University College Dublin

Dublin Urban Design Climate Workshop | June 4th - 10th 2023

CREATING ZERO-CARBON NEIGHBOURHOODS

City Edge in Dublin

UCCRN edu | Urban Climate Change Research Network for Higher Education
Climate-Resilient Design, Planning and Governance of Cities

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Foreword

UCCRN_edu is an Erasmus+ cooperation partnership launched by world-leading Higher Education Institutions (HEIs) which include members of the Urban Climate Change Research Network (UCCRN), an international consortium dedicated to foster multidisciplinary knowledge-based cross-sectoral action on climate change mitigation and adaptation from an urban perspective. Thanks to the Erasmus+ opportunity, the involved HEIs will reinforce their mission of supporting urban climate action in Europe and beyond.

The project aims at overcoming existing gaps in education on climate-resilient urban planning, design and governance by establishing synergies with leading research and teaching institutions, as well as EU and international networks with relevant expertise in policy and governance dialogue with local governments and communities to streamline climate action in cities.

The Partnership aims at developing an educational alliance to form the next generation of urban climate leaders, able to navigate the complexity of the interconnected knowledge domains to foster urban climate action as hybrid and multidisciplinary new professionals, real factors of change in research, design and policymaking.

The students will get the required skills to plan, design and govern climate-resilient cities, integrating urban adaptation and mitigation, and developing a holistic vision to identify and implement transformation pathways in multiple sectors. Therefore, students will get a multidisciplinary educational path and access to research and job careers promoted by UCCRN_edu community in the field of climate-resilient urban design, planning and governance.

Project Pathways

- Integrate Mitigation and Adaptation: supporting planning and design solutions that reduce GHG emissions while increasing resilience, taking the local context of each city into account to identify actions that result in the greatest benefits.
- Coordinate Disaster Risk Reduction and CC Adaptation: integrating these activities into urban development policies through a new, systems-oriented, multi-timescale approach to risk assessments and planning.
- Co-generate Risk Information: triggering processes with the full range of stakeholders and scientists that are inclusive, transparent, participatory, multisectoral, multijurisdictional, and interdisciplinary.
- Focus on Disadvantaged Populations: fostering equity and environmental justice, and addressing the needs of urban poor, the elderly, women, minority, recent immigrants, and otherwise marginal populations that most often face the greatest risks due to climate change.
- Advance Governance, Finance, and Knowledge Networks: developing robust city institutions through capacity-building and participating in city networks for climate action; supporting urban climate governance in longer planning horizons and effective funding and implementation mechanisms and coordination.

These pathways are developed partly via Urban Design Climate Workshops (UDCW) that link these pathways to practicals in the form of case-study projects in different European cities. At the time of the Dublin UDCW there have been three previous events:

1. Paris UDCW (May 28 to June 3, 2022) focused on the "Reinventing cities/Porte de Montreuil" C40 project site. Students and researchers will work on novel design concepts through studies on innovative techniques applied to buildings and/or open spaces in the fields of energy, water, waste, air quality.
2. Aalborg UDCW (November 20-26, 2022) dedicated to deepen cross-disciplinary urban planning skills and competences needed to design and develop climate-resilient communities within a multiscale perspective.
3. Barcelona UDCW (March 18-24, 2023) with a focus on the role of public spaces as a mean for the administration for facilitating climate resilience transition, aligning and maximizing the synergies (and minimizing trade-offs) among adaptation and mitigation.

The Dublin UDCW is focussed on the creation of zero-Carbon neighbourhoods. The selected case study site is part of the City Edge, which describes a large (700 hectare) site west of the city centre.

Contents

1. Outline of Dublin UDCW

The focus of the Dublin UDCW was the planning and design of a Carbon-neutral neighbourhood. The selected case study site is part of the City Edge, which describes a large (700 hectare) site west of the city centre (Figure 1). The plan for this site is based on a public-private partnerships to transform the current land-cover from mostly light-industrial and commercial uses to a high-density mixed-use development with high quality green spaces. The challenge for this UDCW is to plan and design a low Carbon neighbourhood that is integrated (economically and socially) into Dublin.

From the City Edge Project Strategic Framework[1]: *City Edge is identified in national and regional policy as an underutilised part of Dublin that has the potential to be much more intensely used. The City Edge Strategic Framework sets a Vision for the future of these lands, whereby their intensification can play a central role in the sustainable growth of both Dublin and Ireland. Such "Compact Growth" would make a significant contribution to the delivery of much needed new homes and jobs, which in turn would generate sizeable economic, climate and social benefits for the Country. Realising the scale of ambition presented in the framework will require strong governance as well as sustained political and economic support…The City Edge Strategic Framework is a non-statutory plan, which sets the long-term, high-level strategy for the regeneration of the area over a 50 year timescale.*

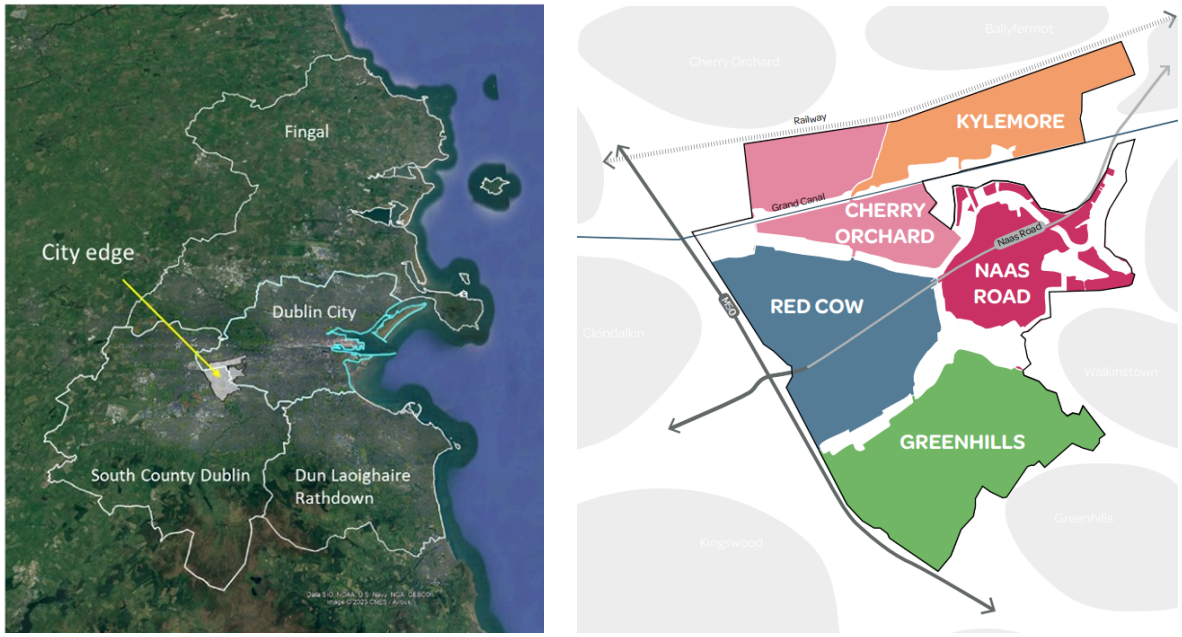


Figure 1. Satellite image of Dublin (left) showing the boundaries of the Local Authorities and the City Edge study area. The map on the right shows the details of the City Edge site, which is divided into five districts. Kylemore is the focus of the Dublin UDCW.

[1] https://cityedge.ie//wp-content/uploads/2022/08/City-Edge-Strategic-Framework-August-2022-Final.pdf

1.1 The City Edge Project

The vision of the City Edge Project[2] is to support the long-term, resilient growth of the Dublin region by making the most of the City Edge lands. Five new neighbourhood, based on 15-minute city principles, will celebrate the area's existing qualities such as the Grand Canal, the River Camac and Lansdowne Valley Park. Whilst a network of new biodiversity rich parks, green and blueways, public transport, local high streets, community facilities and energy networks will help to meet our shared climate challenges.

The objectives are defined as:

- Homes – Accommodate a mixed and balanced community of between 75,000 and 85,000 new people with a choice of different housing types, tenures and sizes.
- Community – Support the needs of intergenerational communities through the timely provision of community, educational, health and social facilities.
- Economy - Create a resilient and diverse employment offer with scope for between 65,000 and 75,000 jobs.
- Movement – Ensure Transport Oriented Development by focussing new mixed-use and compact urban development on enhanced active travel and public transport corridors.
- Natural Infrastructure – Target 50% green cover to meet the needs of the future population while promoting a reintroduction of biodiversity and combatting climate change impacts such as flood risk.
- Sustainability – Fast track to zero carbon and zero waste to help address climate change and promote sustainable communities through the 15-minute city principle.
- Character – Integrate the renewal of the City Edge lands with existing residential communities by supporting good place making within the five local neighbourhoods and by celebrating local distinctiveness and ensuring climate resilient design.
- Delivery – Ensure a coordinated approach to the funding and delivery of infrastructure and utilities so that land can be developed in a timely and coherent manner that realises the City Edge Vision.

The Challenge: The Dublin UDCW focussed on the Kylemore district and used the parameters established in the Strategic Framework (Figure 2) to plan and design a low Carbon neighbourhood.

[2] https://cityedge.ie/

KYLEMORE DISTRICT

LOCATION & LAND USES

Located between the Grand Canal and Kildare Railway line, this linear District will integrate with and extend the Major Urban Centre in the Naas Road District with high intensity retail, commercial employment and ground floor uses along the Kylemore High Street.

Residential led neighbourhoods outside the Major Urban Centre will accommodate employment and commercial uses at ground and upper floors. A mix of urban Industry as well as residential-led neighbourhoods are suggested for CIE, OPW and ESB lands being transferred to the LDA.

Potential Capacity	
Potential Population	12,500-13,500 ca.
Potential Jobs	15,500-16,500 ca.
Area	
Gross Area (Ha)	90
Developable Area (Ha)	63.5
Plot Ratio (FAR)	
Plot Ratio	1.5 - 3
Community infrastructure across the district	
Primary School Places	1512 ca.
Post Primary School Places	986 ca.
Primary Care Centres	min 2
Childcare Facilities	approx. 80
Community Centres	2
Community Parks	3

Indicative Spatial Diagram of the Kylemore District

Figure 2. Plans for the Kylemore district.

STRATEGIC OBJECTIVES

Theme	Objective	The objectives below break down the vision into 8 main themes, and were used to direct the tested scenarios and strategic brief.
LIVEABLE CITY	**Follow compact growth & 15-minute city principle**	Create a compact urban environment with an active travel focus, that supports the health and wellbeing of residents, through access to opportunities, services, resources, and green and natural amenities.
ECONOMY	**Create a resilient and diverse employment offer with scope for up to 65,000 - 75,000 jobs**	Create a resilient and diverse employment offer with scope for between 65,000 and 75,000 jobs.
HOUSING	**Accommodate a range and variety of new homes for up to 75,000 - 85,000 people**	Accommodate a mixed and balanced community of between 75,000 and 85,000 new people with a choice of different housing types, tenures and sizes.
NATURAL INFRASTRUCTURE	**Target 50% green cover**	Target 50% green cover to meet the needs of the future population while promoting a reintroduction of biodiversity and combating climate change impacts such as flood risk.
MOVEMENT	**Focus development on the provision of active and public transport**	Ensure Transport Oriented Development by focussing new mixed-use and compact urban development on enhanced active travel and public transport corridors.
CHARACTER	**Knit into existing neighbourhoods and create a series of character areas that enhance Dublin**	Integrate the renewal of City Edge with existing residential communities by supporting good placeshaping within the five local neighbourhoods and by celebrating local distinctiveness and ensuring climate resilient design.
COMMUNITY	**Integrated urban services and resources**	Support the needs of intergenerational communities through the timely provision of community, educational, health and social facilities.
SUSTAINABILITY	**Fast-track to zero carbon and zero waste**	Fast track to zero carbon and zero waste to help address climate change and promote sustainable communities through the 15-minute city principle.
DELIVERY	**Create a deliverable and credible framework**	Ensure a coordinated approach to the funding and delivery of infrastructure and utilities in order that land can be developed in a timely and coherent manner that realises the City Edge Vision.

Figure 3. The strategic objectives for City Edge.

2. Methodology

The UDCW was organised over 7 days from Sunday to Saturday and had 28 participants drawn from the UCCRN network (Table 1).

Table 1. UCDW participants.

University	Staff	Students
Aalborg University	0	3
Université Gustave Eiffel	0	2
UIC Barcelona	0	2
University of Mons	1	3
University College London	1	0
University of Naples	1	4
University of Pisa	0	1
New York Institute of Technology (NYIT)	1	0
UCD	3	3
CNRS/INEE	1	0

The first two days were assigned to fieldwork, on microclimates (UCD campus) and on city-scale land-use and land-cover and climate impacts. From Tuesday to Friday, the UDCW work was completed in the Urban Design Studio on UCD campus. In this phase of the workshop, the students were divided into teams to focus on Planning, on Design and on People. On Saturday, the work of the students was presented (Table 2). Throughout the Workshop phase, experts presented work on Dublin's plans to become Zero-Carbon, on models and techniques to support Carbon management and on the City Edge project.

Table 2. UDCW Teams	
Team	**Brief**
Plan	Focus on the infrastructure and layout of the area to facilitate the People and Design teams. This should cover the land use considerations and provide some justification for your decision making expressed in Carbon terms; this should include for example, the flows within Kylemore, between Kylemore and the city, the nation and the world
Design	Consider the type of buildings and layout to accommodate the residents/workers/visitors identified by People. It should look at a sample of built/natural environments within Kylemore and seek to maximise opportunities for enhancing green spaces. It should also account for existing land-cover and residents.
People	Given the expected residential/worker population for Kylemore, imagine how the 'future' population will live/work – what sorts of families, jobs, etc. Derive 'day-in-life' scenarios to These provide the assumptions for the design team and reflect the partitioning of the land use as described by the Plan team.

Table 3. UDCW Schedule

Sunday 4th June. Urban Climate Walk
Urban Climate Walk UCD: The walk introduces microclimate types and the physical controls on the climate near the ground. The walk will select specific environments to discuss the relationship between surface cover and climate outcomes. See Appendix 1.
Monday 5th June. City centre & City Edge field study
Dublin City & City Edge field study: Place the case-study area in the context of Dublin's climate change policies and its commitment to achieving zero Carbon. An overview of the geography of the city and its building patterns. The second half of the day examines the neighbourhoods in the west of Dublin, especially the areas of Inchicore and Kylemore. The latter is one of the five districts that comprises the City Edge
Tuesday 6th June. Urban Design Studio
Review of materials: Introduce UDCW and organise the Design/Plan work for the remainder of the week. Talk: **Zero Carbon Dublin Sabrina Dekker**, Dublin City Council's Climate Officer, who will outline the City's plans to manage carbon in the context of its status of an EU 100 city. These Teams should work in the afternoon on their component of the study. **The Govern team:** This team will go by public transport to Inchicore to meet with the Community group (Common Ground). We will be introduced to the issues that face residents of the neighbourhood with is adjacent to the Kylemore site, including the provision of green spaces and social housing.
Wednesday 7th June. Urban Design Studio
Talk: **Models to support zero-carbon design/planning**. Dr. Niall Buckley (IES) will discuss the tools available to evaluate pathways to design and plan zero Carbon neighbourhoods using Urban Building Energy Models (UBEMs). Talk: **Bio-solar roofs in cities.** Emmanuel Gendreau (Sorbonne) will present on the potential for using roofs in cities as a resource. Each team to give a present short verbal presentation on the status of the work. We will be joined by Francesco Pilla (Professor of Smart Cities at UCD).
Thursday 8th June. Urban Design Studio
Talk: **From Edge City to City Edge**. Philip Lawton (TCD) and Carla Kayanan (MU), which places the project in an international urban context.
Friday 9th June. Urban Design Studio
This should be a status report from the teams and a discussion of the work for the day. An important part of the workplan should including writing tasks and the development and inclusion of graphics (including maps, figures, and photographs) and tables. As the emphasis in this workshop is on Carbon, the text should place the work in this context. At the end of the day, we should have a first draft of the text and of a presentation of this work
Saturday 10th June. UCD Village
Formal presentation of work. This event will take place in the UCD Village. Each team will present the work, along with an overview to the audience.

The Urban Climate Walk took place on Sunday 4th June and is described in *Appendix 2*.

2.1 Fieldwork: Dublin and City Edge

The fieldwork part of the UDCW was designed to place the City Edge project within the wider urban context and to outline the challenge of creating zero Carbon cities. The excursion took the form of an east-west path forming a cross-section of the city. There were four major stops where land-use and land-cover were discussed in the context of urban metabolism, that is the resources needed to build and sustain the city (Figure 4).

1. City centre: This focussed on the 'old' city and its built landscape most of which was constructed before building energy regulations. The dense urban environment provides the opportunity to discuss the quality of outdoor spaces and the attempts to enhance greening by creating small parks and street tree parking. The group walked from the city centre toward the Custom's House and the newer part of the city, built from the 1980's.
2. Docklands: The group took the LUAS along the northside of the river Liffey stopping at the Point. This path demonstrates how the new City has emerged with a focus on commercial/financial services and apartments. The landscape provides examples of what can be described as 'business-as-usual' development.
3. Port and Grand Canal: The group crossed the east-link bridge into Ringsend, across the Dodder River and into the Grand Canal Dock. This section of the trip allowed us to look at waste/energy management at the city scale (Poolbeg), river and flood management and the re-design of a space that had a transport/storage purpose.
4. Kylemore: This was the final stop of the field excursion to the site of the case-study. The Luas transported the group to the Kylemore stop from where we moved to a vantage point opposite Labrea Park. The site itself is defined by the Grand canal and the western railroad into Dublin.

Figure 4. The fieldwork route.

2.2 Design Studio

Over a four-day period (Tuesday-Friday 6th-9th June) each of the teams (Plan, Design & People) worked on their individual briefs, while ensuring that each team was aware of what other teams were doing. The UDCW had four lectures relevant to the workshop:

- **Zero Carbon Dublin**. Sabrina Dekker, Dublin City Council's Climate Officer, outlined the City's plans to manage carbon in the context of its status of an EU 100 city.
- **Models to support zero-carbon design/planning**. Niall Buckley (IES) discussed the tools available to evaluate pathways to design and plan zero Carbon neighbourhoods using Urban Building Energy Models (UBEMs).
- **Bio-solar roofs in cities**. Emmanuel Gendreau (Sorbonne) presented on the potential for using roofs in cities for both greening opportunities and solar energy generation.
- **From Edge City to City Edge**. Philip Lawton (TCD) and Carla Kayanan (MU) placed the project in an international urban context and considered if the categorisation of 'brownfield' was appropriate.

In addition, the People team met with a community group (Common Ground) located in Inchicore to discuss general issues that face inner city residents. Common Ground focus on issues of social housing, gentrification, environmental quality, and resilience. Although Inchicore is not in the study area, Kylemore will be its adjacent neighbourhood and there will be a need for integration.

Much of the lectures and discussions were confined to the morning periods. The afternoons were devoted to teamwork using a variety of tools to support research into the current state, the business-as-usual case and the best practice (zero Carbon) case. Common elements to work carried out by each team included the use of boards to capture ideas (Figure 5), co-ordinated discussions with all the teams (Figure 6), mapping exercises to 'fit' plans to the site (Figure 7) and imaginative construction of a 'day-in-the-life' of future residents (Figure 8).

Figure 5. Ideas boards

Figure 6. Group discussion on plans for Kylemore.

Figure 7. Creating places in the neighbourhood associated with emotional responses.

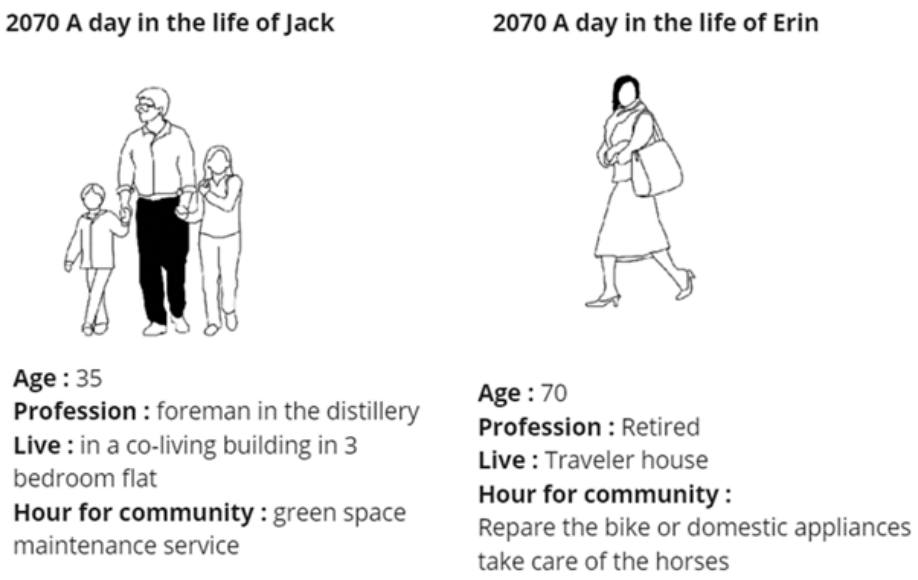


Figure 8. Using 'day in the life' to link people with place.

2.3 Final Presentation

The UDCW was concluded on 10th June with presentations by each of the teams (and team members). This took place in a meeting room at UCD Village (Figure 9). The presentations by the Plan, Design and People teams were discussed. The elements of a new district with a focus on Carbon management were outlined; these included a plan to create a neighbourhood with a distinct personality, to re-use and enhance infrastructure that is already present, such as the Canal and the railway, and to imagine new ways of living in a post-Carbon world. A particular emphasis in the workshop was the consideration for the use of low Carbon materials and utilising the local resources to mitigate and adapt to climate change and create an environmentally sensitive landscape.

Figure 9. Images from the final day.

3. People team

This chapter summarizes the research conducted on the future population and their projected lifestyles/occupations. Further, the team's research into carbon neutral, sustainable, and livable communities, as well as other related design concepts will be presented and discussed in conjunction with different design objectives. Based on the defined themes, a case study has been selected, which encompasses most of the specified design objectives and illustrates Kylemore's potential for future development. The people team's work provides assumptions for the design team and reflects the division of land use described by the planning team.

On site currently, there are mainly industrial uses and low-density retail with one small residential area of Irish Travelers known as “Labre Park” which is a historic site as it was the first site built specifically for Travelers by a Local Authority in Ireland. Labre Park was originally opened in September 1967 at a cost of £50,000 and consisted of 39 concrete 'tigíns' in a row off Kylemore Road. We did not have access to residents of this community to ask for their insights and needs but believe that further engagement is absolutely essential and required for any true redevelopment of the area. We also emphatically believe that the Halting Site and the Travelers should be able to stay where they are, of course with improvements or expansions as necessary and desired by the population.

3.1 Community engagement

Our team had the opportunity to visit with a community organization nearby to the proposed “City Edge” Kylemore District which is the focus area for this workshop. The goal was to understand the existing needs of the surrounding neighbourhoods and communities to ensure the new district is woven into the existing fabric of the community. The organization we were able to meet with is known as Common Ground and is a community arts organization that has been working with the local community since 1999 to ensure equal access to the arts for everyone. With the deep roots they have developed and with the people in the area, they were able to assist with hosting a tour from a local non-profit and an overview of some of the desires and interests of the local community. What emerged from these conversations was captured below in notes first, and then in thematic areas (Figure 11).

Figure 10. People Team visiting the Goldenbrige neighbourhood

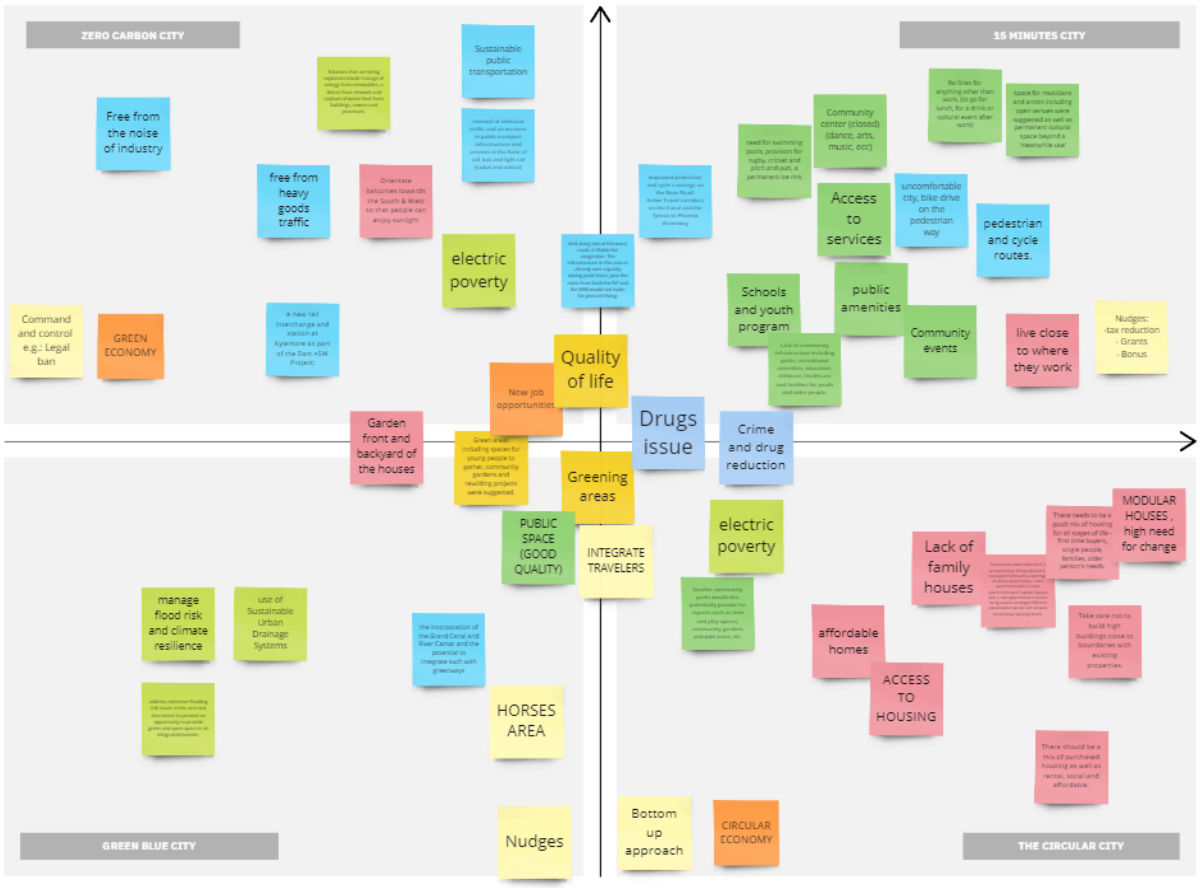


Figure 11. Organizing ideas based on meeting with Common Ground.

3.2 City Edge planning & design parameters

The City Edge project has estimated a future potential population for the Kylemore District between 12,500 and 13,500 people based on the capacity and developable area of the site. We used the median of that population projection, 13,000 people, as a baseline for our exploration of what a future community would look like on the site and to give the Planning and Design teams the population details.

Using a population of 13,000 people, we estimated the make-up of the residents in 2070 using projections for Dublin City and based on the issues that arose during the community engagement (Table 5). We estimate that this population will have an average age of 38 and that 13% of the population will be over 65 years and 18% will be under the age of 15. The total number in employment will be over 6000 of which 41% will work at least one-day from home. To accommodate the population, there will need to be over 5000 housing units, with associated community facilities. The working population of the area is estimated to be 16,000 spread over a number of businesses that are mostly located on the eastern side of the site, close to the trainline.

Table 4. The guidelines provided as part of the Strategic Framework for Kylemore.

Kylemore	
Potential population	12,500-13,500
Potential jobs	15,550-16,550
Area	
Gross area (ha)*	90
Developable area	63.3
Plot ratio (FAR)	
Plot Ratio	1.5-3.0
Community infrastructure	
Primary School places	1512
Post-primary	986
Primary care centres	Min 2
Childcare facility**	60
Community centre	2
Community parks	3

*Not including major green infrastructure
**20 place facility

Table 5. Characteristics of Kylemore residents in 2070

Demographics and employment		Facilities & employment	
Population	13,000	Primary schools	2
Female	6638	Post primary schools	1
Male	6362	Childcare	80
Age over 65 years	1744	Community centres	5
Age under 15 years	2398	Community Parks	5
		Healthcare centre	1
		Playgrounds	20
Employed	6231	Businesses	126
Work from home	2540	Housing units	5358
Own home	7540	Healthcare centre	1
Rent	4690	Jobs onsite	16000

The People team also considered how best to provide an identity for the new area by considering aspects of landscape & heritage, visual arts and food & entertainment. Figure 12 represents our plan for the elements needed in the new community based on our conversations with Common Ground and the surveys completed as part of the surveys done by City Edge project.

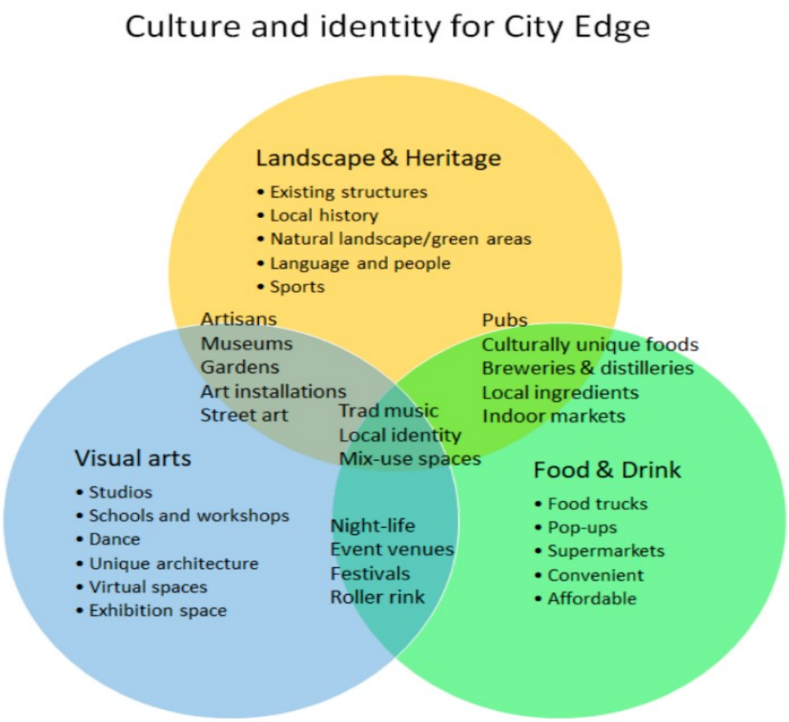


Figure 12. A vision of the elements needed to create a culture and identity for Kylemore.

Table 6. The Strategic Objectives for the City Edge development

Theme	Objective
Liveable city	Follow compact growth & 15-minute city principes
Economy	Create a resilient and diverse employment offer with scope for up to 65,000-75,000 jobs.
Housing	Accommodate a range and variety of new homes for up to 75,000-85,000 people
Natural infrastructure	Target 50% green cover
Movement	Focus development on the provision of active and public transport
Character	Knit into existing neighbourhoods and creat a series of character areas that enhance Dublin
Community	Integrated urban services and resources
Sustainability	Fast-track to zero carbon and zero waste
Deleivery	Creat a deliverable and credible framework

The team examined Kylemore in 2070 within the framework provided by the City Edge strategic objectives (Table 6; Figure 3). After conducting a review and analysis of the CityEdge project and other 'business as usual' cases, the team decided to expand the strategic objectives and explore additional possible goals and interventions that could benefit the development. This decision was made to improve the resilience and adaptability of the existing plan as well as to place a greater emphasis on community engagement and participatory planning. Figure 13 shows the subthemes identified for each objective (goal) and more specific design interventions.

Figure 13. Thematic goals, themes and interventions.

- **Liveable City** & **Environment**: The team found it imperative to include themes targeting People Centric Design, Green and Blue Infrastructure Network and Low Carbon Lifestyles. It became apparent that potential interventions should focus on increasing and enriching the green and blue infrastructure of the area, while also establishing connections with the surrounding infrastructure. These measures have the capacity to improve walkability and to promote a healthy lifestyle. The team found that there is considerable potential in creating shared spaces and streetscapes, as well as ensuring that the new functions and services are arranged in a spatially, socially, and environmentally just manner. Furthermore, alternative strategies to harvest energy from livestock waste cycles and micro-algae cultivation provides interesting alternatives for power generation.
- **Economy**: We identified a high potential for Local Resource Management and Food Production of existing and alternative products (e.g., algae, mushrooms etc.), which is not only beneficial to the green economy but also has the potential of providing new employment opportunities for the area. The interventions defined by the team include elements focused on existing commercial function (e.g., beer brewery) as well as new possibilities (e.g., digital innovation, low carbon building materials etc.).
- **Housing:** In addition to providing Diversity, Affordability and Climate Resilient Solutions (e.g., recycled building materials), one of the key points to mention was the Experimental Phasing of Developments. In this process, the constructions and interventions are carried out in different phases, giving room to discover the planned and unplanned consequences of the design interventions and feeding the learning curve of the development. Among other things, this includes the examination of how the people interact and behave in the new environment as well as how the implemented solutions affect the existing urban realm. Taking into consideration future expectations, this category also involves goals related to flexible remote and hybrid working styles, modular building techniques for potential expansion and lifelong homes. The idea of creating a dynamic urban fabric, where the functions are mixed, has the potential to provide accessibility to every vital service within fifteen minutes of walk (15-minute city).
- **Transportation**: Environmental Friendly and People Centric Design methods were discussed, prioritizing Micro Mobility and Shareable transport. Key issues include the need for infrastructure improvement, including freight train systems, speed designated travel lanes and streetscapes, smart micro mobility enrichment, sharable EV options and the no car policy.
- **Character** & **Community**: The preservation of Existing Values (e.g., Grand Canal, Traveler Culture, Roller Derby etc.), the Character Experience Enhancement and the importance of Participatory Planning and Inclusive Community Engagement have been explored. Notable is the power of involving the community before, during and after the developments to improve the plans and to help in acceptance. Later on to build the community, it is important to allocate time for community management each week (4+1 workweek structure), to provide dispersed, dynamic and adaptable spaces and to encourage different social and age groups to participate.
- **Sustainability**: We focussed on three main themes, Energy Recycling, Water Sensitivity and Sustainable Waste Management. Apart from harvesting, storing and reusing energy and rainwater on-site consciously sorting and handling waste also has the capacity to contribute to a more sustainable and resilient neighbourhood.

Figure 14 shows the links and overlaps between the defined design goals and interventions, a graph was developed to illustrate the relationships and the network of thematic goals. To help with generating ideas for Kylemore, the team identified the BudaPart project (Budapest, Hungary, see Appendix 3), which is a large-scale brownfield development.

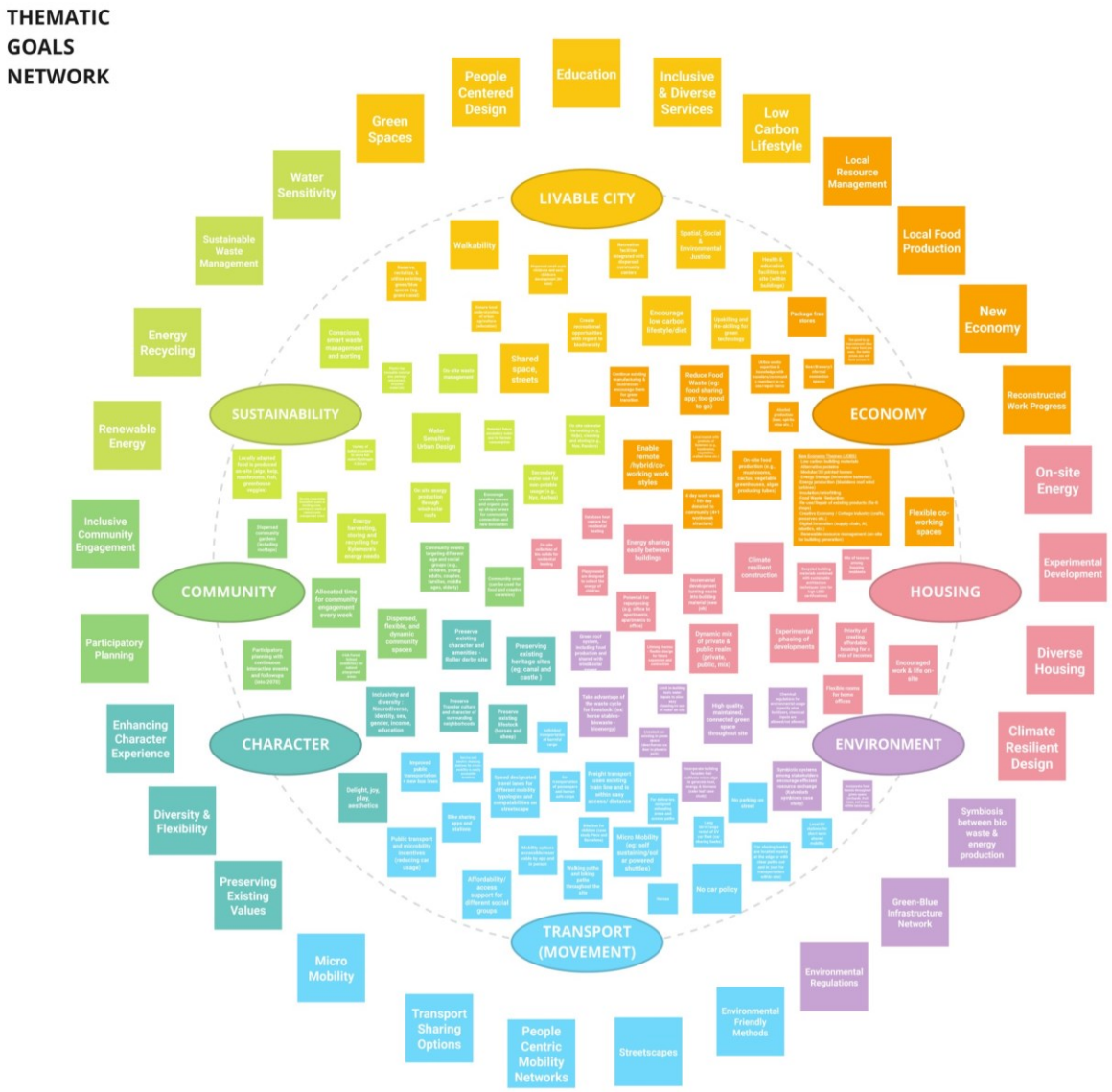


Figure 14. Idea map generated for future Kylemore.

New Industry: Re-visioning the future of work in the Kylemore district, we envisioned this space to be a dynamic mix of the green industry, office, and creative industries (Table 7). After careful research and brainstorming, the following green industries emerged as both trends for the future of work as well as good fits for the logistics of the neighbourhood and population. After identifying the main emerging industry themes, the team worked to understand the spatial implications for these industries in terms of access to rail, storage space, laboratory space, and office space.

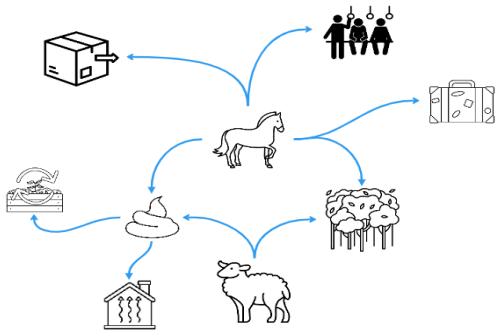
Table 7. New Economy Themes (jobs)

Low carbon building materials 18,580 m2
Alternative proteins – lab space
Modular/3D printed homes
Energy storage (innovative batteries)
Energy production (bladeless roof turbines)
Brewery/distillery
Food waste reduction
Re-use/Repair of existing products (fix-it shops)
Creative economy/Cottage industry (crafts)
Digital innovation (supply chain, AI, robotics, etc.
Renewable resource management (on site)

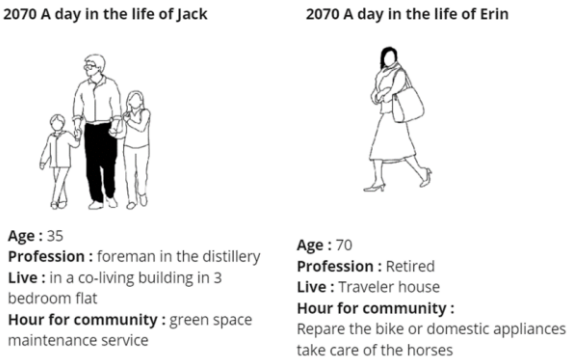
Life in 2070: To design the future neighbourhood we considered what life might be like for residents: How do they eat?; What jobs will they have?; How will they deal with resources (waste, energy, water and food)? What will be the transport options? For example, we considered options for food based on the 50 Foods of the Future report[3] taking into account the agricultural capacities of Ireland and Dublin:

- Fish can be transported by trains to a new station at Kylemore
- Rice and mushrooms could be grown along the canal
- Carrots and potatoes and peas will grow on the urban farm

Considering the identity of the Kylemore village in 2023, it is important to place in the context of 2070. For example, given the presence of horses in Kylemore now, these animals could form an important part of the economy, environment and society.



A useful way of putting these ideas into daily patterns of life is to imagine a typical **day-in-the-life** for selected individuals and trace their pathways. We have selected two persons (Jack and Erin) and consider their unique needs, characteristics, and daily routines.



[3] (https://www.wwf.org.uk/sites/default/files/2019-02/Knorr_Future_50_Report_FINAL_Online.pdf)

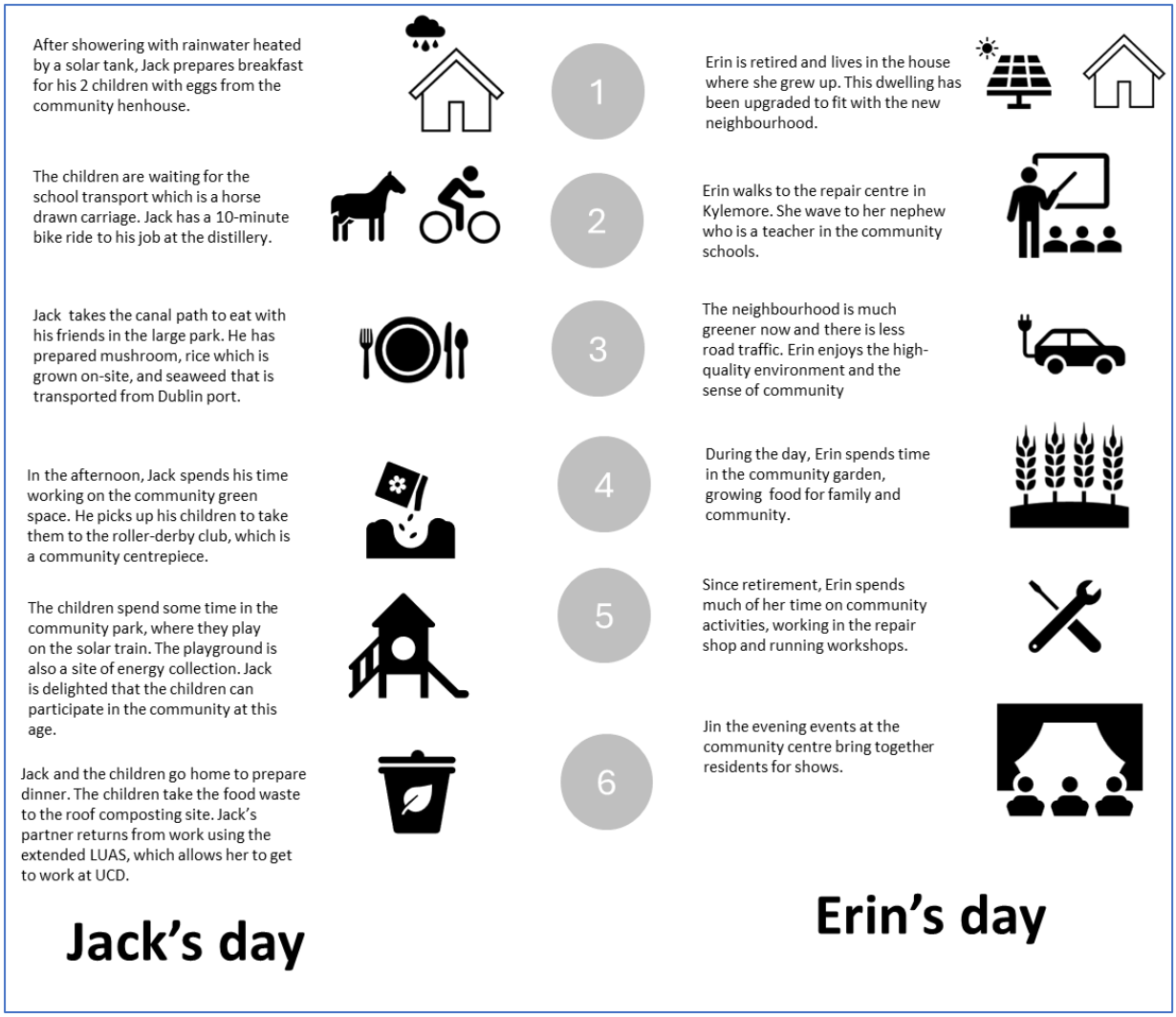


Figure 15. A day-in-the-life for two individuals

4. Planning

The planning team focused on 2 aspects, namely:

1. Land Use zoning of Kylemore, ensuring connections with the surrounding areas and the Dublin city center, considering green areas and transportation
2. Envisioning a net zero carbon neighbourhood for Kylemore and estimating the carbon balance

4.1 Land Use zoning of Kylemore and connections

For this first part, the area around the district of Kylemore was analysed to ensure that it is not regarded as a closed-off district, but a district that fits into the whole area. This means connections of green areas and transportation are needed.

Green and blue infrastructure: Figure 16 shows the distribution of natural infrastructure as it exists now. Dublin is a relatively green city with some large public parks and some undeveloped land. Many of these parks are designed as playing spaces with limited walking paths or landscape design; there are relatively few trees. The blue infrastructure in Kylemore consists of the Grand Canal, which has a walking path; nearby the Camac River flows through the City Edge site. One of our planning goals is to create ecological corridors that will help implement biodiversity and CO2 absorption.

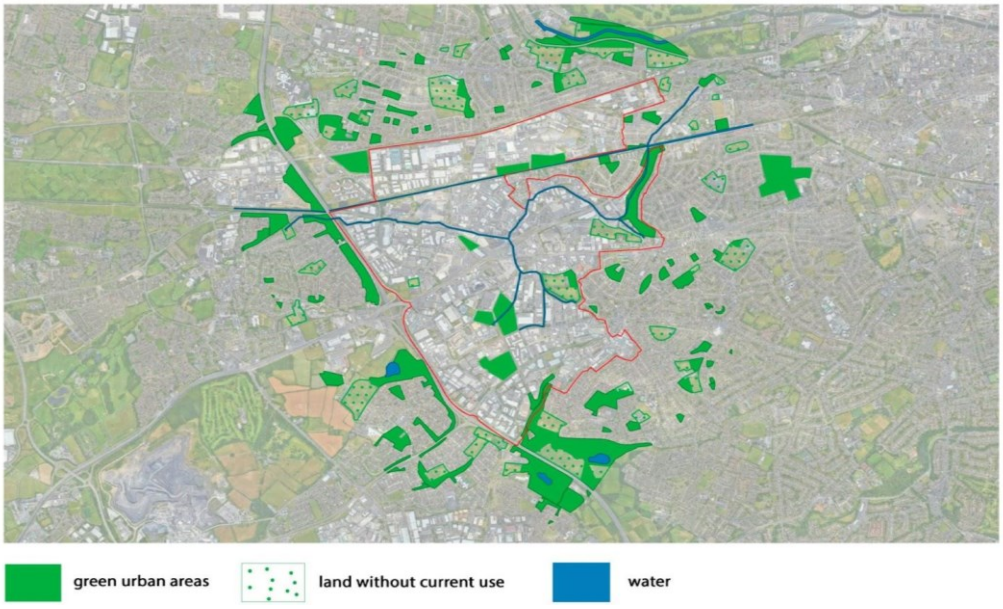


Figure 16. Current (2023) Green and Blue infrastructure in City Edge.

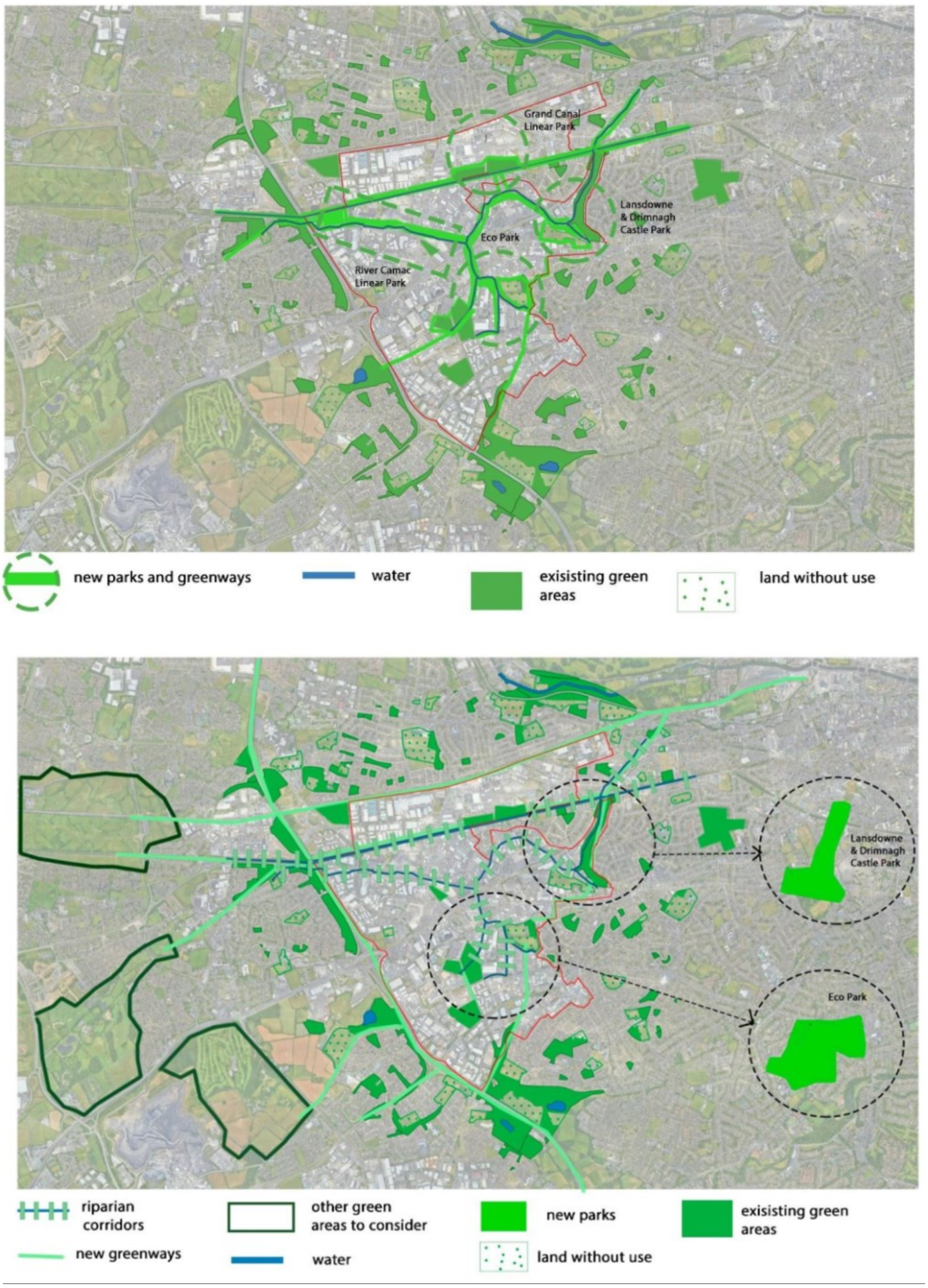


Figure 17a&b. Planned (above) and enhanced (below) blue-green infrastructure.

Under the business-as-usual (BAU) scenario proposed in the City Edge outline, green connections will be enhanced through the revitalization of the riverbanks and the creation of four large parks (Figure 17a). Here, we have chosen a more ambitious green/blue plan that emphasises connectivity. Our aim is to protect existing green spaces, add new green spaces that are currently undeveloped and to connect these with spaces outside the City Edge site. Our focus is on enhancing green infrastructure and developing and protecting riparian corridors to manage the risk of flooding of the Camac River (see Figure 17b). Figure 18 illustrates the multiple benefits of flood management for the community.

Figure 18. The multi-benefits of flood risk mitigation.

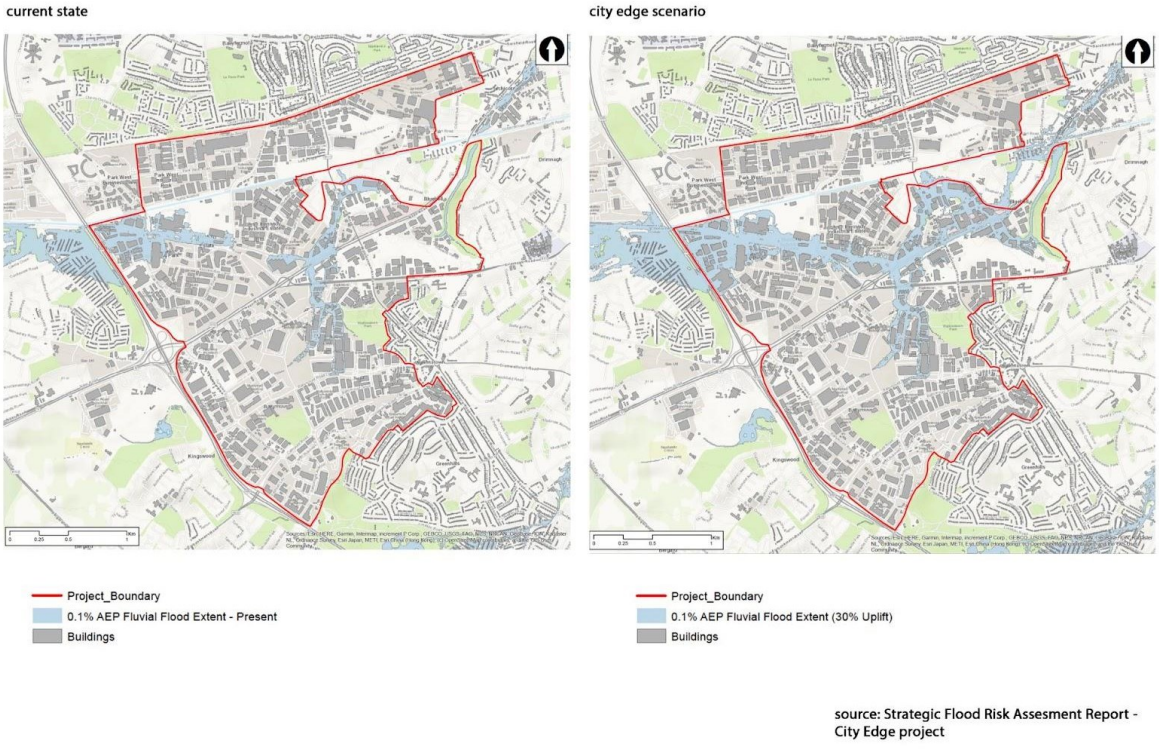


Figure 19. Flood risk estaimates for the City Edge project based on current and future development. Source: CityEdge development plan.

Figure 19 shows the flood risk estimates for Kylemore and in the future based on the City Edge development document. Table 8 outlines our design strategies for enhancing flood management. The preservation and creation of new riparian corridors would require the elimination of engineering works that have forced the river into a narrow path compared to the original channel; this would be complemented by planting of local hygrophilous plant species. Additional measures to intercept runoff (increasing tree cover, creating bioswales and raingardens) would reduce urban runoff.

Table 8. Strategies for improving green/blue infrastructure.

	STRATEGIES	MEASURES	BENEFITS (to reduce flooding risk)	ENVIRONMENTAL BENEFITS
1	Preserve, create and expand riparian corridors 	- remove river engineering along river banks - planting new riparian appropiate species	- reducing outflow velocity of water - erosion protection - river bank stabilization - protecting from excessive sedimentation	- shelter for aquatic animals - improvement of water qualitiy - reduce habitat fragmentation - bring organic matter (leaves or dead wood) -implement grasses
2	Implement green infrastructures 	- bioswales - raingardens - implement urban tree cover	- intercepting urban water run-off	- water reuse - implement green - implement biodiversity

Built (grey) infrastructure: According to the City Edge Strategic Framework, *City Edge is located in close proximity to the city center and could offer a huge opportunity for the creation of a livable city based on the principles of walking, bicycling and public transportation*. The site is currently by several public transportation lines: Luas, the Kildare rail line and frequent bus services, as well as regional and national roads. However, this infrastructure is insufficient to meet the needs of current and future population, especially in the context of sustainability. There are a series of problems that can be meaningfully improved, such as increasing the number of rail and bus stops, the frequency of services and introduction of bike paths.

Our goals are to:

- Make travel easier for commuters and local workers.
- Directly connect the area to the city center through a bike path as well.
- Connect with major universities
- Improve connections to the surrounding area
- Separate bus and car network/lanes
- Separate bus and bike lanes

The City Edge project includes the implementation of several bus routes, as well as increased frequency of rides. Two new transportation hubs will be created that will simultaneously provide for streetcars and buses and will be located on the main street of the new district (Figure 20a&b).

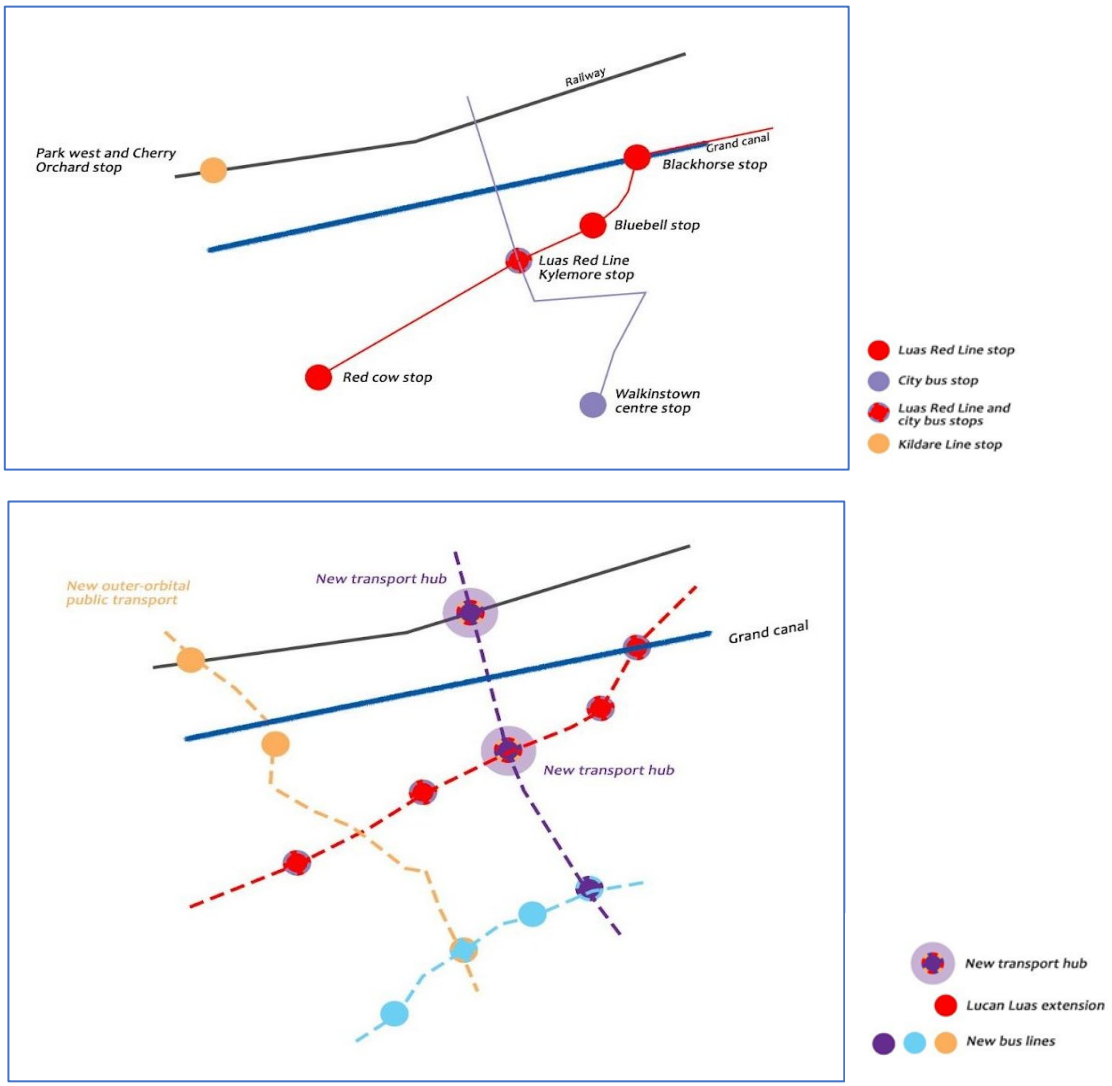


Figure 20a&b. Diagrammatic representation of current (above) and future (below) transport facilities.

Our best practice scenario revolves around two main concepts: creating a 15-minute district and developing a network to connect with surrounding areas. Implementing these would improve people's quality of life and help CO2 reduction. Figure 21 captures the elements of our design. Specifically,

1. New transportation hubs and bus stops should all be within a 15-minute walk.
2. All major features (education, culture, health, leisure) should be in close proximity to the newly identified center and should be within easy walking distance in 15 minutes.
3. Green spaces should be in close proximity to the center and be within an easy 15-minute walk and accessible to all.
4. Neighborhoods should be designed according to a *Mixité* concept:
    - Mix of uses (e.g. employment, retail, social infrastructure, and culture)
    - Mix Housing Types (e.g. houses, flats and, duplexes)
    - Social Mix (families, elderly, students, couples, singles, etc.)

While basic functions such as education and health care, must be within easy walking distance, recreational functions (bars, pubs, restaurants, cinemas, theatre, etc.) may also be located further away. For this reason, two different areas have been designed, a zone with a radius of 1km from the center where everything can be reached within a 15 min walk, and a second zone with a radius of 5km where everything can be easily reached within a 15 min bike ride.

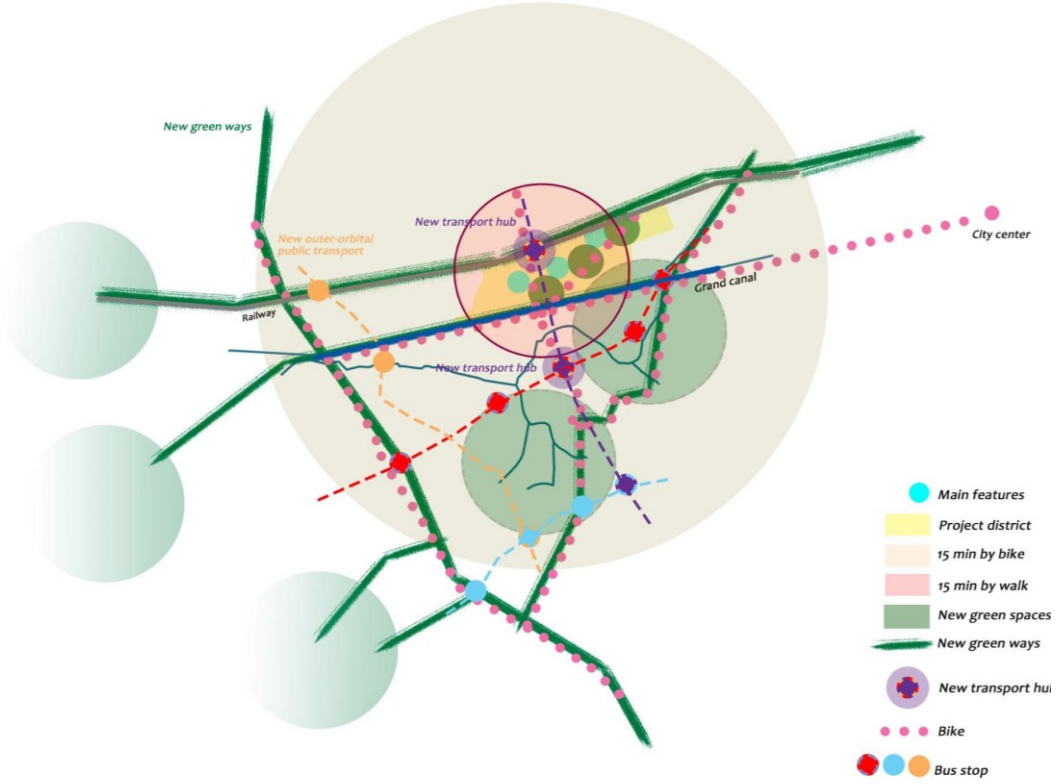


Figure 21. Integration of Kylemore within wider City Edge context.

Using the City Edge transportation network implementation project as a basis, new bicycle routes were chosen to be added, taking advantage of previously identified ecological corridors. Bicycle lanes and pedestrian paths will also be added to the new transportation hubs. Each route will be distinct from that of other modes of transportation, relegating driveways to the three main ones and leaving the rest of the area car-free.

Currently, both green and gray infrastructures are fragmented and poorly connected both to each other and to the surrounding area. The purpose, therefore, is to relate the project area to all neighbouring areas. To avoid the area becoming, it must be well connected to the rest of the city. This will allow not only locals to access the city, but also allow the city to access the area, potentially bringing further economic development to the area. For this, there is a need for a large network of blue, green and gray infrastructure, capable of creating a close connection with the rest of the city of Dublin and surrounding areas, enabling a future flow of people to move nimbly from city center to the new suburb.

Land-use zoning: In the City Edge Project, the envisioned potential capacity for the Kylemore district is 13,000 residents. For the daily lives of these people, they propose 16,000 potential jobs, 2 primary schools, 1 post primary school, 2 community centres and 3 community parks. To accommodate for this, a landuse zoning map was drawn up (Figure 22), taking the plan for connectivity described above.

Figure 22. Land use zoning map for the district of Kylemore.

The communal square around the main street (Kylemore road), is the heart of the district (Figure 22). This should be an open and green square where people can meet, surrounded by leisure activities (such as pubs, restaurants, a cinema). A large underground parking will be situated here to park (electric) cars as well as (electric) bikes; this parking will be accessible from Kylemore road, the only street in Kylemore where cars are allowed. The square is a key feature of the 15-minute district. To envisage this square with large underground parking, we can look to the Gedempte zuiderdokken in Antwerp (Figure 23).

Figure 23. The Gedempte zuiderdokken in Antwerp – a large road which carries traffic hidden by the trees canopy on the right hand side.

Around Kylemore road, there will be high-density residential areas with mixed use, which means there will be retail, leisure, offices or light industry (such as artisanal production) on the ground and first floor and residences higher up. There will also be many small childcare facilities spread across the district to make residents live and work closer to their children. This high-density area will include a mix of housing types and of residents (families, students, singles etc.). On the outside of the district will be lower density residential areas.

In both East and West Kylemore, there will be a community centre to bring people together (organising art and music classes, concerts, community meetings etc.). Both schools will be adjacent to these community centres, with sports facilities close by. In the East, the community centre has a community garden where residents can grow their own food and the school can learn about food production. This vegetable garden leads to a large park that is connected to the "green bike highway" towards the city centre. In the West of the district will be a professional urban farm for local food production. This farm is adjacent to a small community square where markets can be held, potentially also including goods from the Irish traveller community.

In the northeast of the Kylemore area, 223, 00 m^2 of space have been allocated for industry, next to the train rail. We envision the trains will be for both passengers and non-harmful cargo so the industry will be able to make use of this. The main focus lies on innovative industries and those who accommodate a zero-waste living in the area. Research was done by the planning group to identify these "industries of the future" and sizes were taken from case studies to match the allocated site (see Table 9). Subsequently, the planning group planned these into the fitting zones, ensuring that the neighbouring schools can learn from them, and residents have easy access.

The biggest share of the space will be occupied by energy production, which entails warehouses as well as office spaces. Here, energy will be generated, stored and managed. In addition to this, a laboratory will work on innovation and testing pilot-projects on-site. Another use for the area is the production of low-carbon building materials that can be used for building projects in the area but can also be transported to other parts of Dublin using the train tracks. This will be operated in a single-story building with a floor height of 12 m. In synergy with this is an office building where the building of modular homes is managed. Modular homes can be built on-site and do not call for material storage which saves space. To further promote a sustainable diet, a laboratory to develop and grow alternative proteins will be built; it can be configured vertically or horizontally. Another major industry here will be waste management, which includes coordinating food waste and operating a workshop for reuse and repair on-site. On the intersection of leisure and production will be a brewery, operating in a single-story warehouse which will also include a tap room and can attract visitors. Another industry that will be taking place in this area is creative economy with a storefront and a commercial kitchen. Furthermore, the digital innovation industry will take place in an office and a small laboratory space. Lastly, a small office for renewable resource management will be located in each of the buildings in addition to a bigger, regionally operating office.

The following table reflects the initial space requirements that were calculated for each of the industries mentioned above.

Table 9. Suggested use of the available 250,000 m^2 of non-residential building space in Kylemore. These firms occupy 223,000 m^2.

Industry	Area (m^2)	Building type
Low carbon building material production	22580	Warehouse (Single story 12 m)
Modular home design and production	180	Office for project management and assembly - no storage
Energy storage using innovative battery design	2500	Laboratory and Innovation space with testing on site
Energy production using wind turbines	180000	Warehouse for production, storage and associated offices
Alternative protein research and production	2400	Space that can be vonfigured horizontally or vertically but has significant energy demand
Brewery/distillery	6645	Brewery building - One story warehouse types
Food waste reduction enterprise	72	Office to coordinate waste management
Re-use & repair shops	1390	Workshop for on-site repair of small items and retail shop
Creative economy/ cottage industry	1200	Commerical/kitchen to be used for business incubation
Digital innovation enterprises (supply chain, robotics, AI)	6000	Office/labs in the form of clustered office space
Renewable resource management	36	Regional office

In this zone planning, particular attention was paid to the blue and green infrastructure connections and the transport connections. For each a current scenario, business as usual scenario (the City Edge Project) and a best practice scenario (the envisioned project) was drawn up.

4.2 Net zero carbon district

In order to make a district net zero carbon, one must consider all the incoming and outgoing flows of carbon. These can be clustered around 5 themes: energy and heat, transport, materials and waste, urban green infrastructure (UGI) and food (Figure 24). In this workshop, the Planning team did not take into account materials as many of the carbon implications depended on decisions from the design group. Carbon uptake by UGI was also not included as carbon uptake calculations were out of scope.

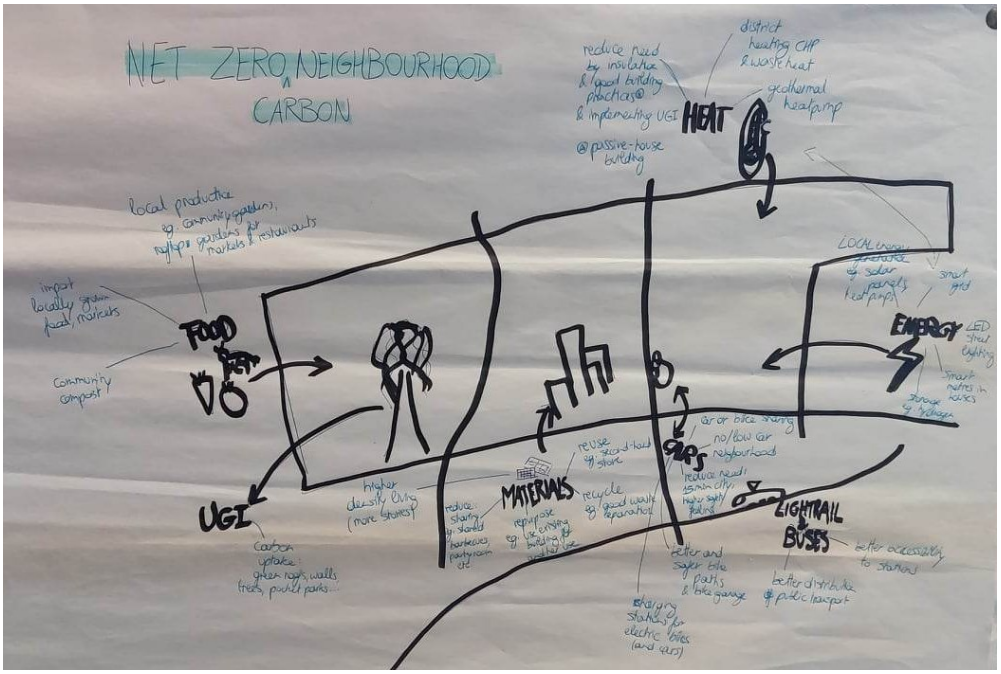


Figure 24. Elements of zero Carbon Kylemore.

4.2.1 Energy

We evaluated future energy needs and the various technologies that could be used to meet demands According to International Energy Agency (IEA), the world population of 9.7 billion people will consume 50,000 TWh of electricity annually. If this energy were shared evenly, the average daily electricity demand based in 2050 is 5155 kWh/person; based on the projected population of Kylemore (13, 500) the total electricity consumption per year is 70 GWh/year.

The domestic heating demand calculations are based on the assumption that all houses will be certified an A1 label of Building Energy Rating (BER), which corresponds to 24.88 kWh/m2/year. For nearly zero-emission buildings (nZEB) the number is lower. Assuming an average occupancy ratio of 2.7 persons per dwelling and a typical household area of 100 m^2, this would mean 5,000 households occupying 500,000 m^2 in Kylemore. The floor area of offices (retail) is 143,756 m^2 according to City Edge planning documentation. Then, for the total area, the heating needs for dwellings and offices with A1 labels are 16 GWh/year. The annual domestic hot water consumption is 1000 kWh per person on average which is 13.5 GWh/year for Kylemore. Therefore, the total heating needed is 29.5 GWh/year. The total floor area of industries is 23,170 m^2 according to City Edge planning documents, however, it is assumed that industries are using waste heat from their processes and from data centres for heating and domestic hot water.

In the following we considered options for local energy generation and efficiencies in energy delivery at neighbourhood and building scales.

Energy efficiencies: Owing to its compact and high-density design there is high potential for district heating (DH) and the Dublin Region Energy Master Plan (DREM) identifies the City Edge Project Area as a Priority Area for DH (Climate Action Plan 2021). 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 fewer 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 fewer pumping requirements, which can reduce running costs significantly.

Energy generation: There are a number of potential sources of energy that can be used in the context of the District Heating System.

Geothermal energy can be used via heat pumps and horizontal or vertical closed loop systems, depending on local resources. Horizontal closed loop systems rely on soil moisture and the composition and thickness of the subsoil; in Ireland, groundwater and soil temperatures are relatively constant all year round and typically range from 9.5 to 11.5 °C. Ireland also has recognised the potential for deep low-to-medium temperature geothermal energy resources suitable for large-scale or district heating and cooling in municipal, residential and industrial areas.

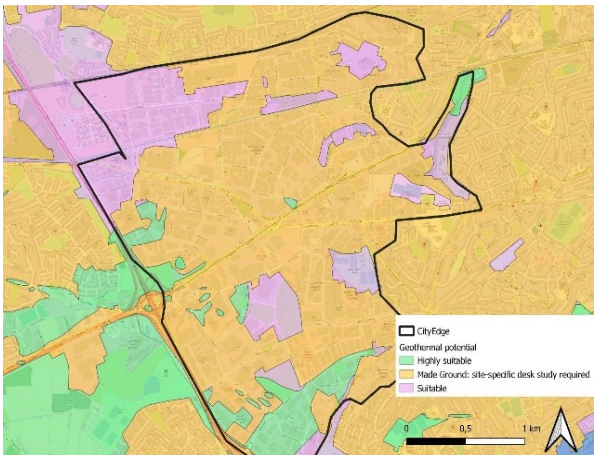


Figure 25. Geothermal energy sources in Kylemore.

Figure 25 shows two suitable spots in Kylemore loacted in planend green areas. At 100 m depth in Ireland, the estimated temperature is up to 22°C and the bedrock in this area is mainly limestone with a thermal resistance of 2.5 W/(m K). Both parameters are very promising for district heating in this area. We estimate that 8 heat pumps (Carrier 61XWHZE) with a nominal capacity of 1.57 MW each could meet all of the heating demand. This is based on the Ygeo Project, which serves a neighbourhood of Paris. The heating needs there are 12 MW with a heat pump system connected to a geothermal heat source, located at 1.8 km depth. The heating network is 10 km long and delivers more than 100 GWh annually to apartment buildings, public facilities and businesses. [Another technology that coule be used is a closed-loop *water source pumps* that can meet heating and cooling demands by distributing water from source that experiences little annual temperature change. In Kylemore, the Grand Canal. Canals can provide a relatively stable and renewable source of water for heat exchange but, it is important to take into account potential environmental issues.]

Wind energy: While solar energy covers a significant portion of the electricity demand in the Kylemore district, the integration of wind energy can still be considered, albeit on a smaller scale. Due to various constraints such as planning regulations, urban location, acoustics, aesthetics, and shadow, the installation of a large wind farm may not be feasible in the area. However, the availability of space allows for the introduction of a small- or medium-sized wind turbine, particularly in the industrial part of the district.

Although the Kylemore district benefits from a favourable location in terms of wind energy availability, with mean wind speeds ranging from 6 to 7 m/s, it is important to balance the energy potential with the concerns of the local community. Placing a wind turbine in a mixed area with residential purposes is often met with resistance from locals, as it can negatively impact the aesthetics and generate concerns related to noise and visual impact. Such factors can also reduce the willingness of individuals to purchase or rent accommodation within the Kylemore district.

To address these considerations, it is advisable to restrict the placement of the wind turbine to the industrial part of the district. By situating the turbine within the industrial area, potential noise and visual impacts can be mitigated, minimizing any adverse effects on nearby residential properties. This approach ensures that the benefits of wind energy generation are harnessed without compromising the residential appeal and desirability of the Kylemore district. A modestly sized wind turbine installation, covering an area of approximately 10 hectares (0.1 km^2) at this latitude, has the potential to generate an annual output of approximately 7- 7.5 GWh. This additional wind energy can complement the predominantly solar-powered electricity supply, promoting a more balanced and resilient renewable energy ecosystem.

For individual houses or offices, *air-source heat pumps* (ASHPs) can complement the district heating system. ASHPs work by extracting heat from the ambient air and transferring it indoors for heating purposes. ASHPs can significantly reduce energy consumption. By operating on the principle of refrigeration, using a refrigerant to absorb heat from the outdoor air and then release it indoors through a compressor and heat exchanger, ASHPs contribute to reducing greenhouse gas emissions and combating climate change. By combining district heating with ASHPs, the overall energy efficiency of the district can be maximized while still accommodating the preferences of individual users.

Solar thermal collectors provide an effective and sustainable solution for supplying hot water and supporting space heating and reduce dependence on conventional energy sources, lower utility costs, and contribute to a cleaner environment. Proper planning, installation, and maintenance are essential to optimize the performance of solar thermal systems and ensure their long-term effectiveness.

Other sources of energy can include *waste heat recovery* that used the heat generated by operations like existing power plants/electricity transformers, data centres, breweries, wastewater treatment plants, etc. This waste heat can be redirected to heat residential and commercial buildings within the district. Similarly, data centres, which operate 24/7 and generate significant heat loads, provide another valuable source of waste heat that can be captured and reused. Breweries, which have intensive heating processes, produce significant amounts of waste heat that could be effectively added to the district heating system. Wastewater treatment plants, which treat and process large volumes of water, also generate heat that can be captured and reused for heating purposes. These waste heat sources have the potential to contribute significantly to the energy needs of the Kylemore district, promoting a circular and sustainable approach to energy use.

Electricity: Grid renovation and modernization efforts are vital for upgrading the ageing energy infrastructure in Kylemore. This involves replacing outdated equipment, improving grid connectivity, and enhancing the overall efficiency and reliability of the electrical distribution system. A *smart grid* that incorporates advanced technologies (e.g., sensors, communication networks, smart meters, and data analytics), can optimize energy generation, distribution, and consumption. Advanced monitoring and control systems can be implemented to detect and respond to grid abnormalities, minimizing downtime and enhancing the system's resilience against power outages. A key aspect of a smart grid is the integration of *microgrids*, that is, localized energy systems that can operate independently or in conjunction with the main grid. They consist of distributed energy resources (DERs) such as solar panels, wind turbines, and energy storage systems. By integrating microgrids into the energy infrastructure of Kylemore, the district can enhance its energy resilience, reduce transmission losses, and support renewable energy utilization.

Implementing demand response management strategies is crucial for optimizing energy consumption and ensuring a balanced energy supply-demand equation. By participating in demand response programs, consumers can contribute to grid stability and cost optimization. In the Kylemore district, real-time energy consumption data can be provided to consumers, allowing them to make informed decisions about their energy usage. Dynamic pricing mechanisms can be implemented, encouraging consumers to shift their energy-intensive activities to off-peak hours, reducing strain on the grid during peak periods.

Solar energy: While large-scale solar PV may not be feasible, rooftops present an opportunity to maximize the generation capacity of solar energy within the district's mixed-use houses. In the context of mixed-use houses, where energy consumption extends beyond residential purposes to include commercial activities, the energy generated by rooftop PVs can be utilized throughout the day, eliminating the necessity for energy storage within these specific properties. Furthermore, the diverse groups of residents and businesses within the Kylemore district present an opportunity for innovative energy-sharing initiatives. By establishing community-driven energy networks, surplus solar energy produced during periods of high generation can be shared among different consumer groups. This approach fosters a sense of collective responsibility and collaboration, as individuals and businesses can benefit from clean energy produced within the community.

Moreover, the concept of energy trading can be introduced, whereby surplus solar energy generated on non-windy days can be strategically sold to the west coast or other neighbouring regions. By participating in energy trading, the Kylemore district can contribute to the wider renewable energy landscape, supporting the transition to a more sustainable and interconnected energy grid.

The combination of PVs on roofs with other roof usages, such as green roofs, offers a multifunctional approach known as biosolar. Biosolar integrates the benefits of both solar PV generation and green roofs, maximizing the utilization of rooftop spaces in the Kylemore district. One of the primary advantages of Biosolar is the optimization of space utilization. Rooftops can accommodate both solar panels and vegetation, allowing for dual functionality. While PV panels generate renewable electricity, the green roof contributes to improved thermal insulation, reduced stormwater runoff, and enhanced biodiversity.

Figure 26. Green roof with PV system

According to PV GIS, the annual global horizontal irradiation in Kylemore was 997 kWh/m2 in 2019 and 1027 kWh/m2 in 2020. Therefore, it is important to create flat roofs with PVs facing south with an optimum angle of 53° ideally with a tracking system to maximize the irradiance obtained during a day. The total area of Kylemore is 90 ha, while 50% of it is a green area as per the City Edge plan. Therefore, the available area for roads and buildings is 45 ha. Assuming that only 50% of this area is

supposed to be the roof and only 20% of this roof is available for PVs because of other utilisation of available area (equipment, water tanks for rainwater, green roof, greenhouses, open space for people or invalid orientation of a roof if it is not flat) and the distance between panels. The useful area for PVs turns out to be 45,000 m^2. Multiplying the useful area by the solar irradiance during a typical year (1251 kWh/m^2), the annual solar energy production is 56 GWh which is 81% of the electricity demand in Kylemore. The rest of the demand could be covered by wind energy or bought from the grid if it is 100% renewable by 2050 assuming that Ireland for example, implemented a large offshore wind farm.

Energy storage: For City Edge to be a net-zero carbon neighbourhood, it can provide energy to the rest of the country. This is possible via energy production or storage. Existing projects employ various batteries such as hydrogen or gravity batteries. Pilot projects are also taking place with used EV batteries that no longer provide a useful range but are still capable of storing significant amounts of energy. Other projects to consider for future interoperability include sand storage and inter-seasonal storage.

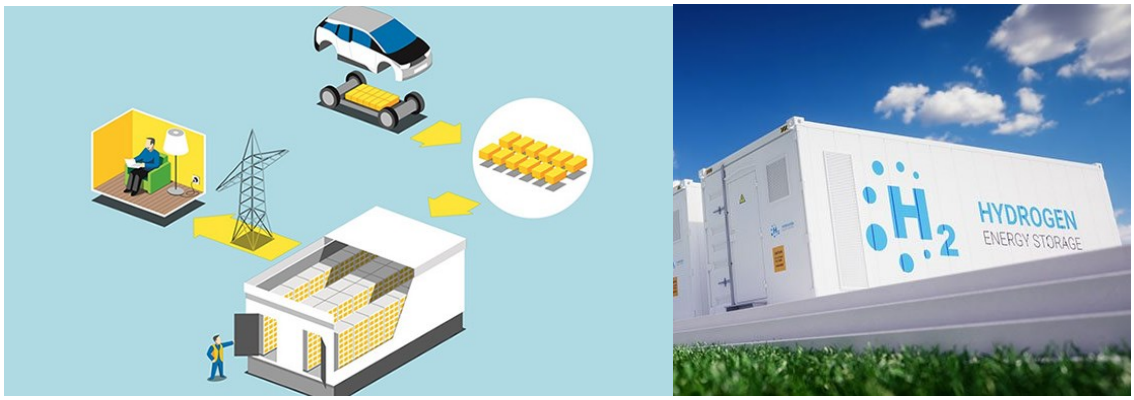


Figure 27. Energy storage using battery systems.

In the vision of City Edge as a net-zero carbon neighbourhood, the concept of Vehicle-to-Grid (V2G) technology plays a significant role in enhancing energy efficiency and grid stability. V2G enables electric vehicles (EVs) to not only consume energy but also serve as mobile energy storage units that can feed energy back into the grid when needed.

It is important to acknowledge that there are energy sources yet to be discovered or fully understood. Advancements in scientific research and technology continuously push the boundaries of our understanding of energy and its potential sources. This could involve new methods of utilizing geothermal energy, extracting energy from oceanic systems, harnessing the power of biological processes, or even harnessing energy from outer space. Moreover, breakthroughs in materials science, nanotechnology, and quantum physics may lead to the development of novel energy conversion and storage technologies. These advancements could revolutionize the way we generate, store, and distribute energy, paving the way for highly efficient and environmentally friendly systems.

4.2.2 Transport

The focus of neighbourhood design is the enhancement and re-use of existing infrastructure to encourage mass transit and personal mobility.

The existing light-rial (Luas) service needs to be enhanced to provide more frequent service to the city centre and other connections. The service takes around 30 min to reach Abbey Street where it intersects with a different Luas line that service the north and south sides of the city. The addition of 2 stations along Kylemore road (one near the park and one in the mobility hub) will make public transport more accessible for everyone. Improving this service will also make it easier to access the national trainline and nearby Hueston station, with connections to Cork, Galway and Limerick. The current bus network does not include an orbital connection around the city using the nearby motorway (M50). In additon, the current bus links to Rathmines and Ranelagh need to be complemented with links to major employment centers such as Liffey Valley, Blanchardstown Centre and Dublin Airport. This will additionally increase draw to the area and its future amenities.

Kylemore is very close to the city centre and could be accessed by bicycle, if the infrastructure were in place. Currently, Kylemore is outside the areas serviced by the public bike schemes (Dublin bike and bleeper bike networks) and this needs to change. The creation of exclusive cycle lanes, away from traffic and pedestrians will also create a feeling of greater safety for cyclists. The construction of simple infrastructure such as covered bike shelters and repair stations can be implemented alongside existing policies such as bike to work schemes to create greater affordability and convenience, raising ridership rates. The expansion of the bike lane along the canal, will enable a rapid bike lane where quick and easy access to Dublin city centre is made possible.

Traditional internal combustion cars are being phased out over time to be replaced by electrified (and other non-emitting) vehicles. In addition there is a desire to reduce the space given over to vehicles generally. Here, we propose a medium-sized parking space under the main square so people can store their (electric) cars there and then take their bike or walk home (within 15 minutes). The neighbourhood would remain accessible for delivery of goods (to retail) or dropping off elderly/disabled people. EVs could be integrated with district scale energy management through a variety of initiatives, such as linking car park spaces with PV canopies and, allowing cars to act as mobile batteries and power the grid during periods of high-energy demand or low production (V2G infrastructure); this can help feed the grid during periods of low energy production. Whilst EVs do not cause noise or air pollution locally, they take up large amounts of space and require expensive infrastructure. Because of this, their access to certain areas should be limited, with a focus on pedestrianizing high-density and high-street areas to create a higher quality of life for residents.

4.2.3 Waste management and materials

In 2022, the average Dubliner produced 138kg of residual waste, 63kg of recycling, and 57kg of organic waste[4]. When translated to the projected population of Kylemore, with the assumption that all households would have a residual, compost and recycling bin, this would result in 205 tonnes of residual waste, 113 tonnes of recycling, and 127 tonnes of organic waste being produced each year. Although emissions are generally trending downwards in this sector, this could easily be overtaken

[4] https://www.epa.ie/resources/charts--data/waste/waste-for-irelands-environment/recovery-and-disposal-of-municipal-waste.php

by population growth. Currently, Ireland is pivoting away from the use of landfills which generate methane, a powerful greenhouse gas and can contaminate soil and groundwater.

Several recycling centres are already in place in Kylemore and these should be enhanced as low-carbon waste disposal sites in the future development. Incineration and energy recovery is currently one of the most popular waste disposal methods, and has helped reduce the amount of waste entering landfills, although it does not eliminate the requirement for them. They have the significant advantage of creating heat, which can be used for power generation or district heating. However, they are expensive to run, pollute the environment and do not encourage reducing waste production.

New technologies are thankfully emerging regarding biological treatment processes[5]. Currently, aerobic and anaerobic digestion allows the breaking down of organic waste into heat, compost, water, methane and carbon dioxide. This refuse heat can further be collected and used for district heating. Any compost acquired can be used within urban farms or in the surrounding countryside. Further developments are also taking place regarding production of hydrogen from biomass, which is expected to become a major component of a 0 carbon automobile and aviation industry. To reduce transport costs and emissions, home composting could also be encouraged. This would additionally serve in community gardens or allotments.

City Edge therefore has the opportunity to shift away from the current municipal waste disposal methods, and process the majority of its own waste within its boundaries. This could further be expanded to collect waste from other parts of the city or country. Combined with the emergence of new technologies, creating a true circular economy, this will allow an offset against embodied carbon costs.

Construction and demolition waste is currently the largest source of waste in Ireland, with 8.2 million tonnes produced in 2020[6]. The majority of this was used for backfilling. Whilst this is a fairly clean method of disposal, it requires further imports of material compared to recycling. Although the current waste treatment methods for C&D waste are already low-carbon due to the reliance on backfilling and recycling within the country, improvements can be made.

Using BIM to create a building's digital twin, and life cycle assessment software, it is possible to calculate the embodied carbon in the construction materials. This allows buildings to be built with a lower proportion of virgin materials, reducing emissions during the construction phase. There are significant quantities of materials on site which can be reused. The disposal of these materials can subsequently be planned in advance, allowing for the choice of materials with higher recycling rates, and the choice of the correct disposal method and site, minimizing the use of materials that would typically be incinerated or disposed of. Whilst getting buildings to net zero will require offsets, minimizing life cycle emissions will increase the chance of meeting this goal.

4.2.4 Food

Currently, Ireland imports about 80 % of the food that is consumed inside the country, more than half of this from the UK[7] (many of these food could potentially be grown in Ireland, such as potatoes,

[5] https://doi.org/10.1016/j.chemosphere.2022.136630

[6] https://www.epa.ie/our-services/monitoring--assessment/waste/national-waste-statistics/construction--demolition/

[7] https://www.export.gov/apex/article2?id=Ireland-Agricultural-Sectors#:~:text=Ireland%20imports%20around%2080%20percent,from%20its%20premier%20trading%20partner)

apples or onions[8]. For a more sustainable scenario, an ovo-vegetarian diet (plant-based with the addition of eggs) is assumed. This is due to the high emissions of the production of meat and milk (https://www.un.org/en/climatechange/science/climate-issues/food).

Looking at the presented future scenario of Kylemore, the main area to produce food is the urban farm, located in the southeast of the study area. If this area of 2.8 ha is used for food production, 725 people's needs could be met by the yield of this farm. This is assuming that an average European consumes 780 kg of food per year (Food and Agriculture Organization, 2018) and an aquaponic farm can generate 200 000 pounds of produce per year[9] (). These numbers mean that around 5.5 % of the population can be provided by from inside the neighbourhood if the whole farm is used for aquaponics. This will vary with introducing other kinds of farming, growing root vegetables or fruits. Furthermore, mushrooms can be grown quite easily and can be considered as a low-intensity food source. Chicken can be kept on the farm which can add educational value but not provide eggs on a large scale. Additional food production can happen on a smaller scale in rooftop gardens and private growing, but this will not be sufficient to make an impact on food provision. The option of using indoor vertical farming has been considered as they produce food more efficiently, but they have been deemed not feasible due to their high levels of greenhouse gas emissions compared to conventional open field farming.

In summary, the farms inside the area (the urban farm and the community garden) cannot account for the nutritional needs of the inhabitants and will mostly serve for educational and recreational purposes. Indeed, those alternative ways of food production are an opportunity to challenge conventional ways of life and consumption, in order to achieve net zero not only through an effective urban design, but also through sustainable lifestyles.

The main source for food will be the surrounding areas of Dublin, as most of the vegetables grown in Ireland today are grown in the Dublin County area. Assuming an ovo-vegetarian an area of 0.35 ha is needed per person per year, which amounts to 4 500 ha for a population of 13 000. Due to the very limited space inside the area, most of this food will have to be brought into the area from outside the city. As most of Ireland's tillage farms are located within the Dublin County area[10] today, this area can act as main source for food. The climate impact of food production and consumption cannot be taken into account very precisely, as it is highly dependent on factors such as where exactly the food is coming from, how efficiently it is grown, and which kinds of food are produced.

[8] (https://horticultureconnected.ie/featured/the-carbon-footprint-of-food/).
[9] https://fish20.org/images/Fish2.0MarketReport_Aquaponics.pdf
[10] https://www.climate-kic.org/wp-content/uploads/2023/03/EIT-Climate-KIC-Ireland-Land-Agri-Food-Systems-Map.pdf

5. Design

This chapter presents a redesign of the Kylemore area to create a carbon neutral, sustainable, and livable community. This design based on an analysis of the current state of Kylemore, the Planning team's calculation of the carbon footprint and land use zoning, and the People team's analysis of on the "future" population and their projected lifestyles / occupations and follows the UCCRN's principles of climate sensitive urban design.

Located on the outskirts of Dublin, Kylemore is an up-and-coming area that is part of the City Edge Program—a comprehensive urban development initiative. Situated in a strategic location, Kylemore offers easy access to the city centre and boasts excellent transportation connectivity. As part of the program, Kylemore is undergoing significant transformation and development to create a vibrant and inclusive community. With its potential for mixed-use spaces, sustainable design, and a focus on community engagement, Kylemore is poised to become a thriving district within Dublin, offering a range of amenities, employment opportunities, and a high quality of life for its residents.

Table 10. Using SWOT Method to Analyse Current Situation of Kylemore

Strengths	Location Natural Assets Transportation & Connectivity Development Potential
Weaknesses	Limited Open Spaces Infrastructure Strain Limited Social Amenities Limited Service
Opportunities	Vacant sites for easier development Existing CIE Infrastructure Grand Canal (amenity) Luas Line F State Owned Land
Threats	Grand Canal (severance) HV Pylons ESB Inchicore Substation Existing CIE Infrastructure Iarnrod Eireann Seveso Site Integration with existing low-rise neighbourhoods -Existing Low Density Housing (Labre Park) -Railway Line (severance)

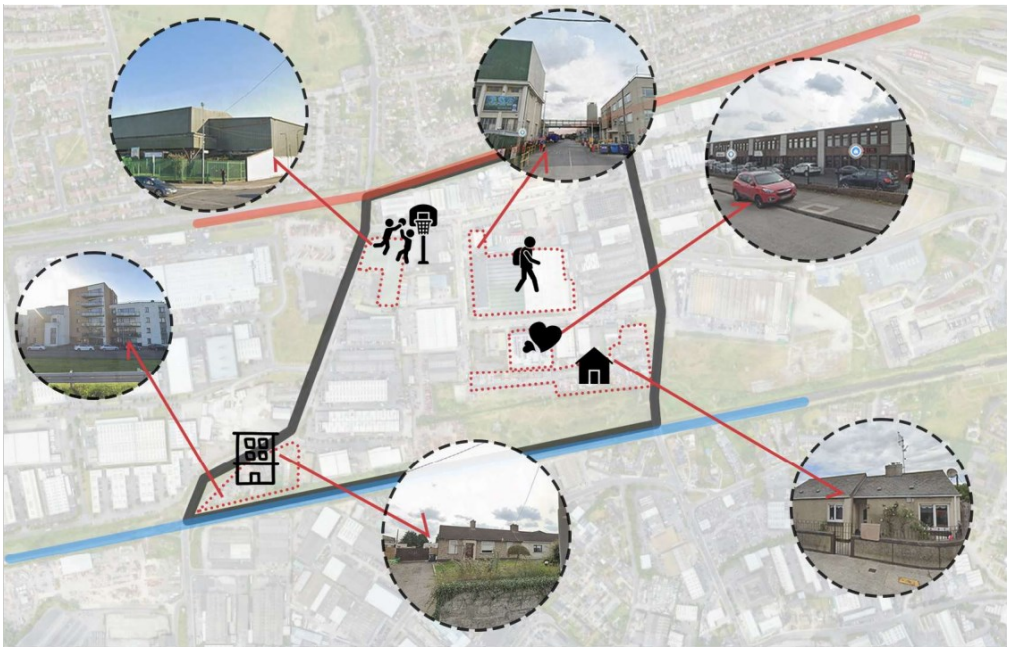


Figure 28. Buildings in Kylemore can be retained and re-used.

We used the SWOT method to analyse the current state of the area (Table 10) and to determine which buildings could be retained (Figure 28) and which would need to be rebuilt in the redevelopment process. The selected buildings capture aspects of the built heritage of Kylemore.

5.1 A diverse neighbourhood

We imagined the Kylemore neighbourhood as consisting of diverse spaces and to envisage the layout, we used a word exercise to connect emotional responses to different parts of the neighbourhood. Figure 29 represents the result of a 'word association' exercise to capture qualitative aspects of life in Kylemore; these expressions reference local agriculture, work, mobility and community.

Figure 29. The word association exercise

The exercise was done to understand the varying uses of spaces has and how an individual might respond. We used this map to shape the Kylemore space and provide a unique character. Given the time constraints we focused the work of the Design team on major areas within the neighbourhood (Figure 30).

In the following we outline key features for the neighbourhood, emphasizing its connection to the city, the types of residential spaces and overall sustainability. Our overarching goal is to design an urban system that has dynamic and vibrant spaces that are well connected.

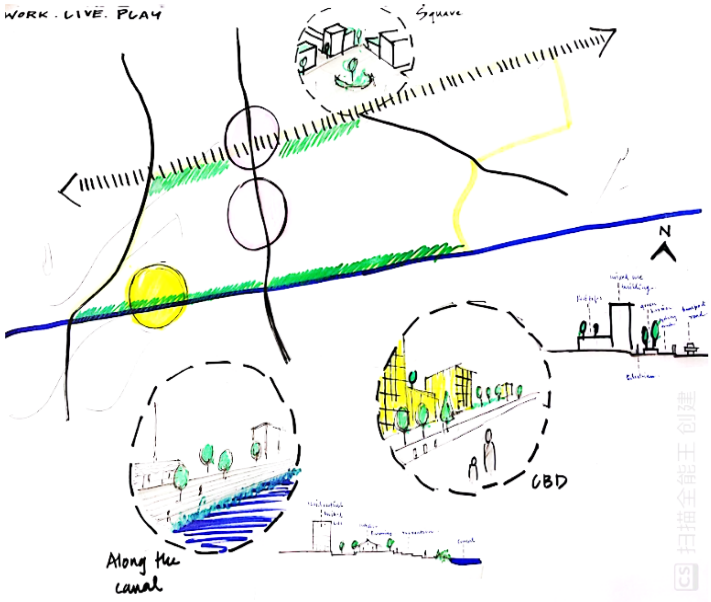


Figure 30. Conceptual sketches for major areas in the neighbourhood.

5.2 Zoning and connectivity

Figure 31 shows the basic land use layout proposed for Kylemore, which has at its center a mixed-use area (pink) which is the core. The areas in blue show the spaces set aside for schools and the community centres and grey represents the industrial area.

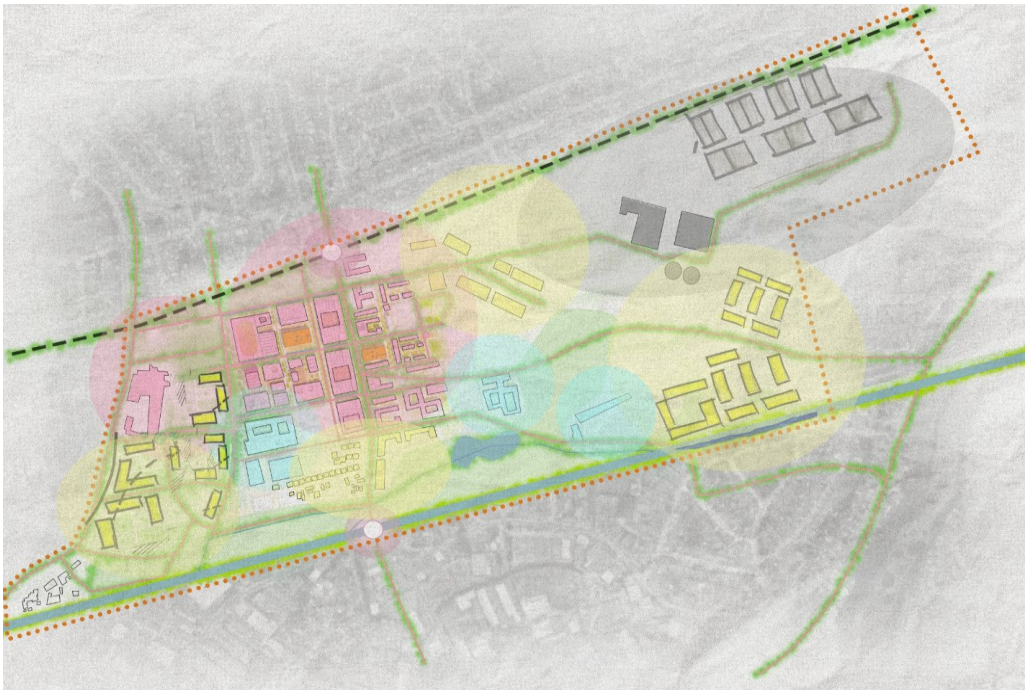


Figure 31. Master plan for Kylemore.

Figure 32. Digital collage of Kylemore spaces
including the areas around the canal, the farm and the town centre.

Figure 32 presents our vision of the different spaces we envisage for Kylemore. A key part of the plan is the integration of the canal into the life of the neighbourhood. The canal represents both an opportunity and a challenge, so we envisage more bridges for pedestrians and cyclists to connect the two sides of the canal. Throughout the year, the canal space would be designed to permit maximum usage both of the banks on either side and the water body itself. Figure 33 shows the use of this space by different age groups over the course of a typical day.

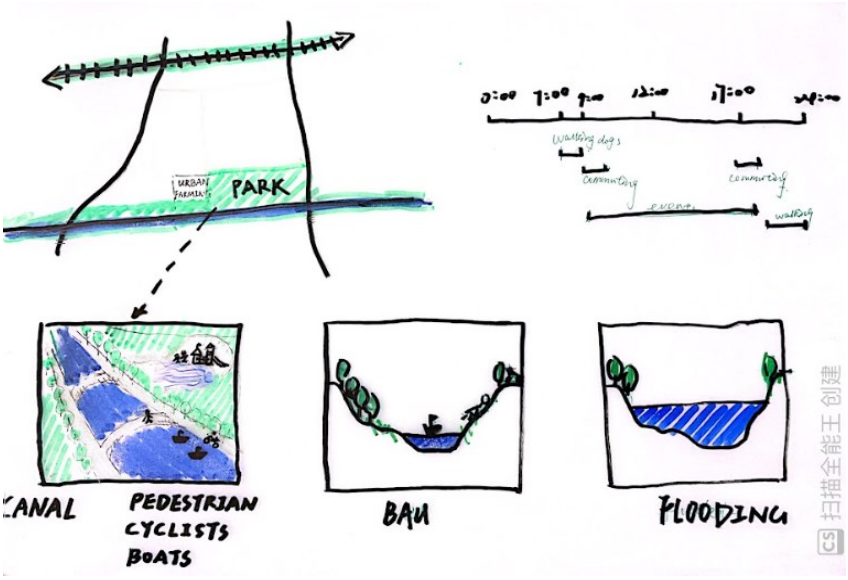


Figure 33. Diagram of the relationship between water and the people in Kylemore.

5.3 Net zero buildings

A central aspect of creating a low Carbon neighbourhood is the design of the buildings.

Figure 34 represents our thinking on the building and operation of a mixed-use building. The construction material would be wood, much of it recycled from other uses. The insulation is A rated and the energy is derived from the district heating system supplemented by PV and heat pumps on site.

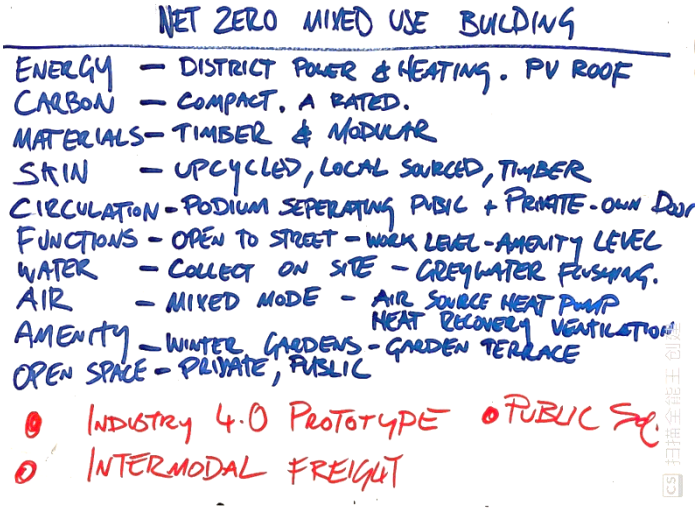
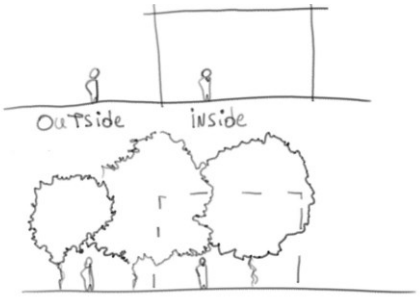


Figure 34. The urban systems at micro level

The idea is to see how we can work on a typology that is in symbiosis with the elements, the sun, the wind, and the materials, to tend toward a zero-carbon project in the future. Creating a zero-carbon neighbourhood is not only the result of technology but of the people who live there and how they will appropriate the neighbourhood. The architectural quality as well as the character plays an important role in the sustainability of the project.



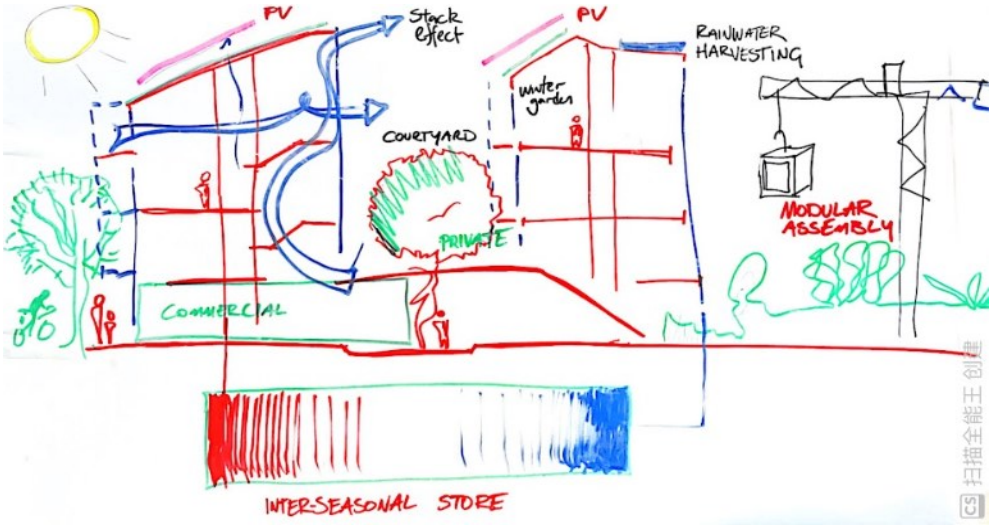


Figure 35 The typical section of a low-density passive residential building.

Figure 35 shows our ideas on the application of the zero Carbon pronciples to building in Kylemore.

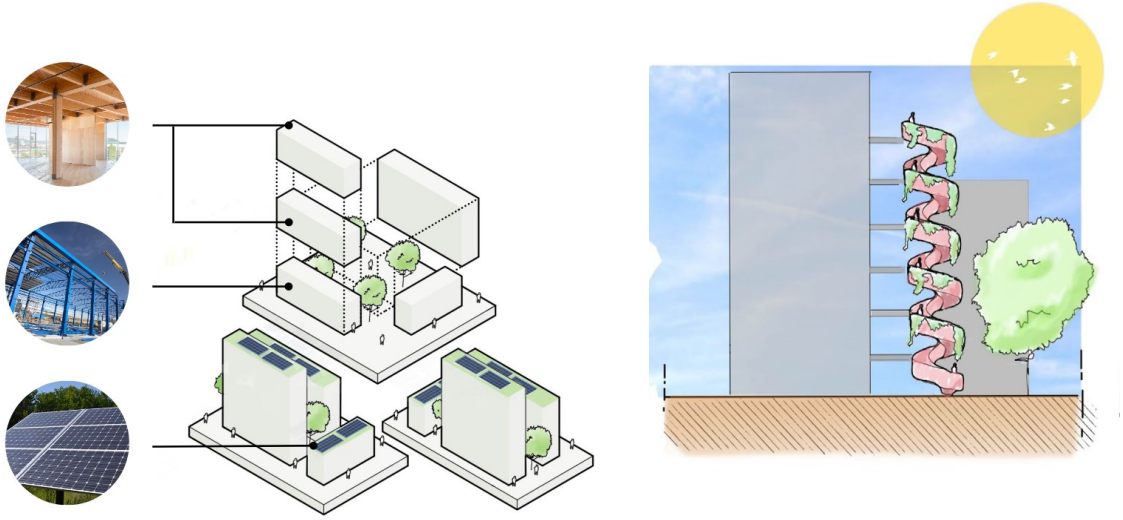


Figure 36. Axonometric diagram and cross-section (with staircase) of mixed-use building

On the site there is potential to dismantle selected structures and re-use the materials to create a strong base for the timber frame residences on higher floor. A key aspect of the design is the management of the volume in relation to the sun to prevent overheating. Figure 35 shows the arrangement of the built volume to ensure solar access to a central area. The variation in heights creates a dynamic space that responds to the Sun. The central passageway would be laid out to limit interior circulation space as much as possible. Access would be with a staircase (with a lift also) that would provide a distinct character.

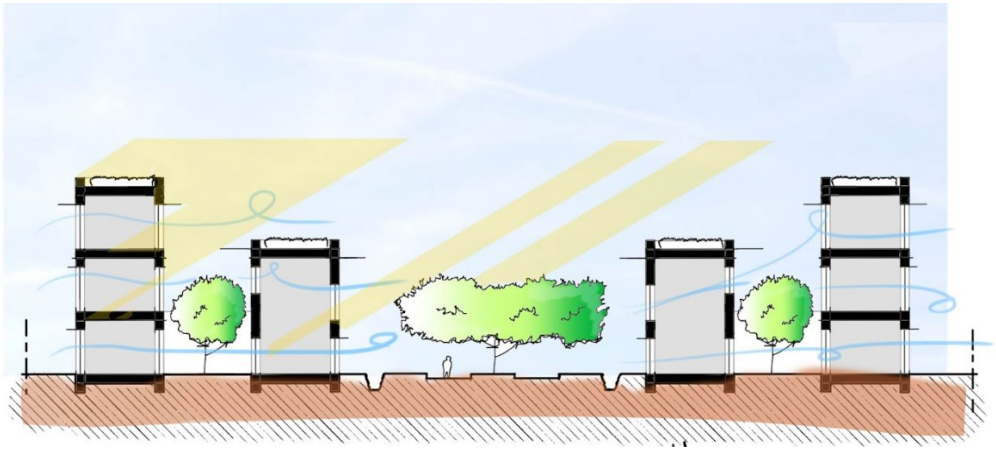


Figure 37. Section across the neighbourhood

Figure 37 applies these principles to a residential space in Kylemore. The bright and varied colours symbolise the diversity of the residents and the different cultures, backgrounds and experiences they bring to the community. This sketch shows that sustainability lies not only in physical design, but also in promoting an inclusive and supportive environment.

5.4 Sustainability

The Design team created a network diagram to link the resource systems to the neighbourhood spaces.

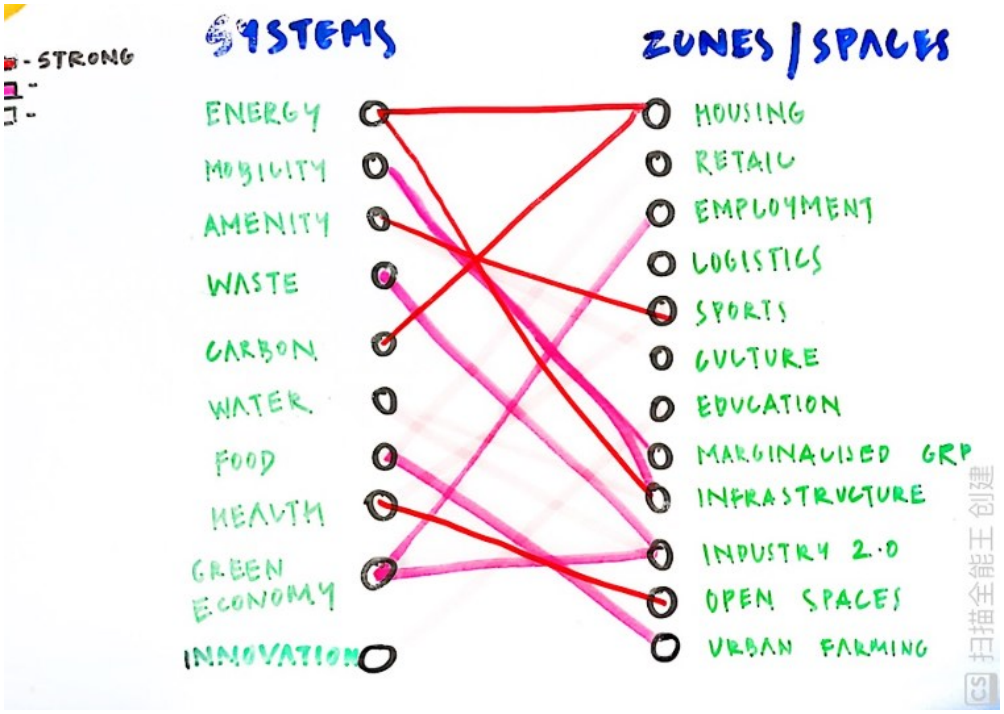


Figure 38. Relation between the urban systems and urban spaces

In this diagram the colours represent the links to create a sustainable neighbourhood:

- Green represents environmentally friendly practices and the integration of nature into the neighbourhood. It emphasises the importance of green spaces, parks, community gardens and sustainable landscaping techniques. By integrating nature, we create a healthy and environmentally friendly environment for residents.
- Blue stands for the efficient use of water resources. It emphasises the implementation of water conservation measures such as rainwater harvesting, grey water recycling and low-flow appliances. The sketch shows how the community values the responsible use of water and strives to preserve this precious resource.
- Yellow symbolises renewable energy sources. Solar panels adorn the roofs, capturing the abundant sunlight to power homes, streetlights and communal areas. This colour reflects the district's commitment to clean energy and reducing its carbon footprint.
- Red represents social cohesion and inclusion. It signifies the provision of communal spaces and facilities that encourage social interaction and foster a sense of belonging. The sketch represents shared gardens, community centres and gathering spaces, where residents can connect, collaborate and support each other.
- Orange embodies sustainable transport options. Cycle paths, pedestrianised streets and electric vehicle charging stations feature prominently. The sketch focuses on reducing dependence on private cars and encourages the use of alternative modes of transport for a greener, healthier community.

We used these ideas to design different spaces in Kylemore.

Figure 39 and 40 shows a vision of the the Kylemore town centre, of a park and a residential area. The town centre should provide a variety of mixed-use dynamic spaces that is bustling with life. This space should emphasise active mobility through walking mostly and be linked to the nearby canal and railway line.

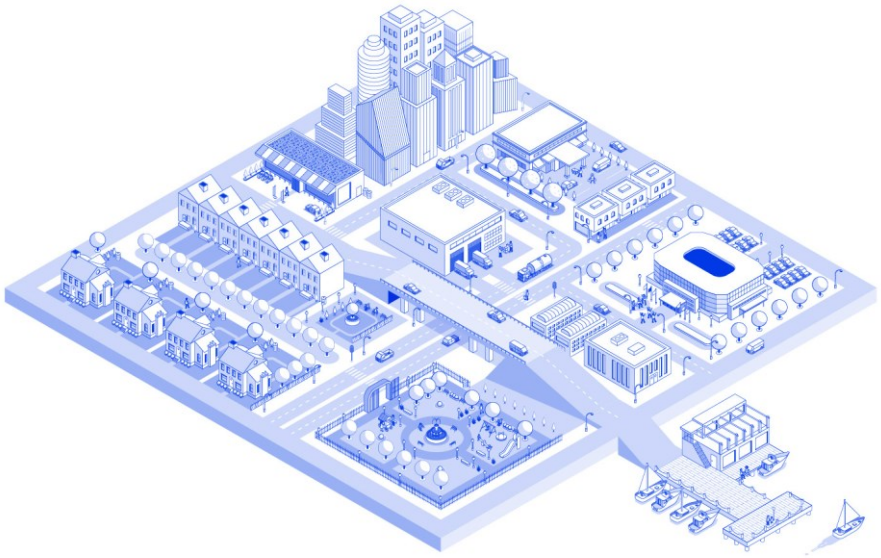


Figure 39. Isometric of the 15-minute city.

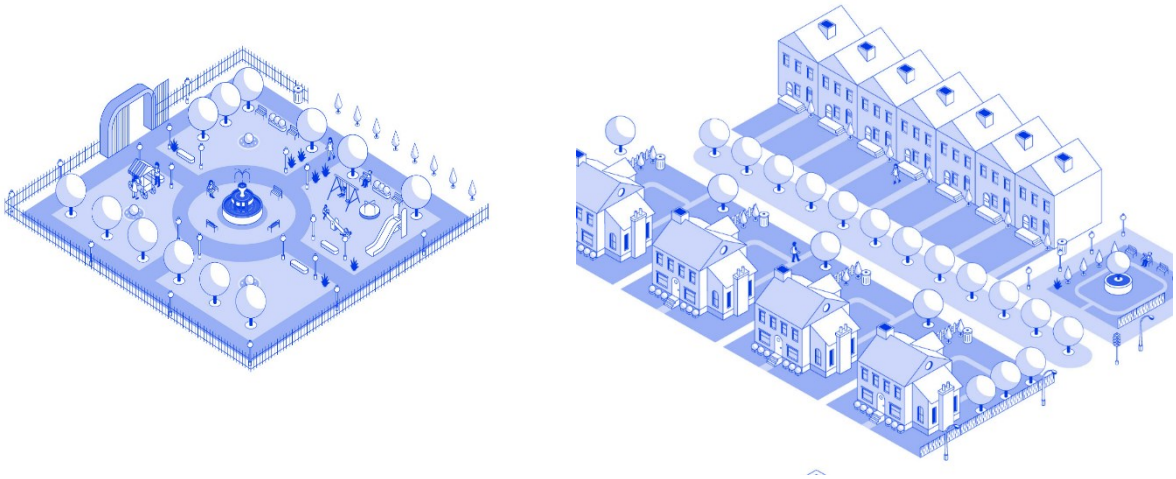


Figure 40. Isometric diagrams of a public park and of housing areas outside the town centre.

Finally, Figure 41 provides sketches of the urban spaces that we would like to create. These spaces emphasise the use of outdoor spaces through the provision of sheltered spaces that provide solar access and well-designed green spaces.

Figure 41. Residents enjoying walking around well landscaped urban spaces.

6. Summary & Reflections

The structure of the event, especially the integration of lectures and fieldwork was a success from a course management viewpoint. Moreover, the use of on-campus accommodation made it easier to develop teams over the available days. However, some issues should be improved.

1. The need for preparation before the event. This requires that student attendees are identified well before the event so that the case-study can be introduced, and work takes place before the event.
2. Consideration for how best to balance the needs for teamwork focussed on specific tasks (such as design) and for integration among teams to ensure coherence. This is a challenge as the student body has diverse skills that are not necessarily fitted to the specific UDCW tasks – hence, the course directors need to be aware of the need to act to overcome barriers to collaboration.

The largest challenge identified by students was dealing with the complexity of carbon cycles and fluxes. Changing several factors separately will always influence the other factors as well and the carbon in the area is also influenced from variables outside the area. Also, predicting a carbon household this far in the future has shown to be very difficult as it depends on a multitude of variables. Furthermore, the ideal of neighbourhood self-sufficiency made the task very difficult, as most of the area is allocated for high-density residential-led use, which leaves limited space for food production and carbon off-setting. Another challenge identified was the ensuring coordination between the three groups (governance, design, and people), as many tasks overlapped, which made for some efficiencies and unclear responsibilities. Overall, it was a very short time to tackle a project with many complex dimensions and it seems impossible to look into all of them within the scope of a week.

From the perspective of the organiser, the Dublin UDCW was a success, given the scope of the work and the limited amount of time available. The focus on the Kylemore neighbourhood (which is currently dominated by light commercial activities) was a good site for the project as there was an abundance of preparatory work available and there were clear boundaries to the space. However, as the students identified, the task of creating a (near) Zero Carbon neighbourhood is really difficult and there is no template available to ensure to that design decisions can be evaluated in terms of Carbon costs. The Dublin event complemented previous UDCW on climate sensitive re-development (Paris), climate change and flooding (Aalborg) and on climate change and heat (Barcelona). However, the systemic topic in the Dublin workshop requires a different set of tools to account for the Carbon costs/benefits that can be linked to design/planning decisions including the types of construction materials, the potential for local energy generation, storage and sharing, the role of green infrastructure and so on. Such a tool would provide a common basis for discussions on the creation of a zeroCarbon neighbourhood during the UDCW.

The challenge of developing effective teams to work on aspects of the project has been common to all of the UDCW events that I have attended. As the students come from diverse backgrounds and have different skillsets, it can be difficult to create coherent (and balanced) teams that can work effectively on aspects of the project. Moreover, making sure that all of the teams work in a co-ordinated way and are focussed on the overall project goal requires oversight. At the Dublin event, a time at the beginning and the end of the workday was set aside for progress reports from each of the teams and provided an opportunity to calibrate the work. However, it is clear that these types of engagements among the

teams should occur throughout the day so that miscommunications do not lead to divergence from the tasks. From my observations, the interventions of the leaders at critical phases of the work, especially as we enter the final days of the event. The photographs in this report capture some of the effective teaching techniques that were employed over the workshop.

What can we take from the Dublin UDCW to improve the experience of future workshops?

Preparation: The work that is asked of participants over the 7 days of the workshop is considerable and this places great emphasis on the preparation of the task. This has two parts. First, the host institution needs to assemble all of the available information and provide a plan for the workshop that is achievable. Second, the students need to be prepared for the UCDW before the work starts. Given the novelty of the project, it is difficult to ensure that these are in place, especially when the workshop takes on a task that is inherently complex. For my part, I would have structured the week's work into smaller achievable parts so that students do not become overwhelmed by the task. Nevertheless, the Dublin event was a success overall and provided a solid foundation for learning and development.

UDCW event space: This was the first of the UDCWs where the students were accommodated on a university campus (UCD) where the workshop was held. As the campus is outside the city centre, the students did not have an 'urban' experience however, the accommodation was affordable and available at the time of the year, which saved a great deal of administrative work. The workshop event was held in a design space that was open plan and allowed materials to be placed on large tables and walls. This type of space is critical in my view to creating a good design environment for sharing ideas and work. So, overall, the fact that the workshop and students were on the same site made the event run smoothly; it also meant that the final event could take place on campus with all the necessary facilities.

Fieldtrips and lectures: The Dublin UCDW included fieldtrips and lectures through the week, which I think helped set a context for the work and varied the education experience. The fieldwork was general (urban climate walk) and specific (Kylemore and Dublin) and contributed significantly to the event. The lectures added to the student's knowledge of the local context and provided some insights into design solutions. In retrospect, I would have included a lecture that set out the terms for a zero Carbon city so that the following lectures were part of a series.

Appendix 1: Timetable

Sunday 4th June **Meet at UCD Village**		
13:00-16:00	Urban Climate Walk UCD	The walk introduces microclimate types and the physical controls on the climate near the ground. The walk will select specific environments to discuss the relationship between surface cover and climate outcomes. In addition, the walk will introduce participants to UCD's geography and facilities.
Monday 5th June Meet at Dublin Spire **(USE LEAP CARD)**		
11:00-13:00 13:00-14:00 14:00-17:00	Dublin City field study Lunch City Edge field study	Place the case-study area in the context of Dublin's climate change policies and its commitment to achieving zero Carbon. An overview of the geography of the city and its building patterns. The second half of the day examines the neighbourhoods in the west of Dublin, especially the areas of Inchicore and Kylemore. The latter is one of the five districts that comprises the City Edge
Tuesday 6th June **Meet at Urban Design Studio**		
09:30-11:00 11:00-11:30 11:30-13:00 13:00-17:00 11:30-17:00	Review of materials: Introduce UDCW Coffee break Sabrina Dekker (DCC) Organise the Design/Plan work for the remainder of the week. Travel to Goldenbridge (Inchicore)	Introduce everyone. Discuss the materials available on the case-study in relation to the field trip. Describe the work plan and organise each of the teams associated with Design, Plan and People. After the coffee break the teams the Plan and Design teams will remain in UCD, while the People team will visit a community centre. Zero Carbon Dublin **The Plan and Design teams** Engage with the Dublin City Council's Climate Officer, who will outline the City's plans to manage carbon in the context of its status of an EU 100 city. These Teams should work in the afternoon on their component of the study. **The People team (Leap card)** This team will go by public transport to Inchicore to meet with the Community group (Common Ground). We will be introduced to the issues that face residents of the neighbourhood with is adjacent to the Kylemore site, including the provision of green spaces and social housing.
Wednesday 7th June **Meet at Urban Design Studio**		
09:30-10:30 10:30-11:00	Discussion Dr. Niall Buckley (IES)	Each team to give a present short verbal presentation on the status of the work. We will be joined by Francesco Pilla (Professor of Smart Cities at UCD). Models to support zero-carbon design/planning.

11:00-11:30	Coffee	
11:30-13:00	Project	Each team works of their component of the project – ensure co-ordination between teams.
14:00-14:30	Emmanuel Gendreau (Sorbonne)	Biosolar roofs in cities
14:30-16:30	Project	Each team works of their component of the project – ensure co-ordination between teams.
16:30-17:00	Present	Each team to present (powerpoint) on the status of their work and the next steps.
Thursday 8th June Meet at Urban Design Studio		
09:30-10:00	Project	Each team to evaluate work for the day.
10:00-11:00	Philip Lawton (TCD) Carla Kayanan (UCD)	Critical assessment of the City Edge project: From Edge City to City Edge
11:00-11:30	Coffee	
11:30-16:30	Project/lunch/project	There is scope on this day to revisit the site if there is a need. If some team members wish to do so, we would leave after coffee and return by 16:30.
16:30-17:00	Present	Each team works of their component of the project – ensure co-ordination between teams. Each team to present their work, playing special attention to the issue of integration (social and physical) of Kylemore with City.
Friday 9th June Meet at Urban Design Studio		
09:30-10:30 10:30-11:00 11:00-11:30 11:30-17:00	Discussion Project Coffee Project/lunch/project	This should be a status report from the teams and a discussion of the work for the day. An important part of the workplan should including writing tasks and the development and inclusion of graphics (including maps, figures, and photographs) and tables. As the emphasis in this workshop is on Carbon, the text should place the work in this context. At the end of the day, we should have a first draft of the text and of a presentation of this work
Saturday 10th June Meet UCD Village		
10:00-12:00	Formal presentation of work	This event will take place in the UCD Village. Each team will present the work, along with an overview to the audience.

This timetable focusses on the daytime activities for Dublin UDCW. An evening event will be organised during the week as a social occasion.

Appendix 2: The Urban Climate Walk

The opening event was fieldwork based (UCD campus) and focussed on the drivers of urban micro-climates. This event emphasises the experience of micro-climates (as detected by the body's sensors) to understand how decisions of green cover, blue spaces, materials, etc. act in combination with the weather and time of day to create spaces that can serve different uses.

The urban climate walk was developed (Futcher and Mills) to link the personal experience of micro-climates in cities to the urban climate effect and the London version has been running for a decade[11]. The walk is used to get participants to be aware of the impacts that cities have on climate at all scales (local to global) and uses human senses to detect, analyse and interpret these impacts. The urban climate effect describes the fact that urbanised landscapes modify the surface-air exchanges of energy and water at the surface by replacing the natural cover and disturbing airflow near the ground. In addition, the occupation of urban space, including the consumption of resources (water, energy, food, etc.) generates wastes into the air, waters, and land. In general, these effects can be ascribed to aspects of city forms and functions, which vary across the urbanised landscapes.

Table A2.1 Drivers of urban microclimates

Form (physical)	
Landcover	The removal of vegetation and the replacement of 'natural' surfaces with impermeable surfaces.
Fabric	The manufactured materials used for buildings and surface cover. These are usually hard, dense, and impermeable. These alter radiative and thermal properties.
Geometry	The urban surface is faceted, and each facet has distinct geometric and fabric properties. Geometry refers to the dimension of buildings and their layout, which impacts on radiative transfers and airflow.
Function (metabolism)	
Transport	Public/private vehicles, distance/time travelled and efficiency of engine/ Generates waste heat, vapour and materials. Time of movement.
Industry	Includes energy production. Nature of productivity and magnitude/timing of emission s
Commercial	Heating/Cooling degree days, times of occupation. Internal heat gains.
Residential	Heating/Cooling degree days, times of occupation

[11] See https://www.cibsejournal.com/uncategorized/walking-among-giants/

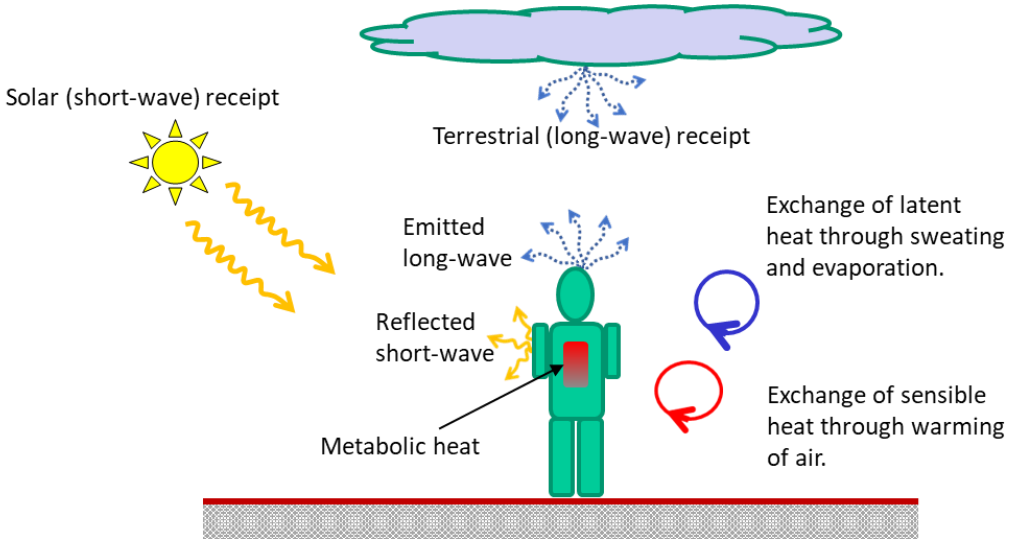


Figure A2.1 Relevant energy exchanges to/from the human body.

Sensing microclimates: The walk focussed on the thermal response of the body to the exchanges of energy, which are modified by passing from one microclimate to another. The formation of distinct microclimates is controlled by the general weather conditions and the heterogeneity of the landscape. Weather associated with calm and clear conditions maximizes the near-surface response of the atmosphere. The clear skies exchange radiation and the low wind inhibit mixing. The heterogeneity of the landscape includes variations of form and functions over short distances – so a good walk identifies a sequence of environmental circumstances that will produce different thermal contexts. Winds mix the atmosphere and diminish differences; clouds and rain reduce radiation input and dampen thermal responses.

The weather station analogy treats you as a mobile (and sentient) sensor, however, recognise that your response to changing conditions depends on your clothing and your metabolism (runners versus walkers) and that age and health also plays a role. Observe the behaviour of groups when seeking the most comfortable environment – shade/sun, shelter/exposure, water/green…. Of course, your body is much more than a recording device and you should use all your senses (sight, smell, sound and touch) to detect changes to your local (ambient) environment.

Recognise that there are different microclimates in cities especially that can be roughly categorised into three types (Table). During the walk interrogate the landscape to see which level is observable.

Management level	Design effort
Strong	These are indoor environments which are designed to provide near constant internal climates by balancing internal and external gains and losses.
Moderate	These include elements of design to provide varying levels of comfort at different times, depending on weather. It could include landscaped parks, courtyards or parts of buildings.
Weak or none	These spaces have had little design intervention, and the climate effect is a result of a series of decisions with minimal consideration for environmental impacts.

Appendix 3: BudaPart (2018-2028)

A model for re-development

Figure A3.1 Budapest Hunagary and BudaPart

As part of the UDCW process, other developments, comparable to City Edge, were examined to provide context and help generate ideas for transfer. BudaPart was selected as an urban case-study comprable to City Edge. The site is 54 hectares and located next to to the Danube.

Historically, the site was developed as an industrial area including docklands but the site became derelict towards the end of the 20th century. The construction of a dam (Kopaszi) protected the site from flooding and allowed the creation of a park. The site is next to the Budapest Infopark (technological and educational center, university campus etc.) and has existing blue-green infrastucture. There are good transportation links with the city by road, rail, tram and boat and there were protected industrial buildings on site. In additon, there are flora and flora assets that needed protection. Planning for BudaPart started in 2016 and outlined a 10 year planning/design strategy to be completed by 2028.

Figure A3.2 Development plan for BudaPart

The plan (Fig. A3.2) calls for mixed land use (residential & office & commercial + recreation) complemented by the green area protected by the Kopaszi Dam (natural reserve, protected area) with additional flood protection with recreational and social functions (e.g., livable areas, recreation, cycle tracks, playgrounds, jogging tracks and sports grounds etc.). The Plan is to be executed in 6 phases consisting of

- 15 residential, 12 commercial/office buildings and 1 hotel
- 3,000 apartments (studio, 2-bedroom, 3 bedroom and more)
- 250,000 m^2 office area
- 15,000 m^2 commercial/retail area
- 25,000-30,000 new residents and employees by 2028

The layout has offices encircling the new residential buildings and an emphasis on 15-minute travel by foot, by bike and micro mobility. Main roads are diverted around the site and car parking is below ground. The plan includes a green-blue planGreen recreational area consisting of a park and dam area, access to Lágymányos bay, and extensive tree planting. Nature-based solutions (hilly terrain with low laying areas closer to dam and Danube river) are used for flood management and water sensitive urban design incorporates rainwater collection, irrigation, permeable paving, etc. The new district is connected to the Budapest Green Belt. The plan received the FIABCI World Prix dExcellence for best Neighborhood Development.

Figure A3.3 BudaPart's building and landscaping.

BudaPart's buildings use energy saving measures and energy efficient design – for example, construction includes recycled materials used, reusable energy, green roofs and, shading devices. High rise buildings use ground floor space for commercial and social services and there is an emphasis on private and public sphere mixing. The walkable mixed-mode neighbourhood concept is implemented through affordable housing, offices, co-working spaces and a variety of services (health centres, dentists and pharmacies). There is no above-ground parking and there are charging stations are available for cars and micro mobility via shared bike schemes.