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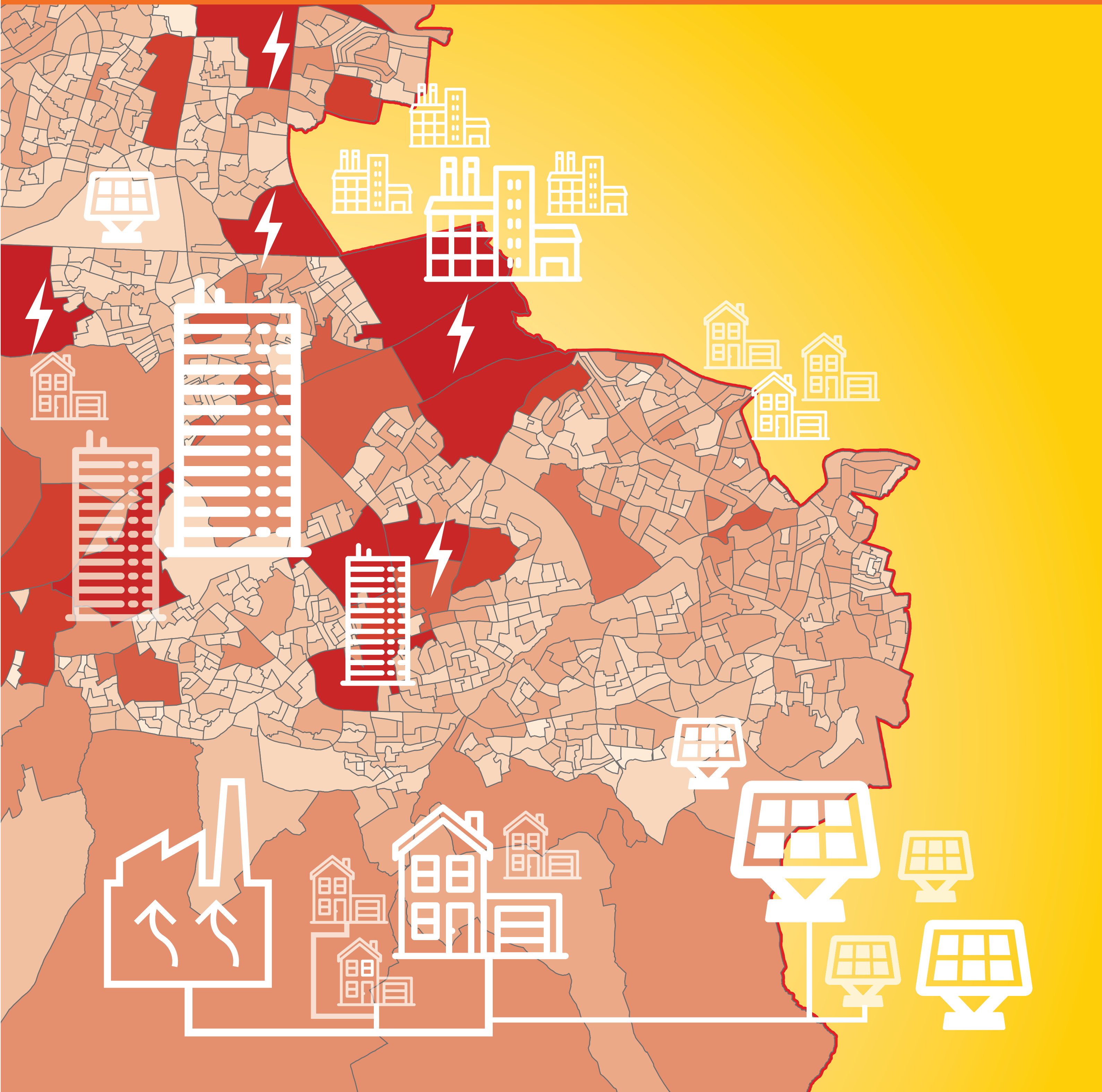
South Dublin Spatial Energy Demand Analysis



South Dublin Spatial Energy Demand Analysis

Report prepared in association with South Dublin County Council by Codema.

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Glossary of Terms

SEDA – Spatial Energy Demand Analysis
BER – Building Energy Rating
CSO – Central Statistics Office
SEAP – Sustainable Energy Action Plan
SDC – South Dublin County
SDCC – South Dublin County Council
DH – District Heating
kWh – Kilowatt-hour
MWh – Megawatt-hour (1kWh $*10^3$)
GWh – Gigawatt-hour (1kWh $*10^6$)
TWh – Terawatt-hour (1kWh $*10^9$)
TJ – Terajoule
CHP – Combined Heat and Power
km – Kilometre
PV – Photovoltaic
RE – Renewable Energy
HH – Household

Executive Summary

To combat the effects of climate change, to reverse the dependency on imported fossil fuels and to reduce energy costs across all sectors, South Dublin County aims to respond in a way that prioritises and unlocks local low carbon and renewable energy opportunities, in partnership with all stakeholders, to 2022 and beyond.

The Opportunity

South Dublin County Council acknowledges that strengthening climate change resilience, reducing energy consumption and finding alternative, non-polluting and renewable sources for energy provision across sectors, are a priority in order to respond to EU and national energy targets to 2020 and beyond. It is clear that continued growth across South Dublin County will require a reliable, robust and efficient energy system to power homes, business and transport needs, over the life of the South Dublin County Council Development Plan 2016 – 2022 and beyond. The County aspires to becoming as carbon neutral as possible and make every effort to increase energy efficiency and unlock renewable energy potential. As such, there is a recognised need to build on County Development Plan energy policies, focusing on evidence based and spatially appropriate policies, objectives and actions.

In partnership with Codema, Dublin's Energy Agency, the Council has undertaken a countywide Spatial Energy Demand Analysis (SEDA), informing the South Dublin County Council Development Plan 2016-2022. By carrying out a SEDA the Council aims to facilitate an enhanced spatial understanding of energy needs, and energy efficiency and renewable energy responses, which vary across sectors, settlement areas, land uses and the built environment.

Objectives of the South Dublin SEDA

An integrated approach to spatial planning and energy allows Planners, local authority staff and other stakeholders to make more informed policy decisions relating to energy efficiency and renewable energy alternatives, whilst also generating an increased evidence base to inform further project feasibility and implementation, and also foster greater public acceptance of energy infrastructure projects.

Key objectives of the South Dublin Spatial Energy Demand Analysis are:

- To develop a closer link between European and National energy policy and spatial planning for sustainable energy provision,
- To base energy planning policies and objectives on a spatial understanding of the existing and future energy profiles of South Dublin County,
- To promote the generation and supply of low carbon and renewable energy alternatives, having regard to the opportunities offered by the settlement hierarchy of the County, the variety of land uses present and the built environment,
- To educate local authorities, public and private sector organisations and energy stakeholders on energy responses that are most relevant to South Dublin County,
- To stimulate the development of a regional methodology for spatial energy demand analysis, energy mapping and energy planning policy development,

- To encourage greater local authority involvement and leadership in the roll out of energy efficiency and low carbon and renewable energy projects in partnership with other stakeholders, and
- To inform EU supported energy projects and the Covenant of Mayors initiative.

South Dublin County Energy Baseline 2014

The energy data for the commercial, residential and municipal sectors, collated under the EU Covenant of Mayors and Sustainable Energy Action Plan (SEAP) 2013 methodologies, has been further progressed and refined to generate County scale tabulations and maps representing a range of energy information, including energy demand, heat density and costs across sectors. A range of data sources have been used to undertake this study, including Central Statistics Office (CSO), Valuation Office, Sustainable Energy Authority of Ireland (SEAI), Building Energy Rating (BER) datasets, and energy data relating to South Dublin County Council owned buildings, facilities and operations. A summary of the annual South Dublin County energy profile using 2014 as the baseline year is shown in Table 1.

Table 1: 2014 South Dublin County Energy Profile and Estimated Costs

Sector	2014 Energy Demand	Estimated Costs
Residential	1.94 TWh	€161 million
Commercial	1.73 TWh	€174 million
Municipal	0.01 TWh	€2 million
Total	3.68 TWh	€337 million

The SEDA has used the County Development Plan Core Strategy projections to generate assumptions on the energy profile of South Dublin County into the future. The SEDA has calculated that even though new homes in the County will be built to higher Building Energy Ratings (BER) standards reflecting changes in national Building Regulations, this sector still has the potential to generate an additional 0.4 TWh by 2022 under the lifetime of the Development Plan. By reviewing past job/population ratio splits for the County and using Core Strategy population projections to 2022, it is estimated that the commercial sector could generate an additional 0.5 TWh of energy demand by 2022.

The Outputs of the South Dublin SEDA

The CSO Small Areas have been used as the geographical boundaries to spatially represent the County's energy profile across the commercial, residential and municipal sectors. This has resulted in a detailed level of analysis which can be refined for further studies and planning strategies stemming from the County Development Plan and other local initiatives.

The SEDA reveals that there is potential for the development of decentralised, local district heating networks and also a range of on-site / in-house low carbon and renewable energy alternatives to address the energy needs of the various sectors operating in South Dublin County, in particular commercial and industrial uses. The SEDA analysis of the residential sector reveals a diverse energy profile spanning homes built over the past one hundred years, in both the rural and urban environments.

The energy profile tabulations have been spatially represented in a variety of County scale maps. Energy Demand maps show the overall energy consumption for each small area (heat and electricity) and is represented in megawatt hours (MWh). Given the high presence of commercial, industrial and municipal operations across the County, a further spatial analysis shows the location and energy demand of these premises, resulting in a finer level of detail for comparative purposes. For premises with high energy demands, the SEDA identifies a range of on-site / in house solutions, such as waste heat utilisation and locally based renewable energy opportunities, for example solar, geothermal, hydro-electricity and small scale combined heat and power (CHP) plants.

To identify areas of potential for low carbon district heating, a heat density analysis has been undertaken. Heat density, measured in terajoules per square kilometre (TJ/km^2), is the amount of thermal energy used within a defined area and is an indicator for the economic viability of district heating schemes. The viability of schemes is increased when buildings are closer together and where 'anchor loads' with high levels of energy consumption are present (i.e. twenty four hour loads). In South Dublin County, Low Carbon District Heating Areas of Potential with an identified heat density above 250 TJ/km^2 are identified as areas of priority.

The analysis of the residential sector reveals that approximately 56% of Building Energy Ratings (BERs) are D1 or lower. Furthermore, 66% of all semi-detached housing is rated D1 or lower, 46% of terraced dwellings and 60% of detached dwellings are rated D1 or lower. Terraced housing and apartments make up the majority of A and B BERs, with the majority of A and B rated homes built from 2006 onwards. F and G ratings are dominated by dwellings constructed in the period 1919-1970, and are identified as high priority in terms of planning for energy efficiency upgrades to increase the BER ratings of these homes and reduce the risk of fuel poverty.

Integrating spatial planning and energy

The South Dublin SEDA represents a robust basis to inform the energy policies, objectives and actions for the South Dublin County Council Development Plan 2016-2022 and other local plans and strategies. The SEDA highlights energy efficiency and renewable energy alternatives that should be further explored in the context of the location of the County (within the Dublin Region) and the variety of the sectors, built environment and land uses present.

This SEDA is the first of its kind to be prepared by a local authority in Ireland and marks a significant step in integrating spatial planning and planning for energy alternatives. By utilising and advancing the Sustainable Energy Action Plan and Covenant of Mayors methodologies, it also points towards the development of a regional methodology and approach to energy demand analysis and broadening the local canvas for planning for renewable energy, across local authority boundaries.

By compiling a detailed local energy analysis the SEDA facilitates the opportunity for further local level analysis. Detailed case studies could be carried out to ascertain the technical and economic feasibility of a range of measures in consideration of EU and National policy, technology advances, whilst also fostering increased local and community ownership of energy projects.

Anthony McNamara

Executive Planner, South Dublin County Council

Introduction

The following report has been produced by Codema on behalf of South Dublin County Council (SDCC) and outlines the process and results of the Spatial Energy Demand Analysis (SEDA). This analysis, conducted jointly by Codema and SDCC, is Phase 1 of a two phase study, currently funded through the SEAI. This first phase analysis focuses on calculating current and predicted future energy demand in the South Dublin County area and placing this data within a spatial context. This mapping process provides a visualisation of areas of high energy consumption, heat demand density and approximate associated energy costs across the county. This SEDA is the first of its kind to be developed in Ireland and is seen as the next logical step to follow on from SDCC's Sustainable Energy Action Plan (SEAP). The results of the SEDA aim to help integrate energy issues with spatial planning and will greatly benefit energy related project planning processes.

Context

Climate Change and Fossil Fuels

Climate change is widely recognised as an issue of increasing significance to the global environment. According to a recent publication co-authored by the UK's Royal Society and the US National Academy of Sciences, '*Climate Change: Evidence & Causes*', the speed of global warming is now 10 times faster than it was at the end of the last ice age, with the last 30 years being the warmest in 800 years (The Royal Society & The US National Academy of Sciences, 2014). The scientists involved have also come to the conclusion that the latest changes in our climate are "almost certainly due to emissions of greenhouse gases caused by human activities" (The Royal Society & The US National Academy of Sciences, 2014, p. B9). This publication is just one of many evidence and research-based papers from all around the world which have made it impossible to deny that Green-House Gases (GHGs) are responsible for climate change and it is imperative to act now in order to curtail the irreversible damage caused by these emissions.

Fossil fuel use is responsible for over half of all GHG emissions globally, and the majority of these emissions come from energy supply, transport, residential and commercial buildings and industry (IPCC, 2007). Reducing energy consumption and finding alternative, non-polluting, and renewable energy sources (RES) for energy provision and transport are the more prominent issues targeted by national and international policies in order to reduce CO_2 contributions.

The significance of Dublin and South Dublin County in the Irish economic landscape means it is imperative to plan and commit to energy saving and CO_2 reduction through multi-level governance structures and local level action. As well as climate change mitigation, there are many significant knock-on benefits to reducing CO_2 levels and implementing more renewable energy in the County, including reduced health effects, decreased fossil fuel dependence, higher security of supply, lower energy costs, increased energy price stability, increased economic competitiveness and a sustainable economy.

The Need for Integrated Energy and Spatial Planning

The increasing need for society to change from the current dependency on fossil fuels to increasing integration of renewable resources to meet energy and material demand means that space is now a fundamental asset for energy production. This is due to the fact that renewable energy is an area-dependent resource, e.g. space and suitability of land for bio-fuel crops, for wind farms, for solar energy, or for hydro-power. (Stoeglehner, Niemetz, & Kettl, 2011).

The feasibility of District Heating (DH) and Combined Heat and Power (CHP) is dependent on many spatial and urban planning related factors such as heat demand density and zoning of building uses. These facts demonstrate the inseparable nature of spatial planning and energy planning.

In order for planners to evaluate the feasibility of integrating a range of renewable energy resources, they will need to have a SEDA to locate where the large energy demands are, what type of energy is required in these locations, i.e. heat, electricity, gas, etc., the areas susceptible to energy poverty due to high energy costs, and areas of high fossil fuel use.

Economic development in Dublin has been, so far, driven mainly by resources that have no immediate geographic link to the area exposed to planning. The fossil fuels and electricity that will be used during the lifetime of a development have, in most cases, no influence on its location as it can be simply connected by pipe or cable to some far-off location. In this way, spatial planning is not currently linked to energy resource management. The planning system now faces the new challenge of taking account of, and creating balance between; designing cities to reduce energy demand, retaining sufficient space for sustainable energy production, and providing energy from local resources, while also evaluating environmental considerations.

Benefits of Local Level Energy Planning

Traditionally in Ireland energy planning is implemented at the national level and not addressed within local or regional level planning structures. Because of this, local authorities do not have the knowledge or autonomy to make strategic decisions on how energy will be provided in their district. Also, due to the fact the national policies on energy are specifically designed to address energy use from a national level perspective, it can be hard for local authorities to fully address energy consumption due to the structure of the national policy framework, and the lack of autonomy and flexibility conferred upon them in the energy sector (Sperling, Hvelplund, & Mathiesen, 2011) (Chittum & Ostergaard, 2014).

In contrast, local level energy planning is routine in many other European countries, in particular Denmark, Sweden and recently re-municipalised areas in Germany. Denmark first introduced laws requiring local level energy planning in 1979 and this regulatory framework has been credited with creating the base for the sustainable growth Denmark has seen in the years since. These laws required municipalities to conduct analyses of their local heating requirements and the available heat sources, and municipalities were also made responsible for assessing future heating needs and supplies and planning around these. In the 1980s the government introduced laws to ensure that all energy projects had to be assessed taking account of the full socio-economic costs and benefits, and based on this, municipalities should only pursue projects which show a high level of socio-economic benefits (Chittum & Ostergaard, 2014).

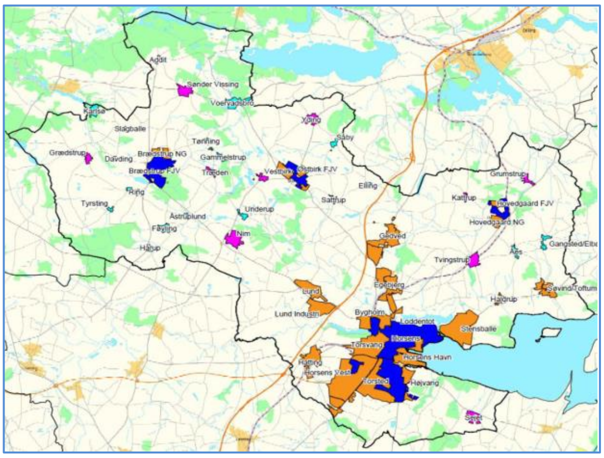
These laws resulted in high levels of locally produced heat and electricity in the form of Combined Heat and Power (CHP) and DH systems with integrated renewable energy sources. Today, around two thirds of Danish electricity is cogenerated with heat, and heat is supplied through DH systems to 60% of Danish households. Studies have shown that this increased use of CHP and DH has reduced overall nationwide emissions by 20%, and reduced CO_2 emissions in the heating sector by 60%. There is currently 386,234 m^2 of solar heating being used in municipal DH projects, along with other sustainable sources such as biomass and waste heat. The use of local energy planning in Denmark has reduced energy costs to consumers, enabled higher integration of renewable energy, reduced energy demand and reduced the overall impact on the environment.

Spatial Energy Demand Analysis as a tool for Energy Planning

Energy mapping resources are used by energy planners in local authorities throughout Europe and are often referred to as the first step in the energy planning process. It is the foundation for planning for current and future predicted energy consumption at a local level. It allows the planner to define 'energy character areas' based on the estimated energy demand and supply characteristics and the RE potential of that area.

The energy map shown in Figure 1 is an example of a SEDA from a Danish municipality, and shows areas within the region which are colour coded according to heat demand density and fuel type used. This map is then used by the municipality's energy planners to decide which areas are most suitable for DH or individual heating solutions such as heat pumps or solar thermal. This SDCC SEDA analysis uses similar methodologies for mapping energy demands as those that are typically used in Danish energy planning.

Figure 1: Heat Map of Municipal Region in Denmark



Once this initial step is complete, deeper techno-economic analysis and energy system modelling of an identified energy character area allows the planner to judge if the area is technically and economically feasible to implement the recommended sustainable energy solutions.

Energy Planning in South Dublin County

SDCC has already gained significant expertise in the area of cross-departmental energy planning through participation in the EU Intelligent Energy Europe funded Leadership for Energy and Action Planning (LEAP) and the currently ongoing Spatial Planning and Energy for Communities in All Landscapes (SPECIAL) project. The LEAP project enabled SDCC to produce its first Sustainable Energy Action Plan (SEAP) in 2013, which has allowed SDCC to take account of all the energy consumption within the county, to set energy reduction targets to 2020, and to establish a range of actions across all sectors which will help the region reach these targets. For more information on the LEAP project, go to http://leap-eu.org/.

SDCC is currently working with the Irish Planning Institute on the SPECIAL project, which aims to up-skill planners across Ireland in order to create higher levels of integration between planning and energy at a local level. This Spatial Energy Demand Analysis fits well with the aims of the SPECIAL project as it provides the SDCC planners with an evidence based tool for integrating energy planning into the normal planning process and the county development plans, and deliver sustainable energy solutions. For more information on SPECIAL, please go to http://www.special-eu.org/.

Relating Policy

EU Policy

The European Union (EU) has put in place a framework for energy for all member states called the *'2020 Climate and Energy Package'.* This set binding legislation for all member states so that the EU as a whole will achieve 20% GHG emission reductions, 20% energy produced by renewable resources, and 20% increase in energy efficiency by 2020. From this overarching EU climate and energy package, there are directives which set specific targets for renewable energy for each member state and outline the measures to be put in place for energy efficiency.

The EU Energy Efficiency Directive 2012/27/EU, and Renewable Energy Directive 2009/28/EC have resulted in national level energy action plans in each area respectively. In terms of the Renewable Energy Directive, Ireland has been set a target of 16% of all non-Emission Trading Scheme (ETS) energy consumption to come from Renewable Energy Sources (RES) by 2020, the sectorial split being 40% electricity, 12% heat and 10% transport energy. Latest figures (2013 energy figures) show Ireland's renewable energy in electricity is at 20.9% of gross electricity consumption, renewable heat is at 5.7%, and renewables in transport at 4.9%, therefore Ireland is approximately half-way toward 2020 targets with 5 years left to improve. This SEDA aims to increase the use of renewables at a local level in order to contribute towards overall national level targets.

Although there are no binding targets for energy efficiency, there are binding obligations on each member state. Of particular relevance to this regional level SEDA, Article 14 of the Energy Efficiency Directive on the 'Promotion of efficiency in heating and cooling' states:

"Member States shall adopt policies which encourage the due taking into account at local and regional levels of the potential of using efficient heating and cooling systems, in particular those using high-efficiency cogeneration. Account shall

be taken of the potential for developing local and regional heat markets."

The SEDA will help to identify the most appropriate sustainable energy solutions for heating the current and future building stock in South County Dublin.

In October 2014, in light of there being no clear framework post-2020 targets, the EU put in place a new '*2030 Framework for Climate and Energy policies'* which has set a 40% GHG reduction on 1990 GHG levels, and an EU-wide target of 27% for renewable energy and energy savings by 2030. There are no specific targets set for each member state under this new framework.

This SEDA will also allow SDCC to stay on top of energy issues in its region and help to future-proof the county for new energy legislation past 2020. The near future will see new policies and directives as a result of the EU's 'Energy Union' proposals and the results of the UN Climate Conference in Paris in December 2015.

National and Regional Level Policy

The National Renewable Energy Action Plan (NREAP) and National Energy Efficiency Action Plan (NEEAP) are a direct result of the overarching EU Directives previously discussed. These outline how Ireland intends to implement the energy efficiency and renewable energy targets set by the European Commission. This SEDA aims to help fulfil the goals of the NREAP and NEEAP by developing renewable energy and energy efficiency at a local and regional level within South County Dublin, and develop strategic energy action plans specifically tailored to the energy characteristics of the area.

A Green Paper on Energy Policy in Ireland was published in May 2014 in preparation for the White Paper version to be finalised in 2015. The Green Paper addresses five priorities relating to Energy Policy;

- Empowering Energy Citizens,
- Markets, Regulation and Prices,
- Planning and Implementing Essential Energy Infrastructure,
- Ensuring a Balanced and Secure Energy Mix,
- Putting the Energy System on a Sustainable Pathway.

The SEDA will help to address the priorities surrounding planning essential energy infrastructure and creating a more sustainable energy system within the South Dublin region. The SEDA allows SDCC to take some control and have some influence over the energy used within the region, which can now be used as a bottom up approach to meeting the new Energy Policy priorities.

The Regional Planning Guidelines for the Greater Dublin Area (GDA) 2010-2022 provides planning guidance on economic, infrastructure and settlement policies for the GDA which includes SDC. These guidelines specifically support the implementation of local level energy action plans, and also suggest they "… *should be presented in a spatially geographic manner where possible in order to provide an extended evidence base in the decision making process."*

This SEDA will fulfil these suggestions under the Regional Planning Guidelines, and SDCC will be the first local authority to do so, which will pave the way for other local authorities to follow suit.

Energy Use in South Dublin County

Due to the new methodologies and updated data used for calculating energy demand in this analysis since the SEAP was developed, it is possible to calculate the total energy demand in all buildings in South Dublin County and show some statistics on where and how this energy is being used.

Table 2: Total Energy Demand & Estimated Costs in all Buildings in South County Dublin (2014)

Sector	Total Energy Demand TWh	Total Heat Demand TWh	Total Estimated Costs Millions €
Residential	1.94	1.70	161.89
Commercial	1.73	0.99	174.45
Municipal	0.01	0.006	2.40
Total	3.68	2.70	338.74

The residential sector analysis provides the most detailed results due to the detailed data sources used. From the application of actual BER data, it is possible to produce a graph of estimated BER ratings for the entire housing stock in the SDC region. The graph in Figure 2 shows the number of dwellings in each BER rating according to the type of dwelling. Just over half of all dwellings in SDC are semi-detached type housing which can be seen by the high representation in the graph. 66% of this housing type have BERs of D1 or lower, and only 4% have a rating of B3 or higher. Semi-detached housing also makes up the majority of the very poor E, F and G ratings. Semi-detached housing has the worst energy ratings of all four housing types in SDC, which can in part be explained by the period in which these dwellings were built. Figure 3 shows the dwelling types by period built. As can be seen, the majority of semi-detached housing was built pre-1990. The period built has an effect on energy ratings due to building material changes and regulatory changes, with newer housing meeting higher standards.

The second most common housing type is terraced housing, which make up just over a quarter of all housing types. Terraced housing units score better than semi-detached units, with 46% having BERs of D1 or lower. Apartments score best with only 37% of ratings D1 or lower, and nearly a quarter of all apartments have ratings of B3 or higher. Again this can be linked to the construction periods of the apartments in SDC, and Figure 3 shows the majority of apartments were built after the year 2000 when higher building energy standards were put in place.

The graph in Figure 4 shows the energy ratings of all SDC housing according to period built. The lower F and G ratings are dominated by buildings constructed in the period 1919-1970.

Figure 2: Number of Dwellings in Each BER Category According to Dwelling Type

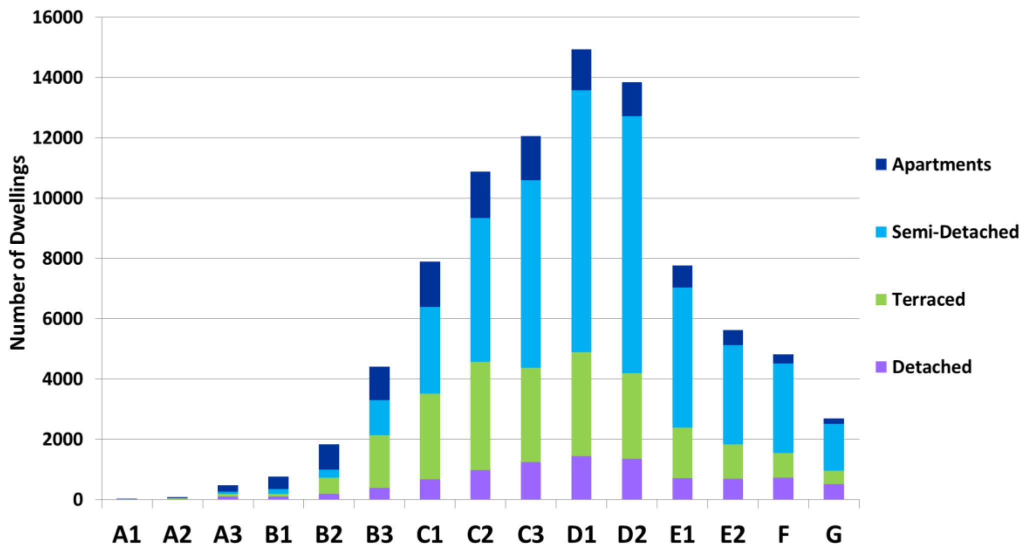


Figure 3: Number of Dwellings According to Dwelling Type and Period Built

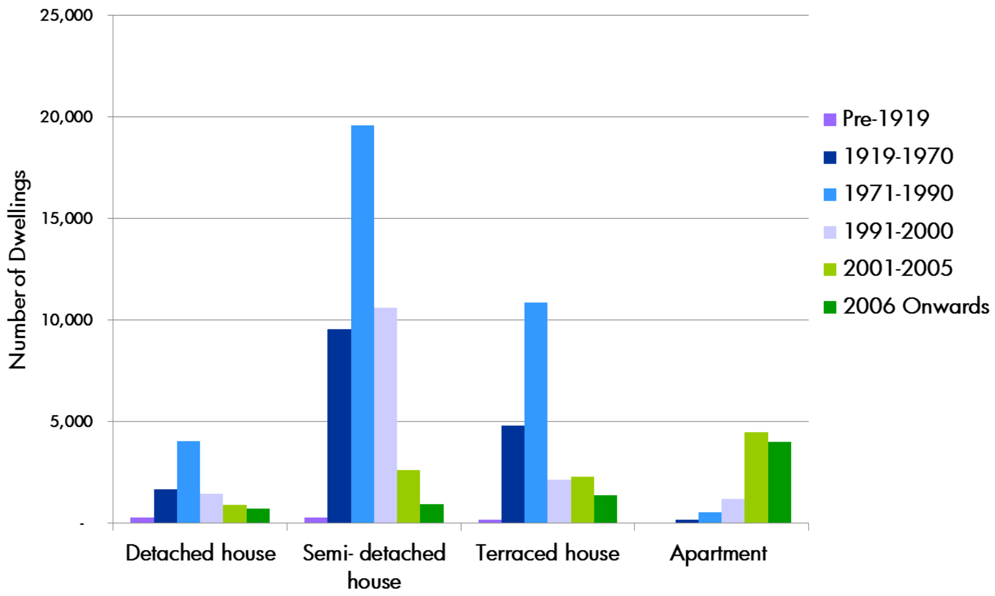
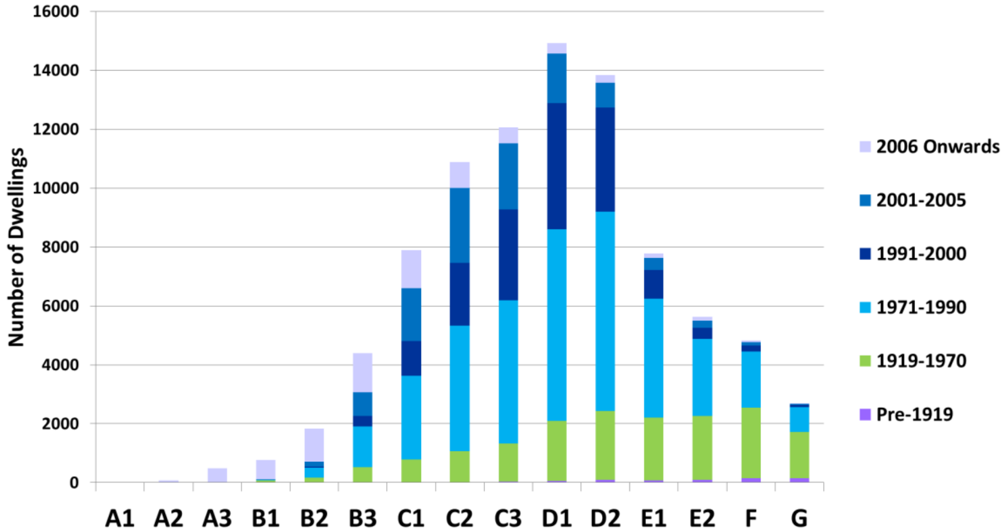


Figure 4: Number of Dwellings in Each BER Category According to Period Built



These housing units should be given first priority in any plans for energy efficiency upgrades in order to move them from the lower ratings up to at least high D or C ratings. This will also help to improve situations for those at risk of energy poverty.

These results help to visualise the current state of energy use in SDC and inform the local authority when creating energy strategies for the region. The following chapter outlines the background methodologies and results of the Spatial Energy Demand Analysis, which places this energy consumption within a spatial context.

Spatial Energy Demand Analysis

Introduction

This section outlines the methods and results of calculating energy consumption in buildings within the South Dublin County (SDC) area. At this time, there is no actual energy consumption data, for example bill or metered consumption, available for every building within SDC, which means that, without going to each individual building and recording energy use, a new methodology needs to be established using the best already available data sources in order to produce a SEDA in Ireland. There is no methodology already established for such a task as this process has never been carried out at a county scale.

From analyses of spatial demand mapping from other countries, and the availability of matching data across all sectors, five main sets of data will be created for the three sectors of Residential, Commercial and Municipal energy use and combined, under the headings of: 1) 'Total Energy Use', 2) 'Total Heat Demand', 3) 'Total Electricity Use', 4) 'Total Fossil Fuel Use', and 5) 'Estimated Total Annual Energy Costs' in each area. This data will help to visualise the areas at risk of energy poverty, areas in need of energy retrofitting and areas which may be suitable for various energy technologies.

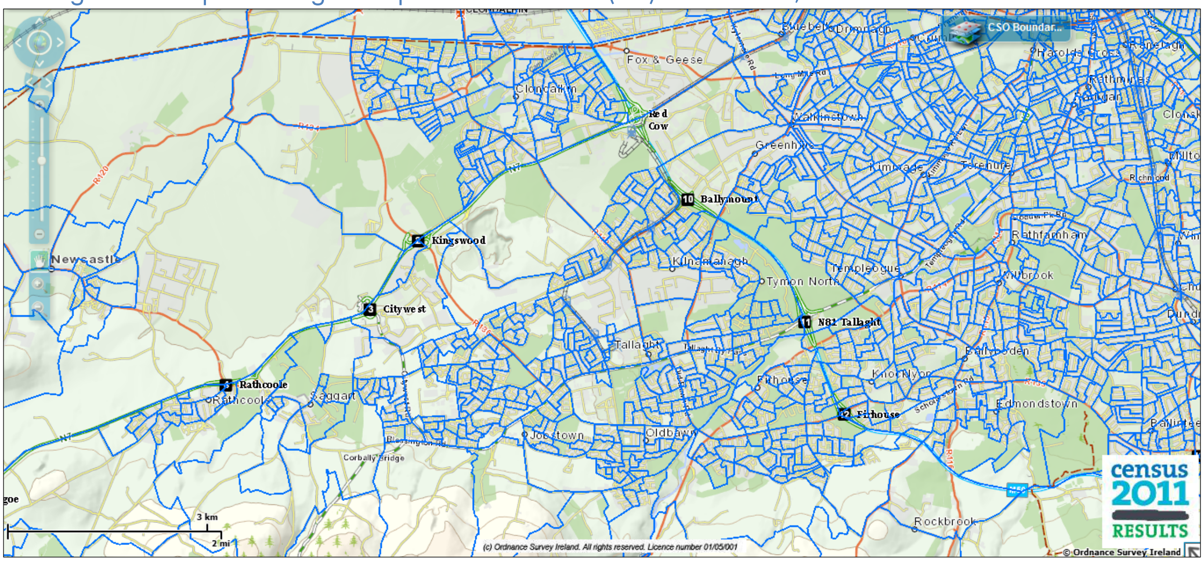
The geographical breakdown of 'Small Areas' are used as the geographical boundaries for spatially visualising the energy data. A Small Area (SA) is an area of population comprising between 50 and 200 dwellings, created for Ordinance Survey Ireland (OSI) and the CSO, and are designed as the lowest level of geography for the compilation of statistics. An example of a map showing the outlines of SAs within SDC can be seen in Figure 5 below. This breakdown is much smaller than the Electoral Divisions, of which there are 49 in SDC, with 906 SAs in total, and this allows the mapping of energy data at the most detailed level available.

District Heating Potential

The energy consumption will also be shown in terms of 'energy density', as the areas mapped vary in size and it is important to compare all on an equal parameter, such as terajoules (TJ) per km^2. Mapping heat density is important as it is a key metric for defining the potential for large scale DH.

DH is a particularly important technology to consider in this case as SDC is an urban/peri-urban area with no coastline, meaning the implementation of many RE technologies such as wind is limited, whereas DH is particularly suited to urban solutions for energy efficiency and can enable higher levels of urban RE integration.

Figure 5: Map Showing Example of Small Area (SA) Breakdown, Source: CSO online SAPMAP



It is also important as heating and cooling are intrinsically local and regional matters, and are often not dealt with effectively at a national level. When municipalities in Denmark carry out heat planning studies, they judge an area to be suitable for DH based on the measurement of heat demand in TJ/km^2, with any areas measuring above $150TJ/km^2$ likely to be economically viable for developing conventional DH systems. In this study, all small areas with heat demand densities above $250TJ/km^2$ will be characterised as suitable for large scale DH systems. The density level is raised in order to narrow the number of potential DH areas due to the fact that DH has not yet been developed at any level in SDC, and a first phase would need to prioritise areas of best potential, and also increasing the minimum density will allow for potential errors in energy estimations.

The density is specifically important for DH economic viability as it becomes cheaper to implement when buildings are closer together due to shorter pipelines requiring less investment costs, and therefore the system becomes more cost-effective than individual solutions (Connolly, et al., 2014). Also, shorter pipelines result in fewer losses and less pumping requirements, which can add significantly to running costs.

With a DH system there is opportunity to supply the heat from one or many sources, which may or may not rely on the location's characteristics. Fuel can be imported in most cases to fuel boilers or CHP units, but will be better placed if close to major road networks for oil or biomass deliveries. Waste heat sources are an ideal input into DH systems as it is a potentially low cost fuel and utilises energy that would otherwise be considered a loss, therefore increasing efficiencies. Large industrial premises often have waste heat resources and such resources should be investigated in the SDC area. Other low cost fuels for DH systems can come from geothermal sources, heat pumps or solar thermal farms which are now common-practice solutions in Danish DH systems. Electric boilers and heat pumps which are smart grid enabled and are timed to switch on/off when electricity prices are low/high can take advantage of low electricity costs and also help to integrate more fluctuating renewable energy on the grid.

Local Electricity Production Potential

In Ireland, it is against regulations to provide what is termed a 'private wire network'. This means that you may not supply electricity to other buildings which are not on the same property as the building which is producing the electricity. This means that, if a building is producing electricity and there is a surplus to what they require to cover their own demand, they must release the surplus electricity through the national grid, or store in some way for their own future use. There are possibilities for large producers to establish contracts and sell this surplus to the grid, but there is currently no electricity supplier offering payments for surplus energy to micro-generation units[1].

Micro-generation is termed as generators rated up to 25 Amps on single-phase systems (most household systems are single-phase) or 16Amps on 3-phase systems (ESB, 2015). This means, when analysing electricity demand of buildings and possible local sustainable solutions to meeting this demand, it will be in terms of individual systems per building rather than in terms of group electricity schemes. This limits the possibilities for technologies such as CHP units as they will be more suited to industrial or large commercial consumers who have large electrical and heating requirements, and who can apply for grid connections, or in large district heating systems where the sale of electricity to the grid can help to offset the costs of heat production.

In terms of individual building renewable electricity solutions, the main technologies used which are at an advanced stage are wind turbines, solar photovoltaic (PV) panels and hydro-power turbines. The potential to use these technologies will depend on the buildings location in terms of space for wind turbines and wind speeds, south-facing roof space and over-shading, and proximity to a suitable hydro source, respectively. Biomass fed CHP units are another alternative to producing renewable electricity, and are not dependent on locational characteristics, as biomass can be imported like any other fuel. Again, biomass CHP units are more suited to commercial or industrial circumstances than households due to high upfront costs and size of demand needed to ensure economic viability.

[1] There was a payment available through application to the ESB for micro-generation, but this scheme ceased in December 2014.

Energy Character Areas

Energy demand mapping is used as a tool in energy planning to define energy character areas. Energy character areas help planners to make evidence based decisions and plans, whether at single-building, community or regional scale. The individual energy characteristics of an area are used to define the appropriate energy solutions or planning policies to be considered.

For example, an area with mature residential dwellings in low density suburbs can often have poor thermal performance and therefore high heat demands per building. In most cases, these areas have little variety of building use and many different building owners, which makes it less favourable for communal energy solutions and more suited to individual micro-generation technologies such as solar thermal and heat pumps.

In contrast, town centres or areas of regeneration which have a high building density made up of old and new buildings with mixed use such as hotels, offices, retail and apartments, are more suited to development of large scale heating and cooling networks. Although there will be numerous building owners and facilities managers involved, these building types are likely to be accustomed to the processes involved in procuring energy services and therefore will be more likely to engage in projects offering energy savings.

Once these areas have been defined as suitable for individual or group energy schemes, the energy character areas can be defined further by overlaying renewable energy potential mapping in order to see which areas are most suitable for development of RE supply. For example, areas suitable for group energy schemes which are located in peripheral semi-rural areas may be situated close to bio-fuel supplies produced within the region, and can therefore agree long term supply contracts with local suppliers and benefit from low transport costs.

It is important to note that the resulting specific energy characteristics of each small area will have a different best-fit energy solution, which may incorporate energy savings and/or a mixture of technologies. There is no one definitive energy solution that is applicable to all areas, and once an area is identified for further investigation it is important that all available solutions are evaluated in terms of socio-economic cost-benefits. The main attributes to consider when assessing the economic feasibility of implementing various energy solutions will be the availability and suitability of low cost renewable sources in the area, the cost to retrofit current energy systems, and the current and predicted future costs of the fuel source being replaced.

All energy data used in this SEDA is based on delivered energy and not primary energy consumption, and therefore losses involved in delivering the energy, i.e. electricity transmission grid losses, are not accounted for.

Spatial energy demand in terms of agricultural land use has not been taken into account due to the lack of energy related data available for the agricultural land in SDC, and the lack of energy benchmarks for the agricultural sector in general.

The following sections in this chapter will first show the overall amalgamated results of energy consumption throughout the SDC area and discuss energy character areas within SDC. This chapter will then go on to outline results and methodologies of each area of energy use, namely residential, commercial and municipal building energy, as the methodologies used for each sector vary.

Total Energy Consumption of All Sectors Combined

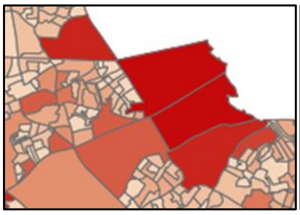
This section will discuss the final results where all energy information for each small area has been combined to give an overall view of the total energy use in each area. The sections following this will then discuss the future energy demand under the time frame of the South Dublin County Council Development Plan 2016-2022, and the methodologies and results of mapping the energy demand in each energy consuming sector separately.

Total Energy Demand and Energy Density

The first map, Figure 8 on the next page, shows the overall energy consumption in each small area. This is the total energy use of all three sectors combined, shown in MWh. The small areas coloured in the four darkest red tones show areas which have consumption above 10,000 MWh. The SAs are all different size areas and therefore the smaller these dark red areas are, the more compact this energy use is. Some of the larger SAs located to the south and west of the county have high energy usage in total, but this energy is spread over a large area, and is not high across the entire SA. To compare, the map in Figure 10 shows the density of the total energy demand in each small area. This then shows the large peripheral SAs which have a large energy demand, but which is spread out over a large area, have low energy demand densities. This map shows all areas in yellow, orange and red have a high energy demand relative to the area size of the SA in kilometres squared.

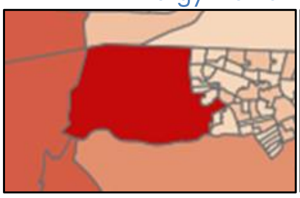
The total energy demand map, Figure 8, shows how much energy is used in each SA, and therefore gives a picture of where in the county the most energy is being used. These areas will have high energy spends, higher emissions and import the highest amount of energy into the region. This map should be analysed in conjunction with the map shown in Figure 9, which shows the location and energy demand of each commercial and municipal building, in order to see why these areas have higher energy demands than others. From a comparison of both maps it is clear to see the areas with high total energy demand have a high number of commercial or municipal energy users and/or some users with very high energy usage per building. As an example, there are four SAs with high energy demands on the border in the north eastern region of SDC, as seen in Figure 6.

Figure 6: High Energy Demand in SAs with High Number of Commercial/Industrial Businesses




From the map showing the commercial and municipal building locations, it is clear these areas have high energy demands due to high number of businesses in those areas. These SAs are home to the Clondalkin, Western, John F. Kennedy, Robinhood and Ballymount Industrial Estates. Most of the areas with high energy use in SDC are high due to the presence of large industrial estates or business parks, such as the Baldonnell, Greenogue, Kingswood, Tallaght and Citywest Business Parks, and the Elmfield, Oakfield, Hibernian and Cookstown Industrial Estates. Grange Castle Business Park, located in the Nangor/Grange area, comprises some of the largest industrial operations in the County; existing uses include pharmaceutical plants, large scale data-centres, a large food processing plant and a few other smaller commercial premises, as seen in Figure 7. Grange Castle Business Park is a high priority in the County as a location for large scale direct investment.

Figure 7: High Energy Demand in SA with High Energy Demand per Business




The next sections will look at the breakdown of this energy use in terms of heat and electricity demands in order to further define best match solutions.

Figure 8: Total Energy Demand (MWh) Map

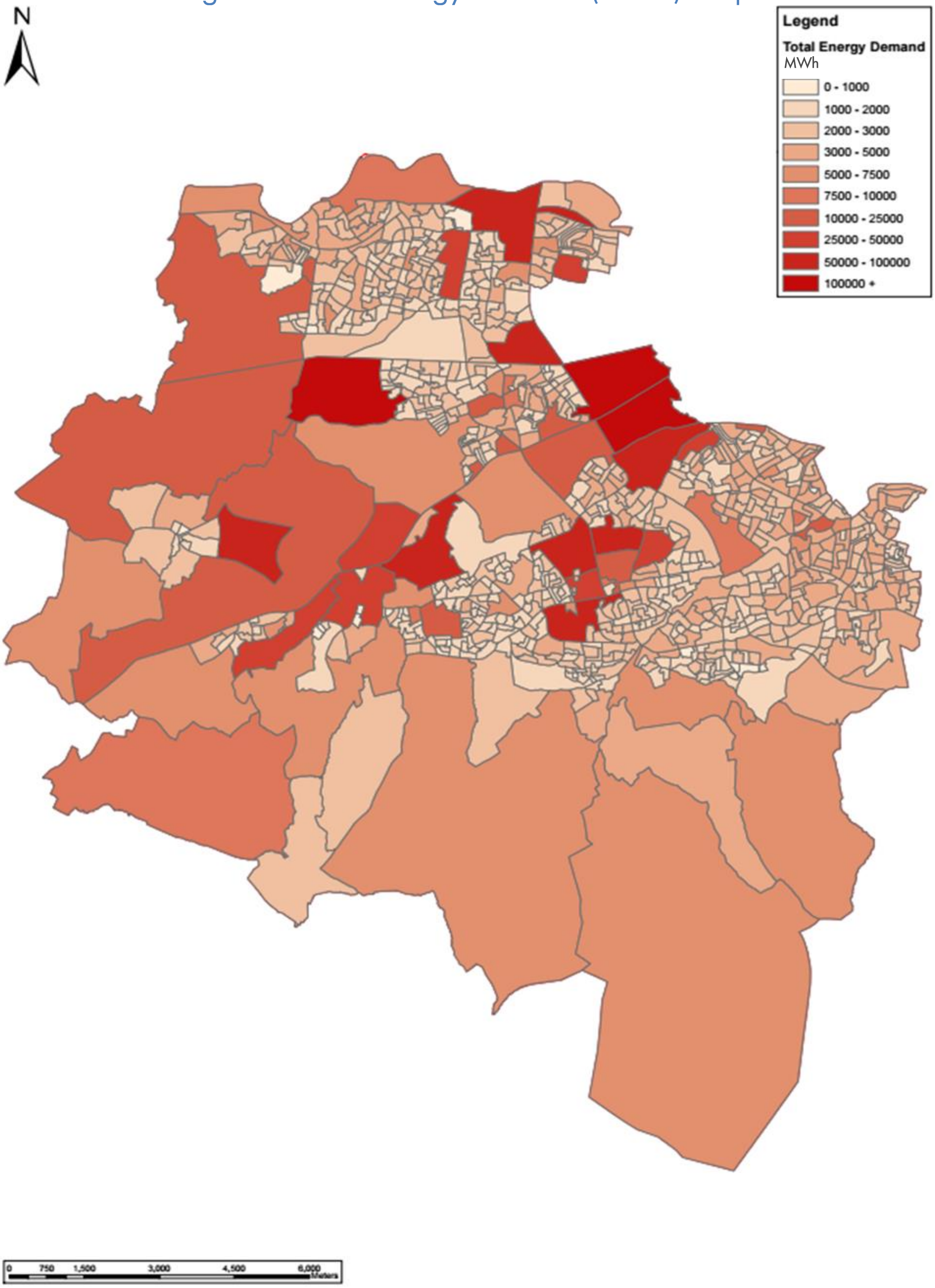


Figure 9: Energy Use (MWh) and Location of Each Commercial and Municipal Building

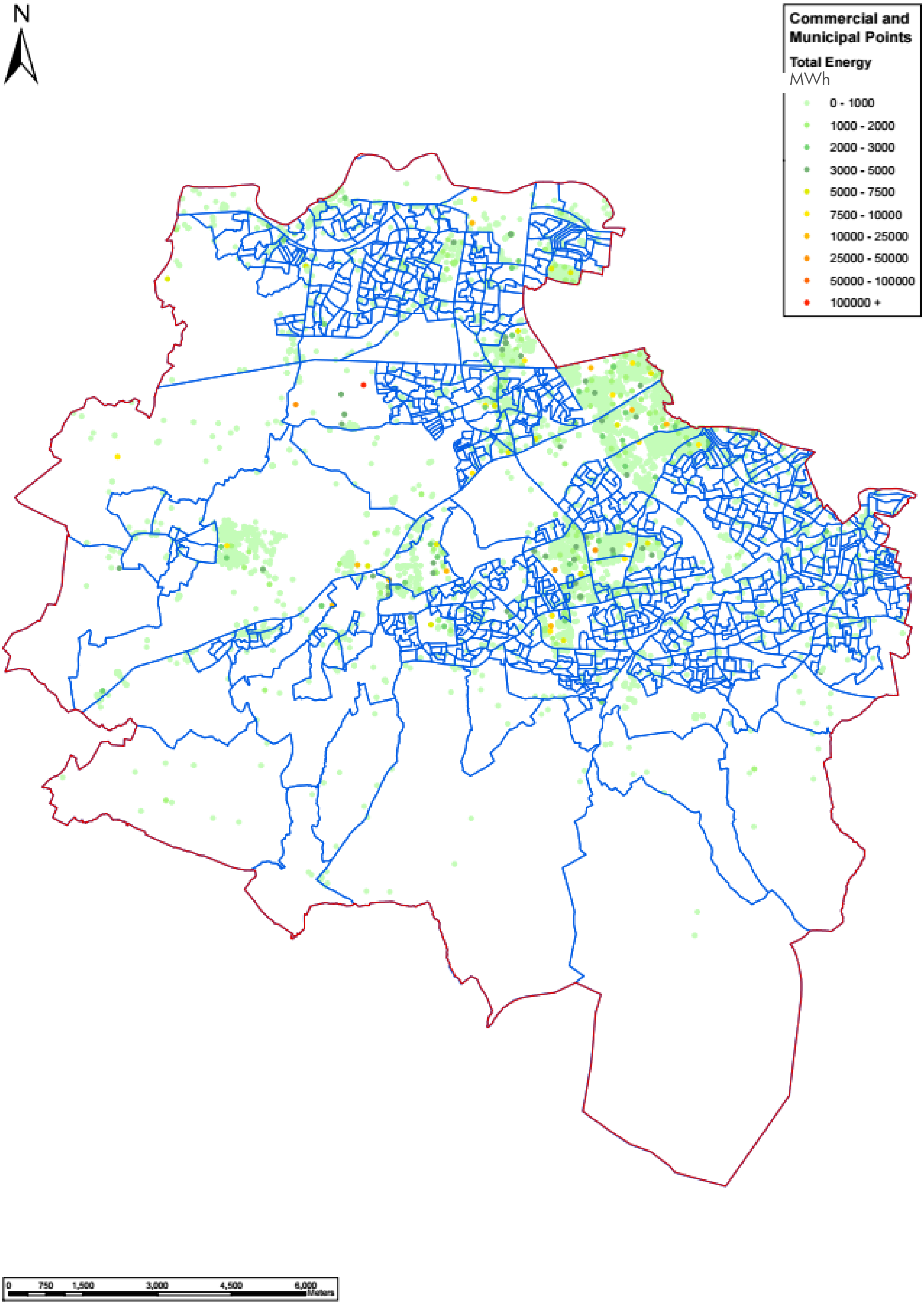


Figure 10: Energy Demand Density (TJ/km^2) Map

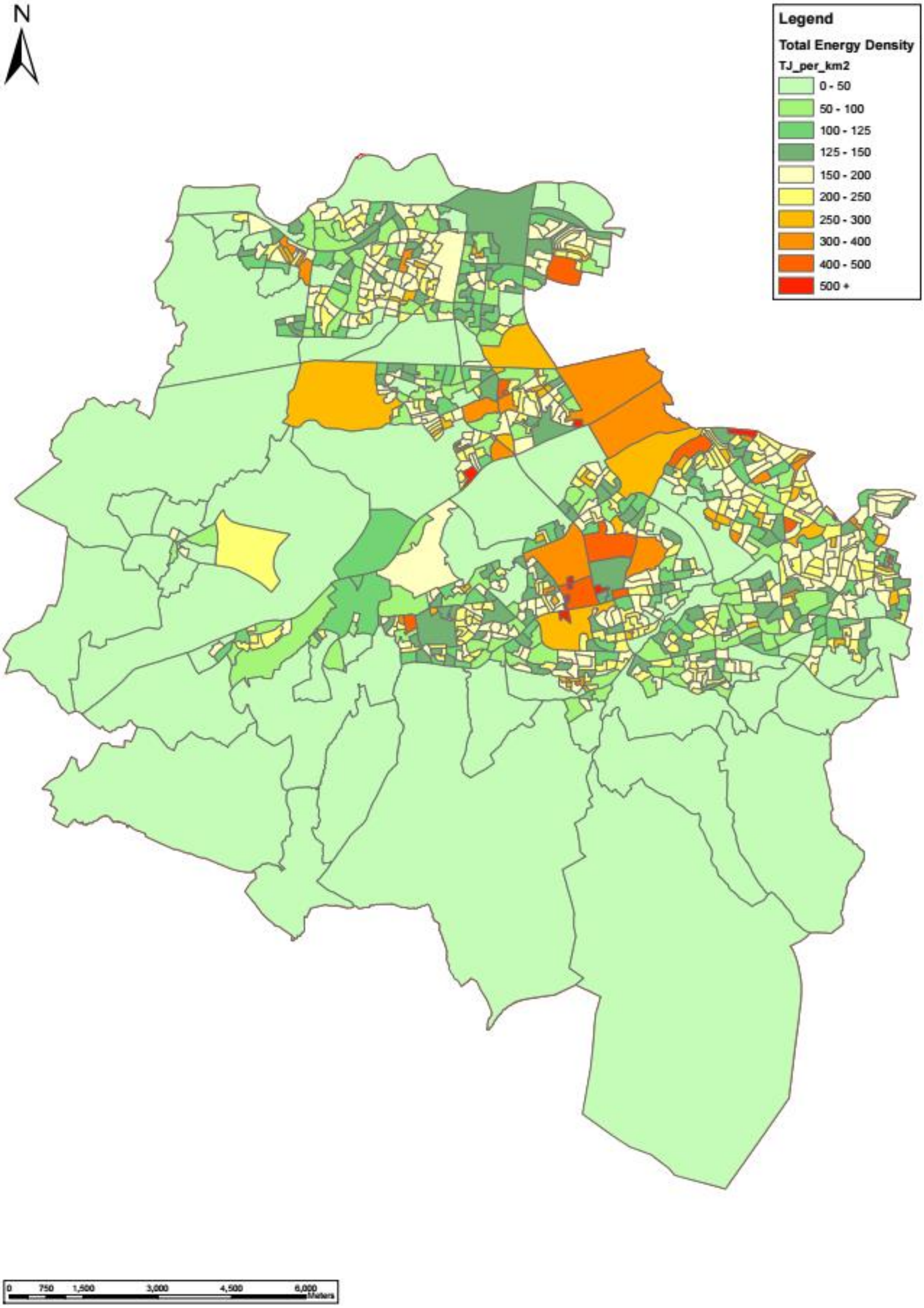
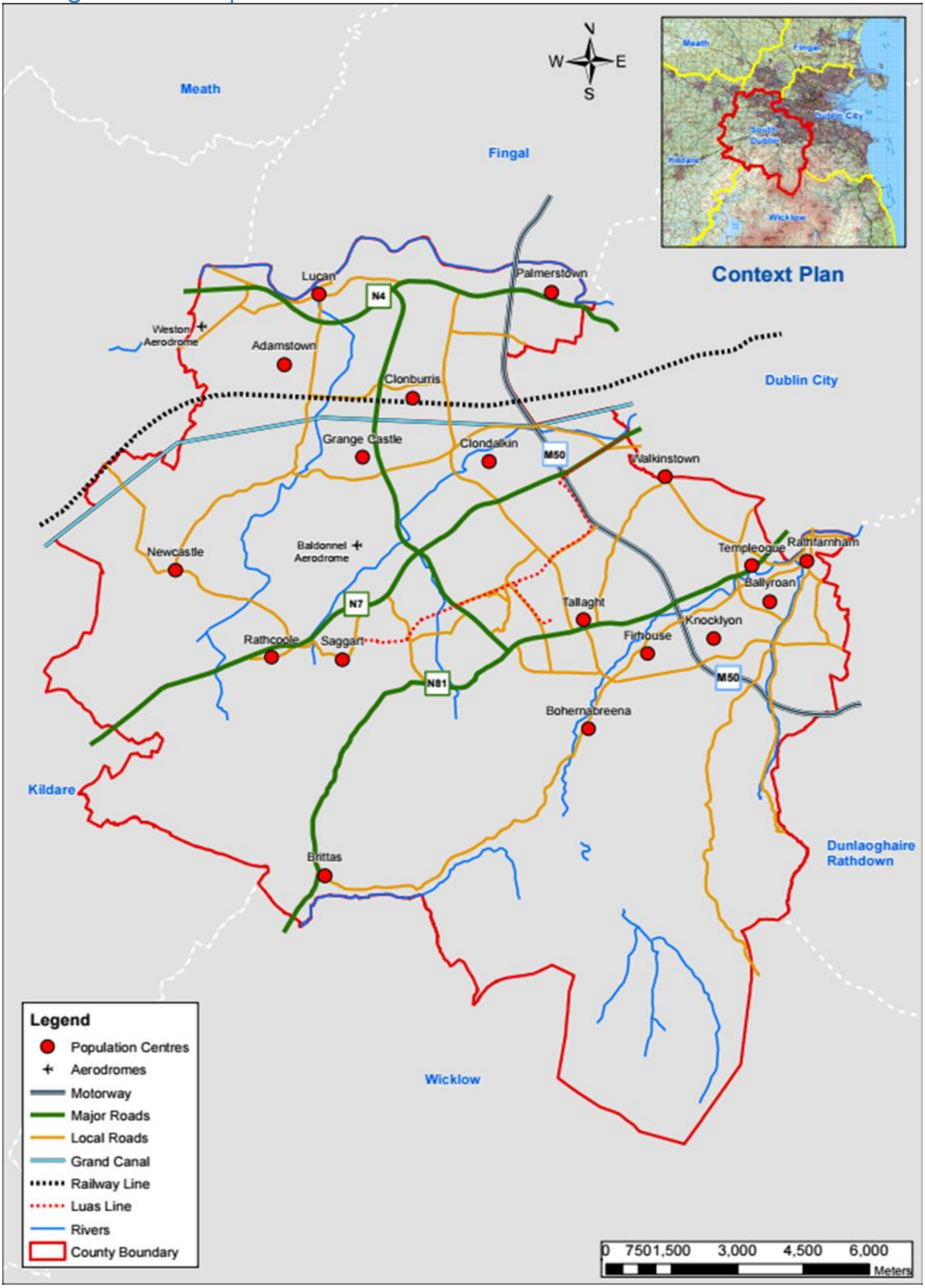


Figure 11: Map of South Dublin with Place-Names & Infrastructure



Heat Demand and Heat Density

In order to identify energy character areas, the total energy demand needs to be analysed in terms of heat and electricity requirements. From a heat density map, it is possible to identify areas which are more suited to district level heating systems, or are more suited to individual heating solutions. As discussed in the introduction to this chapter, the metric generally used to establish initial feasibility of DH systems is any heat density >150TJ/km2, these areas can be seen in Figure 13. In the case of SDC, anything above 250TJ/km^2 will be used to establish the best suited areas for large scale DH systems in order to concentrate initial development of DH in priority areas. The top ten areas according to heat demand density are the areas shown on the map in Figure 14 (page 27) marked with a red dot.

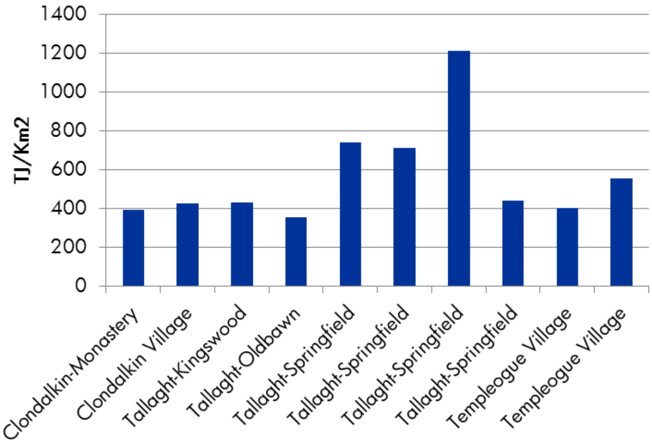
Table 3 below shows the top ten areas in terms of heat demand density in TJ/km^2, shows the size of each SA in km^2 and the TJ of heat demand. Figure 12 shows how these top ten areas compare in terms of TJ/km^2. All of these SAs have areas of less than 1km^2, but many are located within the same Electoral District, and so could be grouped with other nearby areas of high heat density when identifying the best areas for exemplar DH projects. Each area should also be further analysed to identify the mix of building use and the number of buildings involved.

Table 3: Top Ten Areas of Heat Demand Density

ED Name	Small Area	Area km2	TJ	TJ Heat/ km2
Tallaght-Springfield	267147003	0.005	5.53	1212
Tallaght-Springfield	267147006	0.010	7.42	743
Tallaght-Springfield	267147005	0.009	6.27	711
Templeogue Village	267154006	0.005	2.99	554
Tallaght-Springfield	267147004	0.003	1.54	442
Tallaght-Kingswood	267144001	0.034	14.81	432
Clondalkin Village	267053021	0.065	27.73	429
Templeogue Village	267154003	0.059	23.94	405
Clondalkin-Monastery	267050010	0.028	11.07	394
Tallaght-Oldbawn	267146014	0.039	13.86	358

To take an example, the SA numbered 267147005, seen in the previous table, has a heat density of 711 TJ/km2. At the time of analysis, there are 165 occupied dwellings, mostly apartments, 11 commercial properties including restaurants, shops, salons, a large supermarket and a surgery.

Figure 12: Top Ten Areas Heat Demand Density



This SA has a high heat demand in a compact area meaning short pipelines and lower losses, and has a good mix of building uses meaning longer hours of operation, all of which help to make DH economically viable. This SA also borders an SA which contains the municipality head office buildings and the large Tallaght-centre Shopping Centre.

There is a substantial mix of energy users in and around this SA, it has a high energy density, and there are potential anchor loads available nearby. The energy characteristics of this SA and those surrounding it suggest this area would be an ideal case for the initial phase of a large scale DH project, and a techno-economic feasibility study should be carried out taking into account current energy policies, supports, grants, tax incentives, etc. which could influence the economic feasibility of such a project.

Other areas of high heat density are more dispersed, such as those in Templeogue, and may be suitable for smaller scale community heating systems, but again needs further analysis to determine the mix of heat consumer types. The energy density should be recalculated when new large developments are planned, particularly those which include anchor load characteristics. New developments should be required to state their predicted heat requirements, and this can be evaluated with the information already gathered through this SEDA. If the new development creates an additional heat load sufficient to increase the overall heat density in the area to a level suitable for DH, then a feasibility study for implementing DH as part of the development should be a future consideration for

Figure 13: Heat Demand Density (TJ/km²) Map

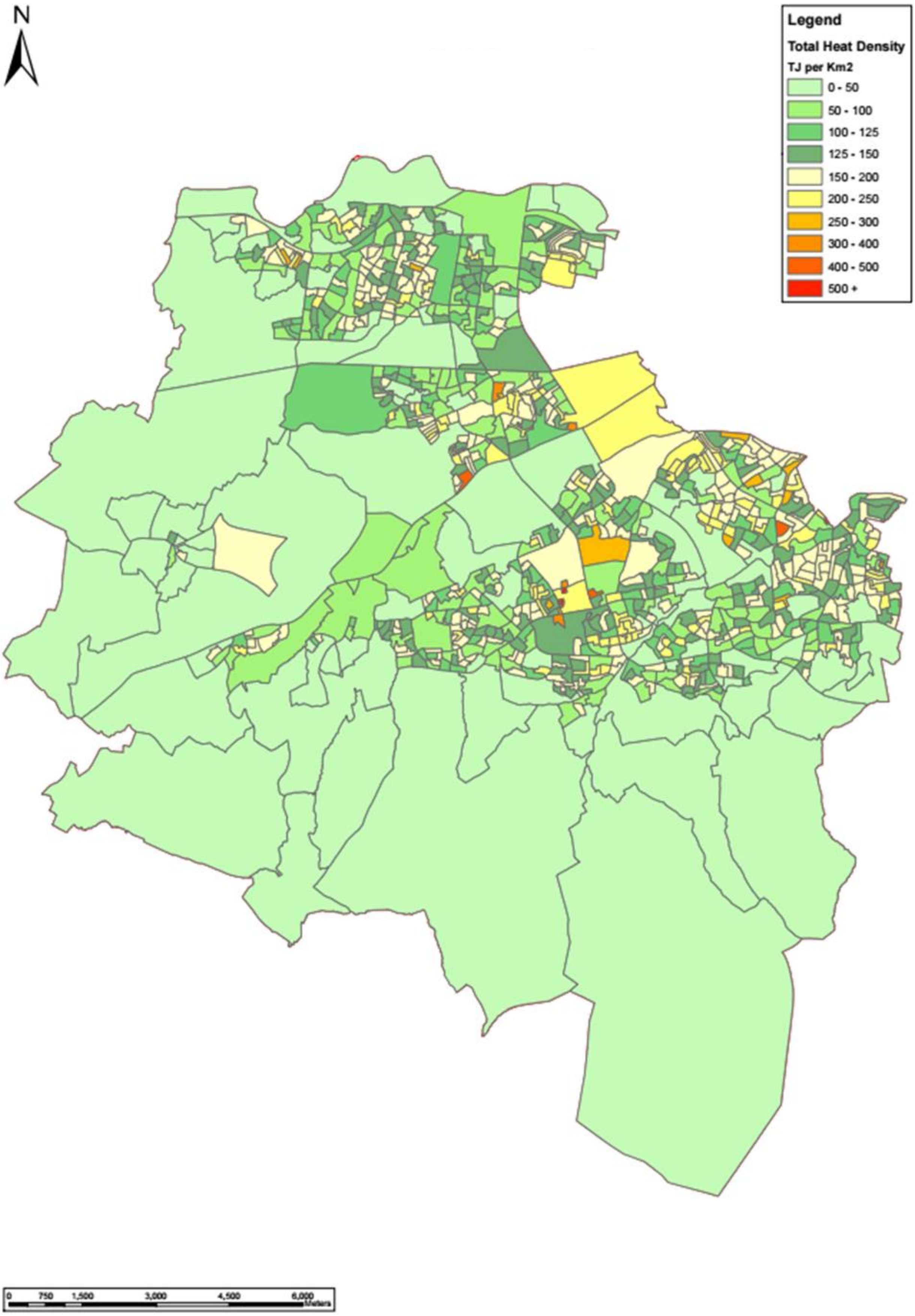
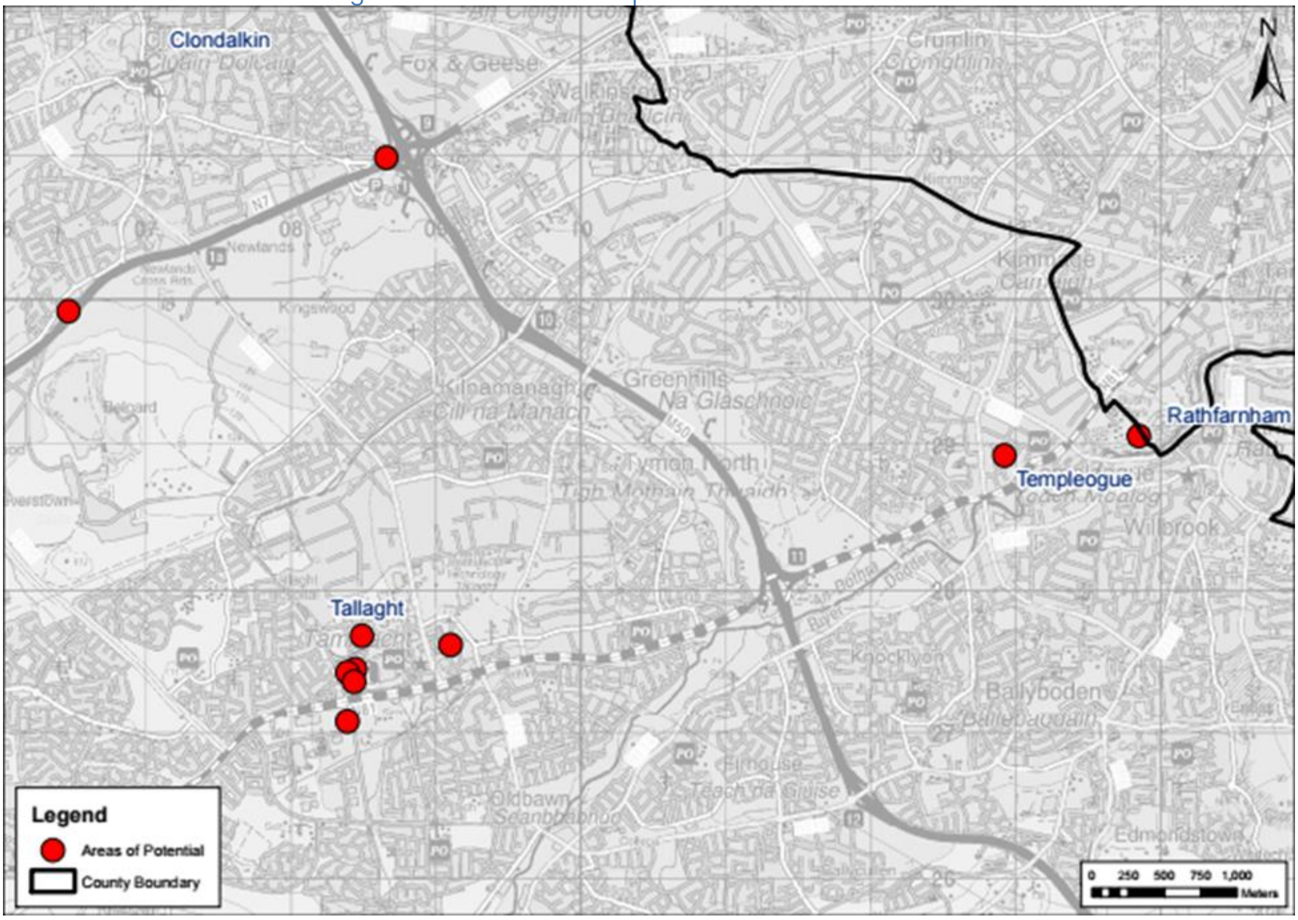


Figure 14: Locations of Top Ten Areas of DH Potential



planning. The costs of DH implementation are greatly reduced when developed in new developments rather than retrofitted.

Areas where there is low heat density need to be analysed in terms of the potential for individual building-based renewable systems. The most obvious choice for most small buildings or dwellings is solar thermal, heat pumps, biomass boilers or stoves, or a mix of these technologies. The only locational aspect affecting the suitability of solar thermal technology is the availability of south facing roof space and if there are over-shading issues from nearby buildings, trees, etc. Solar thermal technology itself has become more economically competitive in recent years, and the output from $4m^2$ of south facing evacuated tube solar thermal panels can provide a four-person home with around 50-60% of its hot water requirements.

Heat pumps are a highly efficient way to meet space heating requirements. They operate using heat sinks such as ground, water and air sources, and through compression can increase these low temperature sources to a much higher temperature for heating. For every one unit of electricity used for operation of the heat pump, up to four units of heat can be produced, and this form of heating is far more efficient than any other electrical heating systems available. Shallow geothermal sources of heat are an ideal source of renewable heat to couple with this technology in order to achieve high levels of efficiency.

Geothermal sources of energy are found by drilling boreholes into the earth to find soil layers with high temperatures. The maps seen in Figure 16 (next page) show deep geothermal temperatures found at different depths in Ireland, with temperatures at 5000m in the SDC region reaching a maximum of 70-80 degrees Celsius. At more shallow depths of up to 500m, the temperatures reach a maximum of approximately 30 degrees in SDC, according to the SEAI Geothermal Mapping System (SEAI, 2004). Even at 30 degrees, these sources can greatly contribute to reducing fossil fuel use for heating and overall energy costs. The largest ground source heat pump in the UK or Ireland is located at the IKEA store in Dublin, which provides 1.5MW heat through a combination of 7 heat pumps and 150 boreholes (Codema, 2013).

Bioenergy in the form of wood logs, woodchip, wood-pellets, biogas and biofuels from organic waste, and energy from waste are viable energy sources and are readily available in Ireland, both from local producers and as imported fuels. Biomass heating is currently the renewable energy source with highest installed capacity in Dublin. Sources of bioenergy crops and forestry located close to and in the SDC can be seen in Figure 15.

Biomass is suitable for use in small scale applications such as individual households in stoves and boilers, as well as in district level heating schemes and in commercial and industrial applications through large scale boilers and CHP units. Biogas, biofuel and waste to energy are more suitable for large scale projects or energy generation plants due to economies of scale.

Figure 15: Bioenergy Sources Close to SDC (Source: SEAI BioEnergy Mapping System)

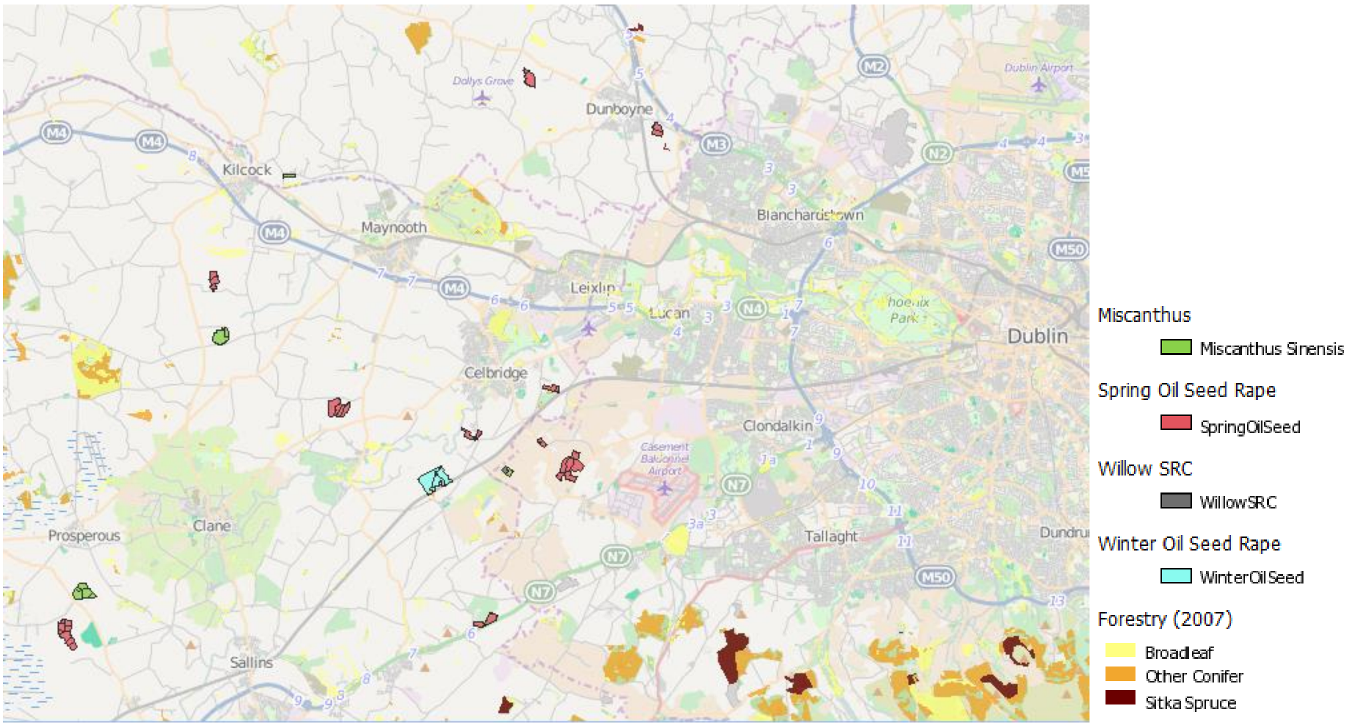
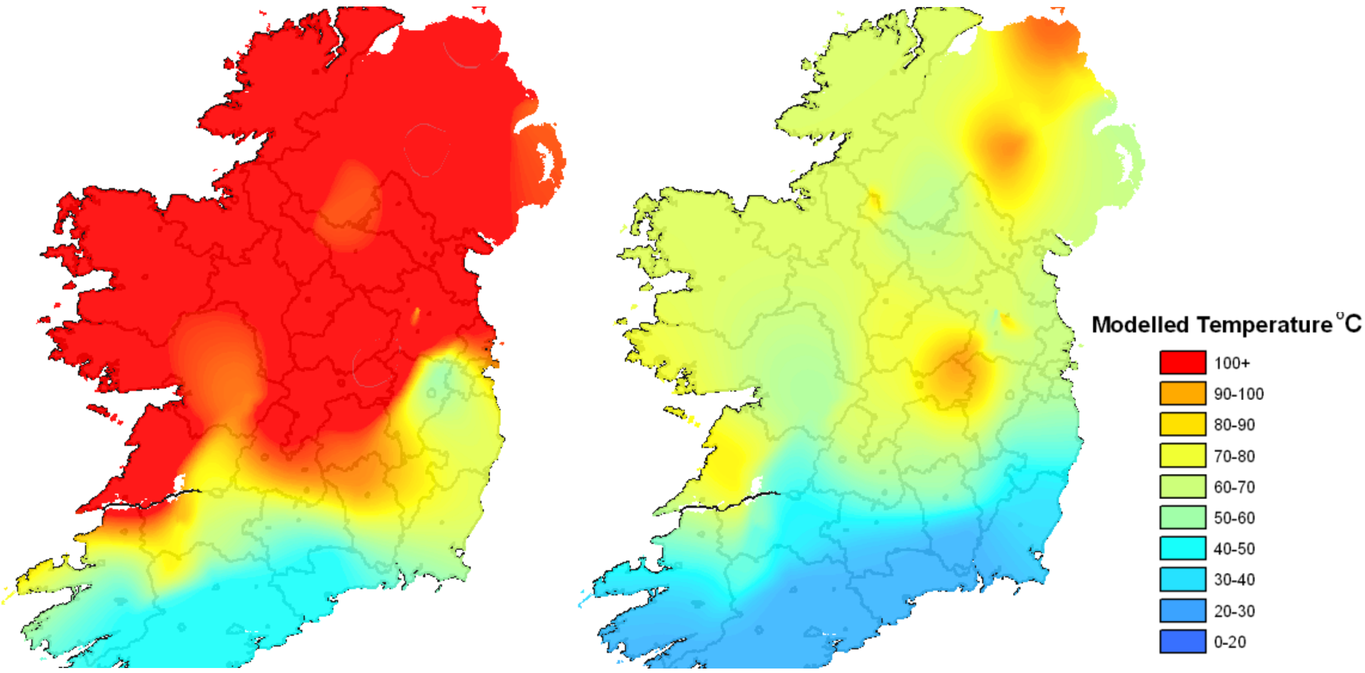


Figure 16: Geothermal Temperatures at 5000m (left) and 2500m (right) (Source: SEAI Geothermal Mapping System)



Electricity Demand

As stated in the introduction to this chapter, due to regulations in Ireland regarding supply of electricity to other buildings, solutions to meeting and reducing electricity demand must be thought of on a building-by-building basis rather than in terms of electricity sharing schemes. Figure 17 (next page) shows a map of the small areas with high electricity demand. The areas which are showing as dark red with the highest electricity demands are mainly those with high levels of commercial and industrial activity, and those with high levels of apartments using electrical heating.

For buildings with daytime electrical demand and high cost of electricity per kWh, solar PV panels can be a cost-effective way to reduce electricity bills and payback in relatively short periods. In Dublin, 1kW of installed south-facing PV, which is equal to around 4 panels, will have an annual output of approximately 900-1000kWh annually. According to electricity use per household found in this study, this amount of solar energy would meet around one third of the household's electricity demand. The payback period will rely on the building's own electricity tariff, as the panels will be used to offset the building's own electricity demand, rather than being sold to other buildings or rather than selling to the grid, as there are currently no tariffs offered by utilities for micro-generation. The price of PV panels has fallen considerably over the last 5 years, and is set to further reduce with increasing global demand.

For larger applications, such as large commercial and industrial buildings, CHP units can supply both electrical and heating requirements. There are many types of CHP units which are designed to run on different fuel types, including biomass, but the most common are gas fired CHP units. These units have very high efficiencies and are ideal for buildings with high electricity and heat use, such as leisure centres, hotels, large offices, etc.

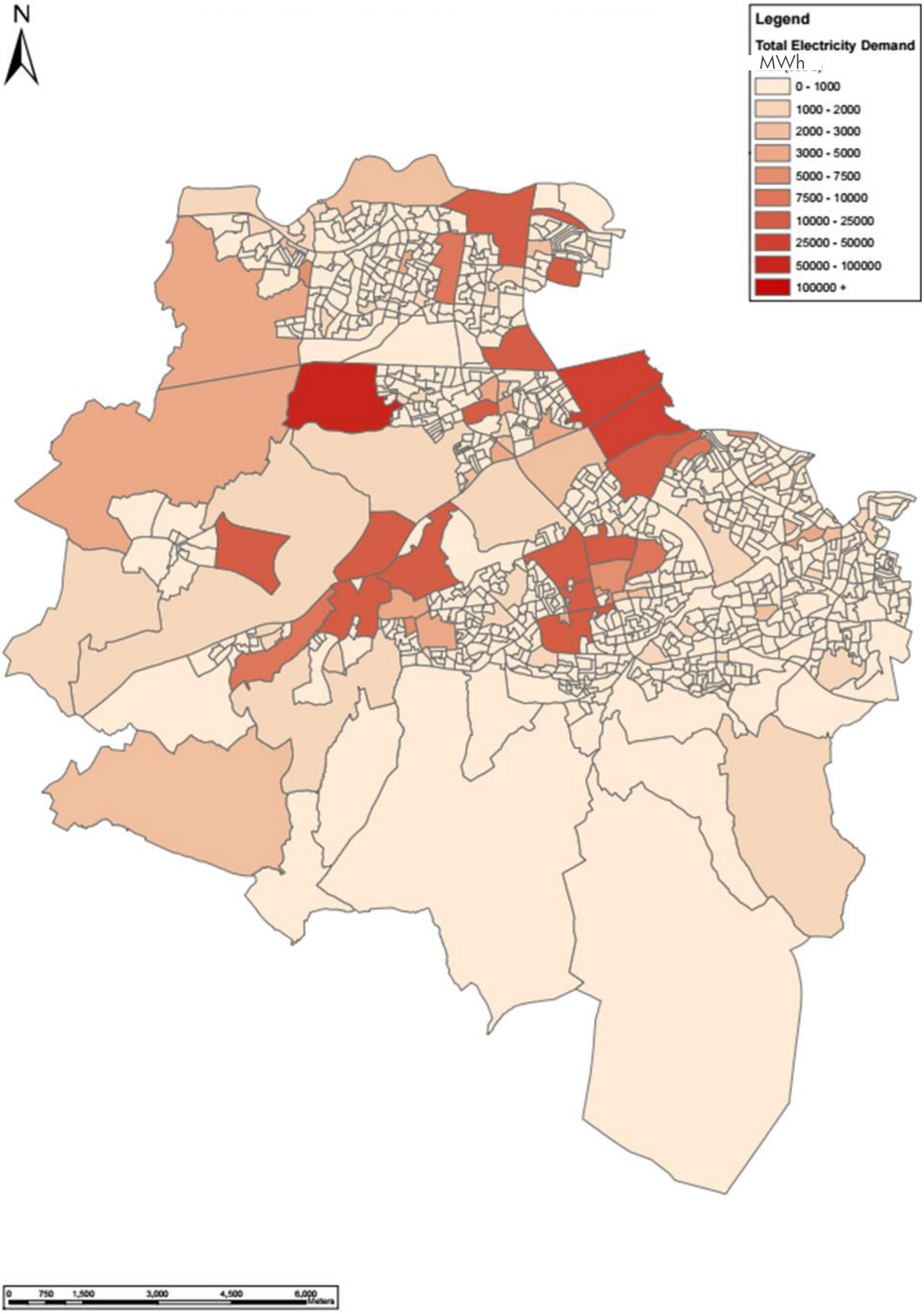
There is also opportunity to develop small scale hydropower plants in SDC to offset building electricity demand. There are numerous rivers and streams flowing through the county from the surrounding Dublin Mountains. Micro-hydropower systems can have good year-round electrical outputs, and can be relatively cheap and easy to install as the technology is long established and well proven. The power output will depend on the flow of the water source and the head height.

Although geothermal heating plants are more common, geothermal energy can also be used to generate electricity. This is generally large scale power plants for the sole purpose of electricity generation and export, rather than electricity generation to substitute individual building energy use.

Wind is the most developed and implemented source of renewable electricity in Ireland. The South Dublin County Council Draft Development Plan 2016-2022 concludes that there are no areas in the County where large scale commercial wind energy infrastructure could be classified as either 'permitted in principle' or 'open for consideration', and there is no realistic or practical potential for economic wind farm development, without having significant and overriding adverse visual and environmental impacts on landscapes.

Small turbines within the urban landscape, like that found on the grounds of the Institute of Technology in Tallaght, can be feasible if there is a large open space available, such as a park or near sporting grounds, where the wind is not diffused by surrounding obstacles.

Figure 17: Electricity Demand (MWh) Map



Future Energy Demand

Based on planning projections from the core strategy of the new South Dublin County Council Development Plan 2016-2022, the amount of additional residential energy consumption that can be expected during this period can be calculated. The distribution of expected housing growth across different areas within SDC is given in planning projections, and to estimate the energy usage, it is assumed all dwellings will have on average a 120m^2 floor area, and will be built to a high building energy rating according to building regulations.

The table shown below, Table 4, shows the areas where expected extra housing capacity will be built, and shows the estimated additional total energy requirements in each area. As well as the total energy, it is also broken down into heat and electricity demand. If all capacity for housing is built, the total additional energy demand is just under 0.5 TWh. Notice the period used is 2016-2022 and therefore does not include housing which may be built in 2015.

In order to predict future commercial and industrial energy demand, planning projections of future predicted employment levels between 2015 and 2022 in a number of business categories within the SDC, informed by the South Dublin County Economic Profile, have been used. To attach an energy demand to each employee, a methodology developed by Codema for SEAP calculations has been applied. This methodology is based on figures from the SEAI's *Energy in Ireland 1990-2013* report, and provides an average energy use per employee by dividing total energy use in each commercial activity by total number of employees per activity.

Table 4: Housing Energy Demand Growth 2016-2022

Areas with Housing Capacity	Capacity for Extra Households	Total Energy MWh	Heating (MWh)	Electricity (MWh)
Palmerstown, Naas Road, Templeogue, Ballyroan, Ballyboden, Edmondstown, Knocklyon, Firhouse / Ballycullen and parts of Greenhills, Terenure and Rathfarnham.	11,919	143028	114422	28606
Tallaght	5,511	66132	52906	13226
Lucan	9,685	116220	92976	23244
Clondalkin	7,440	89280	71424	17856
Saggart/Citywest	4,076	48912	39130	9782
Newcastle	701	8412	6730	1682
Rathcoole	962	11544	9235	2309
Rural - Metropolitan Areas	75	900	720	180
Rural - Hinterland Areas	25	300	240	60
Total	40,394	484,728	387,782	96,946

Table 5: Commercial Sector Energy Growth 2015-2022

Commercial Activity	Jobs Split 2014 in SDC Region	Job increase 2015-2022	Electricity MWh	Fossil Fuel MWh	Total MWh
Retail	36%	3383	61,224	6,427	67,651
Transport Distribution	14%	1315	17,627	5,525	23,152
Industrial & Manufacturing	12%	1128	253,329	67,619	320,948
Professional & Financial	12%	1128	13,079	3,270	16,349
Medical & Health	9%	846	9,809	2,452	12,262
Education	5%	470	5,450	1,362	6,812
Construction & Energy	4%	376	84,443	22,540	106,983
ICT	4%	376	9,170	451	9,621
Tourism & Recreation	3%	282	8,795	2,762	11,557
Scientific & Pharmacuetical	1%	94	1,090	272	1,362
Total	100%	9,396	464,015	112,681	576,696

As seen in Table 5, the predicted job growth in SDC from 2015-2022 will see an increase of approximately 0.58TWh in total energy demand in the commercial sector.

The municipal energy demand has been consistently decreasing since monitoring and reporting on public sector energy use was introduced. SDCC must reduce their demand by 33% on their 2009 energy baseline by 2020. This amounts to approximately 3% per year energy reduction. On this basis, and assuming energy savings are distributed evenly across municipal fleet, buildings and public lighting, it is estimated that the SDCC energy demand in buildings will reduce by 2,500MWh by 2020. It is hard to predict what savings if any will be implemented in the years 2020-2022 as this period is outside the timeframe of the compulsory public sector energy targets.

It is not possible at this time to predict exactly where in SDC the growth in energy demand will occur and so it cannot be placed on to a map until planning applications for new developments are received.

In accordance with core strategy projections to 2022, the energy demand in SDC is likely to increase by just over 1TWh by 2022. This is a significant increase in demand, totalling a 29% increase on current energy demand levels. It is therefore important to plan for this increase, and aim to further decouple growth and energy consumption. Higher BER ratings in residential new builds and applying more stringent building energy regulations in the non-dwelling building sector will help to achieve this decoupling. New potential anchor load type developments need to be fully assessed in terms of district heating potential, and any new commercial developments should seek to re-use any waste heat within local heating schemes. It is also essential to decrease the current high energy use within the inefficient housing stock to offset the future energy growth.

All new dwellings planned to be built in SDC will have to include some form of renewable energy production under the current building regulations for dwellings. Although this does not decrease the overall demand, it does decrease the use of fossil fuels and increases the use of local resources.

Residential Sector

Methodology

When devising a methodology to estimate energy use in all residential buildings, there are two main data sources available which provide a high level of accuracy and detail, and therefore a high level of confidence in the results, and these are the National Census from the Central Statistics Office, and the National BER Research Tool from the SEAI. These sources have allowed a detailed study of the energy use in the SDC housing stock. The only issue is the last Census was carried out in 2011, and so the dwellings built in the 3 years since that time will not be included in this analysis, but are accounted for within growth scenarios discussed previously.

The last Census carried out in 2011 shows the housing stock in SDC stood at 97,298, of these dwellings, the number of occupied, permanent households is 88,229. Only occupied permanent households are examined in terms of energy use as it is assumed vacant households are not using energy, and non-permanent dwellings can move location which is then difficult to map.

The Census data also breaks down these dwellings into dwelling types, i.e. detached, semi-detached etc., and according to the period built. These two characteristics have an impact on the estimated energy use in each household, due to the size of the dwelling, exposed exterior wall area, and the older housing stock will generally have higher energy demands than those more recently built to higher building standards.

In order to attach a location to these dwellings, the Central Statistics Office (CSO) formulated special tabulations which showed the number of each housing type and the period in which each was built within each SA. Also, the area in km^2 of each SA is used to show the energy and heat consumption density in each SA which is crucial for energy planning.

In line with data protection, the CSO were required to 'hide' data when the breakdown could possibly allow identification of individual households. In these cases, the CSO gave a figure of '<3' where the number of households in a breakdown category was either 1 or 2. In these cases, the '<3' was replaced by '1', and so the energy use will be underestimated rather than overestimated. The reason for this is, in energy planning terms, it is better to underestimate the demand. For example, for a group heating scheme to be feasible, the area will need to have a high heat density, and so an underestimate of heat demand is better. Also, the number of instances of '<3' were few, and replacing with '1' means that only 1,648 dwellings are unaccounted for throughout the county, which is less than 2%. The total number of dwellings used for calculations is therefore 88,229.

In order to attach energy data to the housing breakdown from the CSO, the National BER Research Tool database from the SEAI was used to find an average energy profile of each housing type and housing age in each area within SDC. The BER database is constantly updated, and so it is important to state that for this project, the database was accessed on the 2nd October 2014 and analysis based upon the BER data compiled up to this time. The BERs only assess the energy requirements of the building itself and do not take into account electricity used for various appliances, therefore additional electricity use associated with appliance use has been applied based on figures from the SEAI's Energy in the Residential Sector 2013 report (SEAI, 2013 (b)).

The location data for BERs in the database is only broken down as far as postcode level, and so the BERs were grouped according to the eight postcode areas within SDC. These eight datasets were then broken down into four housing type categories of Detached, Semi-Detached, Terraced and Apartments. A small number of older BERs listed the dwelling type as 'house' or 'maisonette', which is not specific enough to match with CSO data and so these BERs were dismissed. The BERs were then broken down further into period built. The periods chosen match those grouped by the CSO and take into account periods were new building regulations were introduced so as to represent changes in building energy consumption.

Eight postcodes were broken down into four housing types and seven building periods meaning there are 224 sub-sets of BER data analysed. Each of these sub-sets creates an average energy consumption based on the number of BERs within that sub-set. Altogether 61,487 BERs have been analysed which gives an overall representation of 70%, but all postcode areas have a different level of BER representation, as shown in Table 6 below, with Dublin 22 having the lowest representation at 23%. The reason some areas have much higher number of BERs available compared to the number of dwellings is that the whole postcode area is not within the SDC boundary and therefore the analysis uses BERs for some households outside the SDC area which is unavoidable due to the lack of more exact location data of BERs. This is not an issue in terms of accuracy in energy estimates as a household will not use more or less energy because it is on one side or other of a regional authority boundary.

Table 6: BER Representation for Each Postcode Area within SDC

BER Representation in Each Postcode Area				
Postcode	Number of SA's	Number of Dwellings	Number of BERs Analysed	% Represe-ntation
6W	52	4,957	2,424	49
12	34	3,437	4,452	130
14	67	6,268	4,970	79
16	50	4,646	4,298	93
20	35	3,511	1,123	32
22	152	14,806	3,352	23
24	319	31,093	7,504	24
Co.Dublin	197	19,511	33,364	171
Total	**906**	**88,229**	**61,487**	**70**

The resultant average energy figures for each of the 224 housing subsets were then applied to the 906 SAs using the CSO's breakdown of data for dwellings in each SA.

Costs have been applied according to fuel mix from BER data and prices are taken from SEAI Cost Comparison Prices for Domestic Fuels (July 2014).

Results

The results of the residential sector spatial energy demand analysis have been calculated and tabulated. An Excel-based spreadsheet of all results for each SA has been produced which can be used to easily look up any SA and see the relating energy figures and other details. The results of this analysis show the estimated total energy demand in all residential sector buildings is 1.9TWh annually, of this, 1.7TWh are used to meet heating demands. Over 1.6TWh are supplied from direct fossil fuel consumption. The estimated total energy cost for residents in SDC is over €160 million annually. The average energy use per household is 21,834 kWh annually, which is 9% higher than the national average of 20,000 kWh.

Heat Density

Table 7 shows the top ten small areas in terms of residential heat demand density. Heat density is an effective indicator for judging the feasibility of certain technologies and energy supply systems, such as large scale DH. All of the areas seen in the table has heat density above 150TJ/km^2, and would be considered eligible for DH under Danish interpretation. As can be seen in the table, eight out of the top ten areas are made up of mostly apartment type dwellings and explains the high heat consumption within a small area. Apartment complexes like those in the areas shown can be investigated further in order to see which energy saving measures would best suit, for example, if the apartments all have their own individual boiler, then the feasibility of supplying all apartments through one central highly efficient boiler could be more cost-efficient than upgrading all individual heating systems.

There are two SA's in Table 7 which do not have a high level of apartments, in Templeogue Village and Templeogue-Cypress, which have high numbers of semi-detached dwellings, the vast majority of which were built before 1980. The area in km^2 of these two SA's is much larger than the other SA's in the table, and they have fewer total dwellings in comparison to some of the others SA's. This shows that even though there are less dwellings and it is a bigger area, the very large heat demand means the heat density is still high enough to put them in the top ten in SDC. For example, the average energy use per household in the Templeogue Village SA 267154003 is much higher than that found in any other SA within SDC. These households are 99% reliant on fossil fuels to meet 78% of their energy needs, and the other 22% is met by electricity from the national grid. The specific energy characteristics of the buildings in this area should be investigated further in order to see why the energy use, in particular the heating energy demand, is much larger in this area and seek methods to reduce demand, costs and fossil fuel reliance. The energy character of this area can be defined further when it is seen in conjunction with the results of the commercial and municipal sectors, shown earlier in this chapter under total energy consumption. For example, if it determines there is a mixed use of buildings within close proximity which also have high heating demands, it may become suitable for a shared heating scheme.

Table 7: Top Ten Small Areas According to Heat Demand Density

Electoral District	Small Area	Number of Each Housing Type in Each Small Area				Heat Density TJ/km2
		Detached	Semi-Detached	Terraced	Apartments	
Templeogue Village	267154006	0	0	0	95	554
Tallaght-Springfield	267147005	4	2	4	148	460
Tallaght-Springfield	267147006	2	0	7	159	405
Templeogue Village	267154003	16	74	1	6	396
Tallaght-Springfield	267147004	2	1	1	50	390
Tallaght-Springfield	267147003	1	0	1	66	332
Rathfarnham-Hermitage	267115013	0	0	0	98	315
Tallaght-Springfield	267147007	1	0	3	87	292
Clondalkin-Monastery	267050006	1	1	5	90	289
Templeogue-Cypress	267149002	3	83	0	1	280

Heat Demand per Household

As well as heat density, it is important to analyse those dwellings with the highest heat demand per household, which may not be in areas of high heat density, but should then be targeted for individual building energy solutions to reduce high heating demands and costs. The top ten areas with highest heat demand per household (HH) are seen in Table 8. It is not surprising that these areas are made up of larger detached and semi-detached type dwellings, which are mostly located within the Templeogue district and the larger peri-urban areas on the outskirts of SDC.

There is a big difference in heat demand per household within Table 8 (next page), with the housing in the Templeogue Village area having nearly double the heat demand of those in the peri-urban and rural areas, and these areas should be prioritised when considering large scale energy saving projects such as the SEAI's Better Energy Community projects. The peri-urban SA's found in Bohernabreena, Lucan Heights and Newcastle, as seen in Table 8, have high levels of detached housing scattered throughout the SA, and therefore have lower housing densities and lower energy densities. The energy use per household is naturally higher as the housing sizes are larger, but also these dwellings have a larger exposed exterior area and many were built before more stringent building energy regulations were enforced. For example, in the first small area listed in Bohernabreena, of the 127 detached and semi-detached dwellings, 87 were constructed before 1990.

The energy planning characteristics to be considered in these peri-urban areas are very different to those in older urban areas, such as differing housing types, periods built, fuels used and surrounding space available for Renewable Energy Sources (RES). In older housing, the level of building envelope insulation is often poor and is the biggest contributing factor to high heat consumption. Larger dwellings in rural areas will have higher availability of south facing roof spaces and are often not over-shadowed by surrounding buildings, and are therefore ideal for solar thermal technologies which can offset large heating fuel costs. There are currently grants available of up to €1,200[2] to households for solar thermal installations through the SEAI Better Energy Homes Scheme.

[2] Grant price as of March 2015.

Table 8: Top Ten Residential Areas According to Heat Demand per Household (HH)

Electoral District	Small Area	Number of Each Housing Type in Each Small Area				Heat Demand kWh/HH
		Detached	Semi-Detached	Terraced	Apartments	
Templeogue Village	267154003	16	74	1	6	67128
Templeogue Village	267154001	27	90	2	7	60916
Templeogue-Kimmage Manor	267150002	4	39	24	3	60239
Templeogue-Kimmage Manor	267150007	20	79	0	2	45787
Bohernabreena	267035001	125	2	0	0	37055
Bohernabreena	267035012	107	7	0	1	36096
Templeogue-Kimmage Manor	267150014	27	41	0	1	35396
Lucan Heights	267101012	63	12	1	1	35062
Newcastle	267107005	90	23	1	2	34848
Newcastle	267107002	110	3	0	4	34429

Renewable technologies for heating are often a more suitable option for households which have high costs due to a reliance on oil for home heating, as they often do not have the option of connecting to the gas grid, and the payback will be faster compared to those using cheaper gas fuels. Biomass heating options such as wood-burning stoves and biomass boilers are other sustainable household heating solutions, but are currently not covered under the Better Energy Homes Scheme.

Electricity Demand per Household

It is becoming more important to target large users of electricity in the domestic sector as Ireland now has the highest domestic electricity tariff in Europe, excluding taxes and levies, and 3rd highest when all taxes and levies are included, just behind Denmark and Germany (Eurostat, 2014). It is likely that a lot of the apartments in the SDC area are electrically heated as this was the typical practice in apartment building design in Ireland. There are different technological solutions to meet electricity demands which can be combined with the heating solutions previously analysed. The top ten areas with high electricity use per Household (HH) are seen in Table 9.

Half of the areas (found in Firhouse and Tallaght) in this table are predominantly made up of apartment type dwellings, which is likely due to electrical heating systems. If these apartments are on costly and inefficient electrical storage heating technologies, then options to convert to a smart energy system using new highly efficient electrical storage systems or heat pumps can be investigated further.

Table 9: Top Ten Residential Areas According to Electricity Demand per Household (HH)

Electoral District	Small Area	Number of Each Housing Type in Each Small Area				Electricity Demand kWh/HH
		Detached	Semi-Detached	Terraced	Apartments	
Templeogue Village	267154003	16	74	1	6	28581
Templeogue-Kimmage Manor	267150002	4	39	24	3	25330
Templeogue Village	267154001	27	90	2	7	22647
Templeogue-Kimmage Manor	267150007	20	79	0	2	13854
Templeogue-Kimmage Manor	267150006	0	14	48	20	10252
Tallaght-Kiltipper	267143008	0	0	0	66	10141
Firhouse Village	267084026	1	0	1	69	10036
Tallaght-Springfield	267147023	6	0	2	134	9841
Tallaght-Kingswood	267144001	0	0	1	51	9738
Tallaght-Jobstown	267140054	1	0	2	128	9723

The other areas in Table 9 are again in the Templeogue area and four of the five are the same areas found in the previous heat demand table. These areas therefore have some of the highest heating and electricity demands in SDC. Due to the high costs of energy, in particular electricity, it is important to target these areas in order to combat against potential fuel poverty issues. The small areas with the highest residential sector energy costs are shown on the map in Figure 18 (next page). All small areas have approximately 100 dwellings. SA's with high number of dwellings with large floor areas and dwellings which use more expensive fuels such as home heating oil, will have higher energy costs than others. Also, areas with high levels of electrical heating and older housing with poor levels of insulation will also have higher than normal energy costs. A list of the top ten areas according to energy costs per household is shown below.

Table 10: Top Ten Areas according to Residential Energy costs per Household

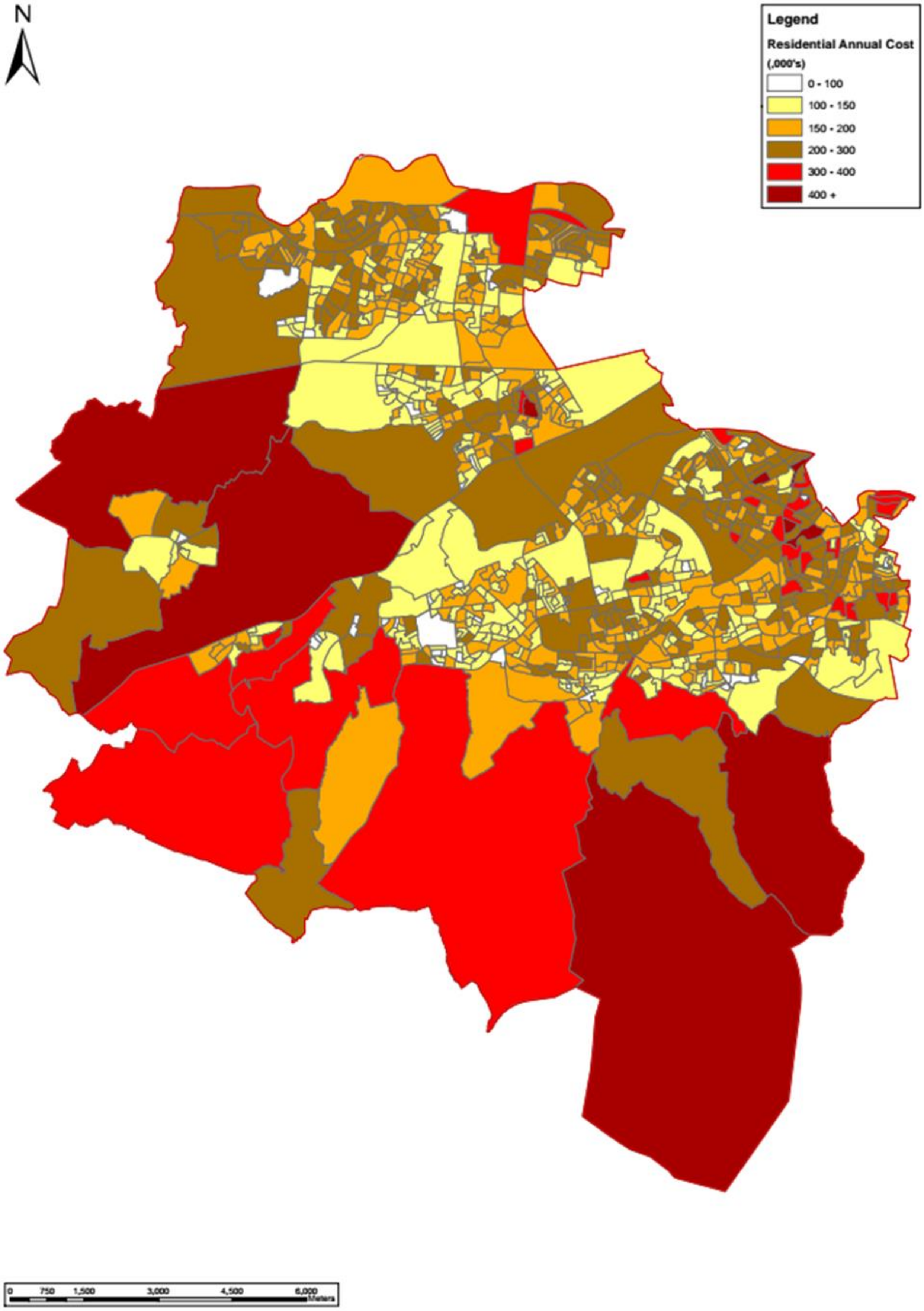
Electoral District	Small Area	Cost of Energy €/HH
Templeogue Village	267154003	7666
Templeogue-Kimmage Manor	267150002	6797
Templeogue Village	267154001	6675
Templeogue-Kimmage Manor	267150007	4770
Bohernabreena	267035001	3647
Templeogue-Cypress	267149002	3527
Bohernabreena	267035012	3513
Newcastle	267107005	3362
Newcastle	267107002	3358
Edmondstown	267083001	3306

Again, there is a big difference between the costs per household within the top ten table, with some in the Templeogue area having nearly double the costs of others. Fuel poverty is not only concerned with the energy costs per household, but also the ability of the household to pay these costs. An additional analysis of low income households is needed in order to match with the estimated energy demands and associated costs found in this study to find the areas worst affected by energy poverty in SDC.

On the basis of the results from this holistic level residential sector SEDA, the next step is to focus in on and further investigate the areas of high energy use identified. This investigation should include a sample of actual energy use from billing information from a range of housing types in order to compare to theoretical energy demand used in this analysis to actual energy use and estimate a margin of error. The energy planning process would also benefit from further detailed spatial information on availability of renewable energy sources, i.e. a solar map of the residential roof areas to identify roof areas with best potential for solar energy production (for an example of this see the solar map of Danish cities available at http://www.energyroof.dk/solaratlas-for-denmark).

The results of the residential sector analysis will be overlapped with energy information from the commercial and municipal sectors later in this chapter, and can then be incorporated into further feasibility studies of larger scale energy solutions which may not be cost-effective for small scale or residential applications, such as large scale DH or large scale geothermal heating solutions.

Figure 18: Estimated Annual Energy Costs for Residential Energy Use per Small Area



Commercial Sector

Methodology

There are very few sources of openly available energy information for the commercial sector building stock in Ireland, which makes it difficult to estimate with any degree of accuracy the energy consumption in these buildings. For energy benchmarking of these buildings, the main source of data comes from the UK's Chartered Institution of Building Services Engineers (CIBSE) technical documents. This data is widely used in Ireland for modelling commercial sector energy consumption, and is used for the comparison benchmarking in Display Energy Certificates (DEC) in Ireland. The CIBSE energy benchmarks have been established based on audits of numerous different types of commercial buildings in the UK in order to establish an average energy use per metre-squared floor area[3] for each commercial activity type. The benchmarks used in this study come from CIBSE Guide F: Energy Efficiency in Buildings 2012, and CIBSE Energy Benchmarks TM46: 2008 (CIBSE, 2012) (CIBSE, 2008).

In order to apply these benchmarks, the floor area of the commercial buildings needs to be established. The Valuation Office (VO) holds this information for commercial buildings for rating purposes. The VO provided a list of approximately 7,230 commercial businesses within the SDC area, listing the business type, i.e. pub, hotel, retail, office etc., the floor area in metres-squared, and the latitudinal and longitudinal coordinates for each building. This information allowed the creation of energy estimates for each building and placement of the buildings exact location on the map. It is important to note that it is not guaranteed that this is an exhaustive list of businesses and there may be some businesses unaccounted for. To check inaccuracies and estimate the number of total commercial properties in SDC, the online business Geo-directory was used. As seen in Figure 19 an estimated boundary of SDC was outlined in the directory search engine, and the results listed 6,687 commercial addresses within this boundary.

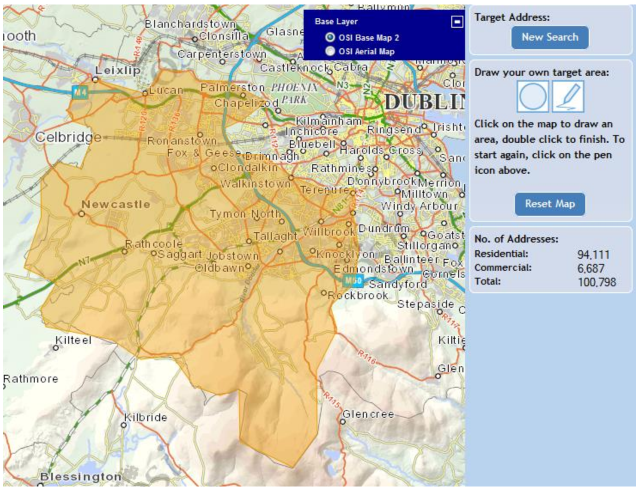


Figure 19: Geo-Directory Listing of Commercial Addresses in South Dublin County Area

There are just over 500 more businesses listed by the VO, the difference in the figures is likely due to rates being required by the VO from numerous separate businesses located at the same business address.

There are approximately 230 businesses on the VO list which did not have a floor area attached, and so it was not possible at this time to attribute energy demands for these buildings. This is an area for further work, with the possibility of estimating floor areas from GIS software coupled with x and y coordinates.

The floor area measurement used by the VO for different building uses, found in the VO's Code of Measuring Practice for Rating Purposes 2009, often differs to the floor areas used to measure energy use in the CIBSE guides. In these cases, a correction factor has been applied according to the CIBSE floor area conversion tables found in Guide F, for example to convert gross floor area to sales floor area, etc.

The problem for mapping the commercial sector energy using the SA breakdown is the SAs are sized according to housing density and not commercial density. Because of this, there are some SAs which have a large land area as they do not hold many households, but can have a high number of commercial buildings within that SA. The problem with this is then when the high levels of commercial energy are mapped in these 'large' SAs, it is unknown where in this large land area the cluster of commercial activity is located, and it also shows the entire SA as having a high energy usage. This problem is overcome in three ways.

[3] This is delivered energy given in kWh/m^2

Firstly, two of the large SA's which have high commercial activity in one or two particular areas have been sub-divided to create three additional SA's, as shown by areas outlined in red in the map below. Secondly, the commercial energy *density* will also be mapped, which will mean the large SAs will not be ranked in the same order and it will be obvious that the whole SA does not have a large energy demand. Thirdly, a map showing the position of each commercial and municipal building, colour coded to match its energy use, shows clusters of high energy users (Figure 9).

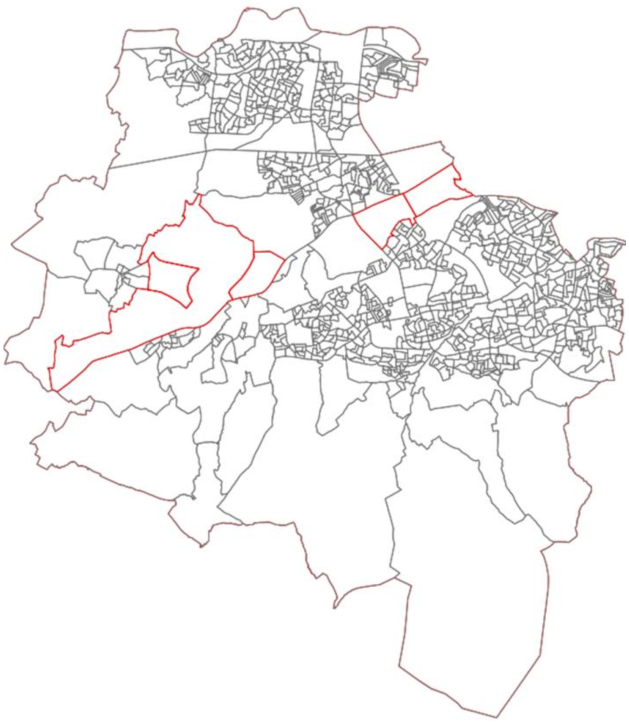


Figure 20: New SA Sub-Divisions created (red)

Estimating the costs of energy associated with commercial energy use is difficult as the CIBSE energy benchmarks only breakdown the energy use into electricity and fossil fuel consumption. The only available source of information on fossil fuel types used in this sector is from national level studies, which give a breakdown of fuels used in the industrial and services sectors, and so this is used to give an estimate of fossil fuel types consumed. Using this data will have the unwanted effect of pricing more energy use according to oil prices rather than gas prices, as there will be higher use of gas in the SDC area compared to the national average due to the infiltration of the gas grid, and therefore costs allocated to fossil fuel uses are likely to be slightly overestimated for this sector. The costs used are from the latest SEAI Commercial/Industrial Fuels: Comparison of Energy Costs (July 2014), which includes all taxes and standing charges, and costs are allocated to each building taking account of the price bands used in gas and electricity pricing.

Results

The largest energy users within the commercial sector are the large industrial units, the majority of which are large factories with average floor areas of around 20,000m^2. Within the top ten commercial energy users, there is a large industrial pharmaceutical plant and a large data centre located within the same small area, the data centre has a large electrical demand due to cooling requirements. A holistic view of how groups of facilities in close proximity use energy and the energy systems that are in place could enable combined large scale energy projects between different commercial properties. Many technical solutions to reduce energy use or supply energy through RES can be unfeasible due to economies of scale, but with groups of large industries being supplied by a central energy distribution system, this barrier can be overcome and create mutually beneficial outcomes.

There are many large industrial estates within SDC which have high energy use within a small land area. Four such small areas can be seen in the top ten small areas according to high commercial energy density in Table 11 below, which are found in the Tallaght-Kingswood, Tallaght-Springfield, Clondalkin Village and Terenure-St.James electoral districts.

Table 11: Top Ten Small Areas of High Commercial Energy Density

Electoral District	Small Area	No. of Business-es	Area m2	Area km2	Total Energy Density TJ/km2	Heat Demand Density TJ/km2	Electricity Demand Density TJ/km2	Number of Businesses in Each Sector									
								Industrial	Health	Hospitality	Leisure	Office	Retail	Utility	Fuel/ Depots	Miscellaneous	No Category
Tallaght-Springfield	267147003	2	4559	0.005	1235	880	355	0	0	0	1	0	1	0	0	0	0
Tallaght-Springfield	267147005	11	8822	0.009	921	250	671	0	1	0	0	0	9	0	0	1	0
Tallaght-Kingswood	267144001	58	34294	0.034	739	396	343	0	0	1	0	15	38	0	0	1	3
Tallaght-Springfield	267147006	5	9979	0.010	694	338	356	0	0	0	0	0	3	0	0	2	0
Clondalkin Village	267053021	13	64585	0.065	495	355	129	12	0	1	0	0	0	0	0	0	0
Tallaght-Kingswood	267144002	128	550202	0.550	473	248	142	101	0	0	1	16	1	1	1	1	6
Tallaght-Oldbawn	267146014	11	38731	0.039	471	265	206	0	0	1	1	1	5	0	0	0	3
Terenure-St. James	267157010	163	241539	0.242	462	220	142	134	0	0	0	3	3	0	0	3	20
Tallaght-Springfield	267147030	257	888176	0.888	444	285	120	188	1	0	2	19	25	1	1	6	14
Terenure-Cherryfield	267155003	57	67944	0.068	419	154	265	5	1	1	0	10	29	0	0	4	7

These areas all have a majority of industrial business types and have very similar energy densities. The SA listed in Clondalkin Village has the highest energy density of these industrial areas, but the smallest number of businesses as the area size is much smaller. This SA also holds a large hotel with a large heat demand, which is why the heat demand density is much higher than the other industrial areas. Other businesses in this SA are listed as warehouses, stores, industrial showrooms and food preparation plants. Due to the small number of businesses that would be involved and the high energy demand within a small area, this SA could be ideal for investigating the feasibility of implementing an exemplar alternative energy project focussed on industrial sector energy use.

The SA with the highest level of industrial activity in Table 11 is found in the Springfield area. This area is the largest in size, at just less than 1km^2, but holds 252 industrial activities, as well as a large national hospital, many retail outlets, supermarkets, and leisure centres. This area has high potential for the first stages of a shared heating and cooling system, with the hospital playing a major role as a potential anchor load. This SA is also very close to other high energy density areas within the Springfield area which could link in at a later stage.

Within the identified areas of high industrial energy demand, further analyses should include investigation into possibilities for utilising waste heat sources from industrial processes to supplement heat supply of nearby heat consumers.

The other SAs shown in Table 11 are home to commercial activities other than industrial uses, such as offices and retail outlets. These are mainly found in the SAs which are centre to retail activities in SDC in the Tallaght -Springfield, -Oldbawn and -Kingswood areas, which have small km^2 area but high retail energy use.

In the case of very small areas with low numbers of businesses such as the SA found in Tallaght-Springfield shown in the top ten table, which only has two businesses listed, these types of areas should be further investigated with all buildings including dwellings and municipality buildings in the area taken into account. The small area in question has a large number of apartments and the two businesses listed, a gym/fitness centre and a restaurant, are likely located in the same complex, which could make this complex an interesting case study for a single complex level small scale DH system as it has a mix of energy demand profiles and fuels used within a compact area.

The commercial sector energy consumption is further analysed alongside the other energy sectors earlier in this chapter, and previous maps show exactly where the high levels of commercial energy use are located.

Municipal Sector

Methodology

Since 2011, public sector bodies are required to report their energy use annually in accordance with EU Energy Efficiency Regulations. Public bodies report their use to the SEAI through a Monitoring and Reporting portal. Because of these obligations, real energy data is now collected and available for all buildings for which SDCC are responsible for energy use.

Real energy consumption and associated costs have been mapped for all the SDCC buildings within the SDC area according to address location using GIS. There are 141 buildings and service related energy data points mapped for the municipal energy demand map. These buildings together consume just under16GWh annually. Costs have been applied to each building using the metered energy data matched with the latest SEAI Commercial/Industrial Fuels: Comparison of Energy Costs (July 2014), which includes all taxes and standing charges, and costs are allocated to each building taking account of the price bands used in gas and electricity pricing.

Results

The biggest energy users in the Local Authority sector include the leisure centres in Tallaght and Clondalkin, Tallaght Stadium, depots and the civic centre, theatre and offices. The highest concentration of municipal energy use is therefore in the area where the civic buildings are located which is in the Tallaght-Springfield district close to the Tallaght town centre. This is an area of high commercial and residential activity, as well as other large energy users such as Tallaght hospital and the large sports stadium.

Municipal and public buildings such as schools, hospitals and leisure centres are often referred to as 'anchor loads' in energy planning terms. These anchor loads are defined as buildings which normally have high steady energy demands over long periods of the day which can provide a large base-load demand, they are often public buildings meaning it is potentially easier to obtain commitment to participate in innovative energy projects, and they are reliable long term clients. These anchor loads can therefore play a pivotal role in the first phase development of large scale DH systems. The large municipal energy users, as shown in Table 12, should be analysed further in terms of fuel and energy used for heating requirements, and match with other potential large heat demands within close proximity to identify areas in which DH could potentially be cost-effective and easier to implement.

Other municipal buildings will be analysed in conjunction with the residential and commercial sector energy demands in the next section which looks at the overall total energy demands in SDC.

Table 12: Top Ten Municipal Energy Users

Building/Site Name	Division	Small Area	Total Energy Demand kWh	Total Heat Demand kWh	Total Elec Demand kWh
TALLAGHT TOWN CENTRE, CIVIC CENTRE	CIVIC CENTRE	267147025	3498079	1442583	1895209
CLONDALKIN SPORTS & LEISURE CENTRE	LEISURE CENTRE	267053031	2810701	1911382	686943
WEST TALLAGHT LEISURE FACILITY	LEISURE CENTRE	267140038	2623550	1833728	586075
TALLAGHT STADIUM	STADIUM	267146005	466047	270942	165000
ESKER LODGE PUMPING STATION	DRAINAGE	267100032	440456	0	440456
CIVIC THEATRE	CIVIC THEATRE	267147025	421407	288501	100850
CLONDALKIN CIVIC OFFICES	CIVIC OFFICES	267050007	327838	165058	144440
NEWCASTLE ROAD (Public Lighting Division)	PUBLIC LIGHTING	267103015	317280	11950	304002
DEANSRATH HOUSE/DEPOT	DEPOTS	267049019	253434	70276	175350
BALLYMOUNT AVENUE ROADS DEPOT	LANDLORD SUPPLY	267006003	194820	0	194820

Conclusion

This South Dublin Spatial Energy Demand Analysis has allowed the identification of energy character areas in the South Dublin County area by allocating actual and estimated energy demands to each building based on the best available data sources. The mapping process has resulted in the visualisation of areas of high energy consumption, heat demand density and approximate associated energy costs across the County.

The results of the SEDA enable the local authority to base planning policies on an evidence-based spatial understanding of energy demands in the SDCC area. This facilitates a bottom-up approach to tackling National and European energy efficiency and renewable energy targets, and helps to integrate national, regional and local level energy planning. Due to the detailed level of analysis involved in this SEDA, the results can help to inform Local Area Plans and Strategic Development Zones within South Dublin County. This SEDA also allows planners to better prepare for future energy demands, and move to decouple growth and increased energy consumption within the County.

Key Findings

The South Dublin SEDA has identified:

- Priority areas for District Heating development
- BER levels of the housing stock in South Dublin County
- Areas with high levels of low efficiency dwellings
- Areas of above average household energy use
- Clusters of high energy users in commercial sector
- Opportunities to lower fossil fuel use and utilise local sustainable resources

Recommendations

The areas identified within this SEDA that are deemed to be very suitable for DH schemes in terms of heat demand density should be prioritised by the Council when evaluating implementation of low carbon DH networks in South Dublin County. Through supporting DH implementation, the Council can kick start a new method of delivering energy in South Dublin County which will result in lower energy costs, lower carbon emissions, and greater utilisation of local resources. The potential to use renewable and low carbon resources, such as CHP and deep geothermal sources, in DH systems in South Dublin County is most relevant in the ten highest Areas of Potential as shown in Figure 13. Many of these areas are located within the same Electoral Division area, and so could be grouped with other adjoining / nearby areas of high heat density, thereby representing the areas most viable for district heating projects.

There should be particular focus on utilising currently wasted heat sources, found in areas identified in the SEDA that have high levels of commercial activity and industrial processes. The opportunity to use these heat sources which are currently going to waste, and at the same time reduce cooling costs, is currently not fully recognised, and the local authority should encourage the utilisation of waste heat to supply nearby heat demands. Further analysis of the location and size of waste heat sources and the opportunity to recover such waste heat is recommended.

Where the heat density is low and waste heat is unavailable, the Council should seek to support individual building-based sustainable solutions, such as roof-top solar installations, small scale hydro schemes, small scale CHP, biomass, and both air-source heat pumps and ground-source shallow geothermal.

The local authority should also look to innovative management and funding methods in order to implement energy reductions in their own building stock, such as Energy Performance Contracting (EPC) and using services provided by Energy Service Companies (ESCOs).

Following on from this first-phase analysis, areas of interest in terms of potential to reduce energy demand and implement local sustainable energy solutions should be further analysed in more detail, taking into account technical and economic feasibility according to current markets, policies and technological advances.

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Works Cited

Chittum, A., & Ostergaard, P. A. (2014). How Danish Communal Heat Planning Empowers Municipalities and Benefits Individual Consumers. *Energy Policy Vol.74*, 465-474.

CIBSE. (2008). *Energy Benchmarks TM46: 2008.* London: CIBSE Publications.

CIBSE. (2012). *Guide F: Energy Efficiency in Buildings* (3rd ed.). London: CIBSE Publications.

Codema. (2013). *Renewable Energy in Dublin: Market Assessment.* Dublin: Codema.

Connolly, D., Vad Mathiesen, B., Lund, H., Moller, B., Hvelplund, F., Sperling, K., et al. (2014). *Heat Roadmap Europe; Inputs for Technical Modelling and Policy Recommendations.* Aalborg: Aalborg University.

ESB. (2015). *Connect a Micro-Generator*. Retrieved March 18, 2015, from www.esb.ie:http://www.esb.ie/esbnetworks/en/generator-connections/micro_gen_connections.jsp

Eurostat. (2014). *Electricity prices for domestic consumers, from 2007 onwards - bi-annual data.* Retrieved December 17th, 2014, from eurostat.eu: http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

IPCC. (2007). *IPCC Fourth Assessment Report: Climate Change 2007 Synthesis Report.* Intergovernmental Panel on Climate Change.

SEAI. (2004). *Geothermal Mapping System*. Retrieved March 2015, from SEAI Geothermal Mapping System: http://maps.seai.ie/geothermal/

SEAI. (2010). *Solar Thermal Information and Resources.* Retrieved March 2015, from www.seai.ie: http://www.seai.ie/Renewables/Solar_Energy/Solar_Information_Resources/Solar_Thermal/

SEAI. (2013 (b)). *Energy in the Residential Sector: 2013 Report.* Dublin: SEAI.

Sperling, K., Hvelplund, F., & Mathiesen, B. (2011). Centralisation and Decentralisation in Strategic Municipal Energy Planning in Denmark. *Energy Policy Vol.39*, 1338-1351.

Stoeglehner, G., Niemetz, N., & Kettl, K.-H. (2011). Spatial Dimensions of Sustainable Enrgy Systems: New Visions for Integrated Spatial and Energy Planning. *Energy, Sustainability and Society, 1*(2).

The Royal Society & The US National Academy of Sciences. (2014). *Climate Change: Evidence & Causes.* The Royal Society & The US National Academy of Sciences.

Notes

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