |                |
+------------------+-------------+------+-----+---------+----------------+
```

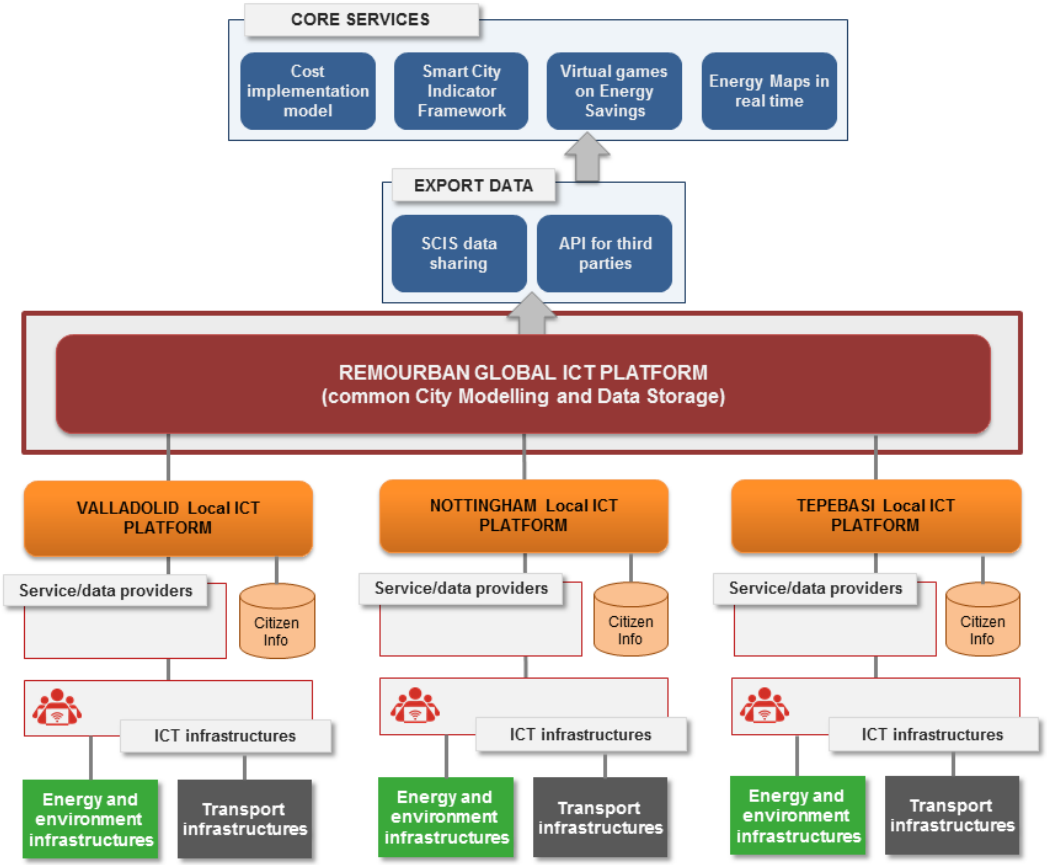
```
+-------------+-------------+------+-----+---------+-------+
| Field       | Type        | Null | Key | Default | Extra |
+-------------+-------------+------+-----+---------+-------+
| sensor_Id   | varchar(45) | NO   |     | NULL    |       |
| terminal_Id | varchar(45) | YES  |     | NULL    |       |
| sensor_type | varchar(45) | YES  |     | NULL    |       |
| description | mediumtext  | YES  |     | NULL    |       |
+-------------+-------------+------+-----+---------+-------+
```

```
+-------------+-------------+------+-----+---------+-------+
| Field       | Type        | Null | Key | Default | Extra |
+-------------+-------------+------+-----+---------+-------+
| terminal_Id | varchar(45) | NO   |     | NULL    |       |
| property_Id | varchar(45) | YES  |     | NULL    |       |
| description | mediumtext  | YES  |     | NULL    |       |
+-------------+-------------+------+-----+---------+-------+
```

Data Security and Backup

- The database is only internally accessible and the administrator should grant permission for even internal users.
- An IP based HDD is purchased and will be used as a backup for the main database.

Smart Control and Monitoring System



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Intelligent Energy Mapping Tool

Building/District energy

Transport energy

Building/District energy control/management

District/city energy control/management

Citizen and authorities view of the energy mapping tool[2].

Summary

- The REMOURBAN project provides the opportunity to set up the first substantial Low Temperature District Heating scheme in the UK.
- Intelligent control will be embedded in all LTDH associated stages, from generation and distribution to substation and end-user metering.
- A ‘top-up’ shortcut from the primary flow mains of the existing DH connection will be included to act as a temperature boost for the supply water to mitigate the risk of flow water temperature being below the required level.
- The LTDH at Nottingham demo site will prioritise the end users’ demand, such as what thermal comfort they need, and aims to find the most economical way to satisfy these needs through energy sourced from waste heat.

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Questions ?

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