IMPLEMENTATION

Development is a process, and in a market economy is incremental and not necessarily linear. On the other hand, critical mass is required in order to affect change or at least to provide the stepping stones for future development. Perception is critical – particularly given market forces – and is disproportionately influenced by the quality of the public realm.

Implementation of this Development Framework has three strands:

• An identification of key networks linkages to be achieved (some vehicular, some slow traffic).
• An identification of key public space improvements to be achieved
• Development of particular sites

The dovetailing of the delivery of the first two above with development is necessarily a loose fit but it is within a coherent robust logic that will withstand the vagaries of the market.

Key sites have been identified which by virtue of their location and single or limited ownership, could develop quickly. Overall, however a more developed methodology is required.

The area is characterised by a large number of individual owners. Larger sites may have within them the means of delivery of public space and linkages, but for the majority of sites different mechanisms will be required. Incentives for the consolidation of sites or joint venture arrangements are required.

Given the nature of the market economy and the general absence of lands in State ownership in the area, the essential mechanism must be one of incentive. The existing zoning matrices are restrictive in terms of use and as applied can be restrictive in terms of density. Changes in zoning are likely to increase values in overall area terms. Mechanisms of incentive might include the following:

• An allowance of increased density (by a set factor and relative to the existing established plot ratio) related to the provision of required linkages and/or public open space. A formula for this incentive might look like the scheme B on the following page.

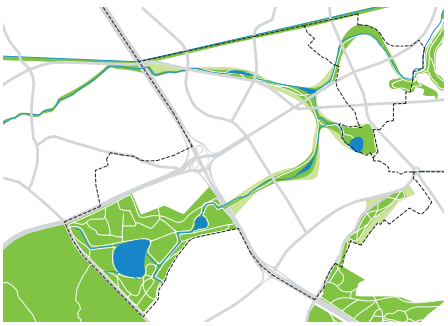
• An allowance of increased density in respect of assembled sites relative to what might be considered allowable on individual sites. A formula for this incentive might look like the scheme C on the following page.

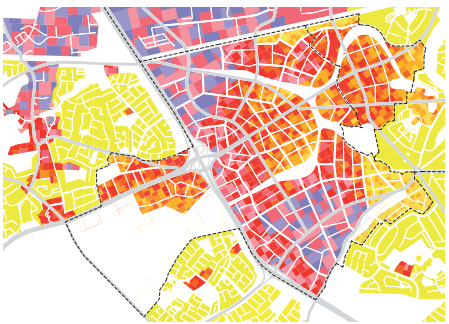
• A minimum site area below which increased density would not apply.

• Capital contributions as allowed for under the Planning Acts

• Land swop arrangements

Perception is critical – particul





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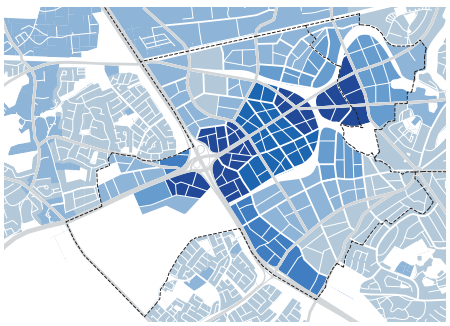
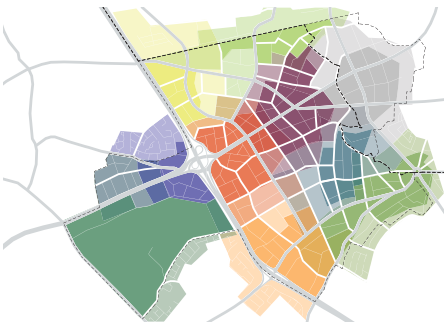




Incentives

This Development Framework identifies both a network and public space logic for the area. In terms of property impact, the network connections are generally discrete, fixed in dimension and therefore quantifiable. The total surface required for the connections within the Framework perimeter is approximately 150,000m2, or 2% of the study area.

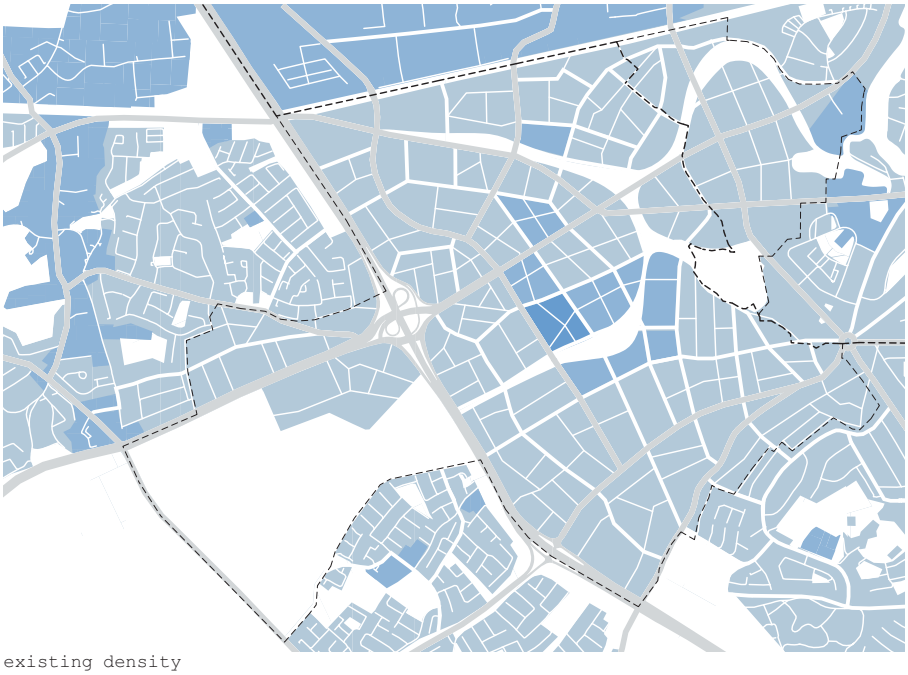
The public space proposals are invariably representations of a principle rather than being finite. Nevertheless those principles are imperatives and include:

• The establishment of green continuous linkages – specifically the east west green linkage along the line of the existing watercourses
• The spatial elaboration of these liner events in order to provide scale and identification
• The provision of green buffers at locations where adjacent uses are incompatible
• The provision of new or opened water bodies as part of a comprehensive surface water management regime
• The provision of characterising open spaces necessary to support local needs resulting from new adjoining land uses.

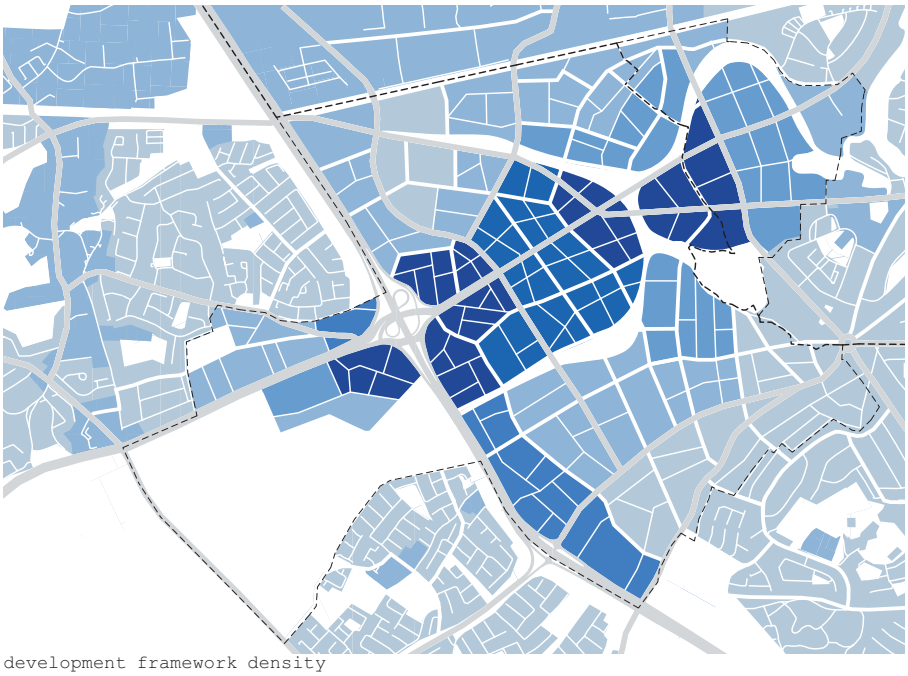
The total surface required for the public space proposals ranges between 500,000m2 and 850,000m2, or 8% to 13% of the land within the Framework perimeter. According to the County Development Plan a minimum of 10 % should be provided.

The total surface needed for the framework to take place ranges between 650,000m2 and 1,000,000m2 or 8.5 to 13.5% of the land within the Framework perimeter.

The average floor area ratio in the area today is 0.5. The development framework proposes floor area ratios ranging from 0.5 to 2.0 - essentialy a significant increase of density



existing density



development framework density

for sites in proximity to the Naas Road and Luas stops.

The effect of the implementation of the Development Framework has many different consequences, such as an improvement of the image of the area, improved accessibility and reduced congestion. This allied to the new mix of uses, allows for developments that are valuable and will have a positive effect on property values.

With this in mind the increase in density resulting from a mechanism for incentive, should be in relation to the surface needed for creating linkages and public space. Therefore an average of 10% increase of density compared to the Framework densities is desirable.

The proposals of allowances for higher densities to allow for linkages and public space or stimulate assembling of lands shown here are examples of a principle that need to be tested further and fine tuned.

It requires a Masterplan for each character area to define precise dimensions and positioning of the open space, to define the street profiles and their positioning, to define priorities, to find the swap mechanisms needed between private and public partners and to find the regrouping mechanisms between private landowners necessary to realise the Development Framework.

A system of incentives is proposed whereby development control can be used to facilitate and encourage particular form(s) of development consistent with the Development Framework. Those incentives take the form of an increase in nominal plot ratio in return for a specific public planning gain (meaning the achievement of specific objectives of the Development Framework). There is a finite limit to the extent to which such methods can be used.

Two immediate conditions are envisaged: Firstly where structural linkages are identified in the Development Framework (be they movement- and/or amenity-based), and secondly where the existing pattern of small plot renders meaningful and/or comprehensive redevelopment impossible.

The first condition is referred to as Atypical Condition B and is envisaged where a land take is sought and offered and the plot ratio on the residual site area is increased by way of commercial compensation. This form of compensation is envisaged in situations where the land take is up to a maximum of 40%.

The 2nd condition is referred to as Atypical Condition C is where the potential plot ratio of the larger assembled sites generates larger gross floor area than the sum of the individual site plot ratios would. This is predicated on the particular increased sites being advantageous in respect of shape, orientation, and their particular location necessary to facilitate configurations envisaged in the Development Framework.

In no circumstances is it envisaged that both conditions (B and C) above would apply to the same site.

Site Area existing	SAe		2000 m2	SAe	2000 m2	2000 m2	2000 m2	2000 m2	2000 m2	2000 m2
Plot Ratio existing	PRe		0.50	PRp	0.50	0.70	1.00	1.30	1.50	2.00
Gross Floor Area existing	GFAe	SAe*PRe	**1000 m2**	GFAp	SAe*PRp	**1000 m2**	**1400 m2**	**2000 m2**	**2600 m2**	**3000 m2**	**4000 m2**

Existing

A - sites are not subject to proposed land takes

Site Area existing	SAe		2000 m2	2000 m2	2000 m2	2000 m2	2000 m2	2000 m2	2000 m2	2000 m2	2000 m2	2000 m2	2000 m2	2000 m2
Percentage site loss	Psl		40%	40%	40%	40%	40%	40%	10%	10%	10%	10%	10%	10%
Site Area reduced	SAr	SAe*(1-Psl)	1200 m2	1200 m2	1200 m2	1200 m2	1200 m2	1200 m2	1800 m2	1800 m2	1800 m2	1800 m2	1800 m2	1800 m2
Factor1	Fa1	SAe/(SAr+(SAe-SAr)/2)	1.25	1.25	1.25	1.25	1.25	1.25	1.05	1.05	1.05	1.05	1.05	1.05
Plot Ratio proposed	PRp		0.50	0.70	1.00	1.30	1.50	2.00	0.50	0.70	1.00	1.30	1.50	2.00
Gross Floor Area factored	GFAf	SAe*Fa*PRe	**1250 m2**	**1750 m2**	**2500 m2**	**3250 m2**	**3750 m2**	**5000 m2**	**1053 m2**	**1474 m2**	**2105 m2**	**2737 m2**	**3158 m2**	**4211 m2**
Plot Ratio effective	PRf		1.04	1.46	2.08	2.71	3.13	4.17	0.58	0.82	1.17	1.52	1.75	2.34
Percentage increase in Gross Floor Area		GFAf/GFAp%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	5.26%	5.26%	5.26%	5.26%	5.26%	5.26%

B - capacity factoring based on accommodating new linkages

Site Area existing	SAe		10000 m2	10000 m2	10000 m2	10000 m2	10000 m2	10000 m2	10000 m2	10000 m2	10000 m2	10000 m2	10000 m2	10000 m2
Base line site	Bls		5000 m2	5000 m2	5000 m2	5000 m2	5000 m2	5000 m2	500 m2	500 m2	500 m2	500 m2	500 m2	500 m2
Factor2	Fa2	SAe/(Bls+(SAe-Bls)/1.2)	1.09	1.09	1.09	1.09	1.09	1.09	1.19	1.19	1.19	1.19	1.19	1.19
Plot Ratio proposed	PRp		0.50	0.70	1.00	1.30	1.50	2.00	0.50	0.70	1.00	1.30	1.50	2.00
Gross Floor Area factored	GFAf	SAe*Fa2*PRe	**5455 m2**	**7636 m2**	**10909 m2**	**14182 m2**	**16364 m2**	**21818 m2**	**5941 m2**	**8317 m2**	**11881 m2**	**15446 m2**	**17822 m2**	**23762 m2**
Plot Ratio effective	PRf		0.55	0.76	1.09	1.42	1.64	2.18	0.59	0.83	1.19	1.54	1.78	2.38
Percentage increase in Gross Floor Area		GFAf/GFAp%	8.33%	8.33%	8.33%	8.33%	8.33%	8.33%	15.83%	15.83%	15.83%	15.83%	15.83%	15.83%

C - capacity factoring based on size of site

Delivering sustainable development

Example:
Copenhagen cycling culture

The Danish capital, Copenhagen, is the world's leading example of long-term transformation towards more sustainable modes of transport. In the early 1960s Copenhagen was on a similar trajectory of car-oriented growth to most other European cities. By 2005 however 36% of journeys to work within the city were by bike, a third by public transport and only 23% by car. Between 1995 and 2005 the number of journeys by bike doubled. However, change was a long time in the making, and was not primarily driven by 'transport' policy. It began in 1962 when, as part of an experiment led by the architect Jan Gehl, Copenhagen's main street, Stroget, was pedestrianised. A significant increase in pedestrian traffic and custom for shops and cafes was observed. Over the following decades, the amount of pedestrian space in the centre of Copenhagen was increased sevenfold. 18 public squares that had been parking lots were transformed. The number of people spending time in the city centre quadrupled, pavement cafes proliferated and both the day and the season for Copenhagen's active streetlife lengthened. Early success gave city leaders the confidence to implement complementary policies, including major investment in cycle lanes, reducing city centre car parking and developing 'shared surface' streets on secondary routes. The proliferation of bikes, many of them chained informally to fences, is now one of the signature features of Copenhagen city centre. By 2002, Copenhagen newspapers were reporting a new problem: congestion on the cycle lanes.

As stated in the introduction, the role of a framework plan in achieving sustainability is to fix what is essential at this stage and be flexible about the rest. The armature for sustainable development on the Naas Road – predicated on enhanced access and movement, integrated walkable neighbourhoods and a robust urban form – is the focus of this plan.

Realising ambitions for sustainable development in practice is a complex process which involves a more detailed layering of landscape and architectural design, infrastructure planning and phasing, public and community involvement, commercial planning and market assessment, and ongoing governance and management. It is beyond the remit of this Framework to prescribe how this should be managed, but, to ensure that sustainability outcomes are secured, there are a number of key issues and principles that will need to be considered from the very beginning of implementation of the Framework.

A long term vision for sustainable movement

The current urban condition around the Naas Road makes encouraging sustainable movement extremely difficult. The area is already heavily congested and failing to address increasing levels of private car ownership and use will jeopardise the ability for the Framework plan to deliver meaningful, sustainable and transformational change.

The Naas Road is not alone in facing this constraint. As the Dublin Transportation Office's '2030 Vision' consultation document sets out, over the next three decades Greater Dublin's population is likely to exceed 5 million, car ownership could increase by over 40 per cent, average speeds are likely to drop further and congestion increase with attendant environmental and health effects, and transport-based emissions could more than triple. A city-wide strategy for modal shift towards more sustainable transport options – walking, cycling and public transport – is therefore essential to ensuring Greater Dublin can both respond to the 'environmental imperative' and avoid stifling opportunities for regeneration and development.

Those responsible for the planning and delivery of regeneration and development schemes also need to explore how to break the link between development levels and current measures of accessibility. Without this, the comprehensive redevelopment of areas such as the Naas Road will be severely compromised, potentially leading to increased sprawl as developers seek opportunities in less constrained but more car-dependent locations. While current accessibility criteria can be used to inform the first phase of development, the Framework Plan cannot be

bound by them when setting the wider vision for the area. The broader question is not how do we define accessibility for the 10 years it will take to deliver the first phase but rather how will accessibility be defined in 10, 20, 30, 40 and 50 years time.

The Department for Transport has calculated that investment in public transport and associated infrastructure under Transport 21 is unlikely to have a significant impact on private car use. Instead a range of other interventions will be required to deliver the 40/60 modal split that begins to achieve a meaningful reduction in car use.

Given the limited options for increasing capacity and therefore use on public transport in and around the Framework area this level of modal shift will only be achieved following considerable efforts to increase levels of walking and, in particular, cycling. Tallaght and Dublin City Centre are both within cycling distance of the Naas Road and the aim should be that cycling becomes the main transport option for journeys under 6km. The Dublin Transport Office has set an ambitious timescale for increasing the proportion of trips made by bike from 4% to 30% by 2016 . Applying this target to the baseline average modal split for the Framework area would result in 55% of journeys being made by walking, cycling, bus and LUAS. This assumes no increase in public transport capacity or levels of walking. A modest increase in walking (likely given the increased levels of internalisation enabled by a good mixed-use plan) and public transport use should achieve at least a 60/40 modal split.

Achieving this level of modal shift will require a multi-agency approach working with Dublin City Council, the National Roads Authority and the Dublin Transportation Office to develop a range of site specific, borough and city wide initiatives and interventions including:

• Ensuring that a fundamental principle of local, regional and national planning, transport and design policy and guidance is to promote cycling as the primary mode of transport for journeys under 6km and walking as the primary mode for journeys under 1km.

• Implementing a city wide programme of advice and support on alternative travel options similar to the TravelSmart initiative run by Sustrans in the UK, which has led to relative reductions in car trips of between 9 and 14%.

• Improving the cycle network both within the Naas Road and on key routes to and from Tallaght and Dublin city centre, including widening and resurfacing of cycle lanes, improved signage and cycle priority at junctions. This should include identifying opportunities for improving existing (such as the Grand Canal towpath) or creating new traffic free commuting and leisure routes.

• Developing a strategy for the phased reduction in car parking spaces in Tallaght and Dublin City Centre with associated increases in cycle parking and facilities.

• Creating new bus routes, including express routes to Tallaght, Dublin City Centre and other key destinations, to serve those areas of the Naas Road that are more than 400m from a LUAS stop, improving services on existing bus routes and providing real time travel information on all routes.

• Removing the link between home ownership and parking provision by minimising private ownership of residential parking spaces within the Naas Road and developing a strategy for the phased reduction of residential parking over time, supported by access to a car club and car share schemes.

• Conducting a biannual survey of pedestrians and cyclists to inform future planning and identify priorities for improvement.

• Introducing peak time demand management such as congestion charging or road pricing, with income invested in public transport, cycle facilities and public realm improvements.

Public and stakeholder involvement in the planning and delivery process

Example:
Malmo Western Harbour

The Western Harbour area of Malmo, Sweden, is a 140 hectare former docks district which is being regenerated as a major new extension of the city. The area will house a growing population and economic base driven in part by the creation of the road and rail link across the Oresund to Copenhagen and a new rail tunnel under Malmo city centre to link to the development. The aim is that the area will be a "city of tomorrow", defined by the harmonious integration of social, economic and environmental sustainability principles. Planning began in 1997 and the first stage of development was an "Expo" of 1,300 homes and mixed uses in 2001 designed to demonstrate different elements of sustainable urban development, including the effect of more than 30 architects and 30 developers working at small scales within a larger framework and clear design codes. However, the full programme is scheduled to take until 2035 and the Western Harbour will eventually house 10'000, 20'000 jobs and 11'000 students at a new university complex. A key principle of the evolution of Western Harbour over nearly 40 years is that, although the first phase of development was high-performing, each phase should improve on the previous one, both in terms of the outcomes it achieves and the process through which it is brought forward. Developers are encouraged to collaborate on a vision for development in advance of negotiating contracts, and the involvement of many different professionals and stakeholders from phase to phase alongside the community in reviewing progress and planning ahead makes for a process of continuous 'learning by doing'.
See www.malmo.se

Achieving a culture of sustainability requires that, from the very outset of development, the principle is established that people will be asked to live in and use this place differently from the ways in which they currently would others. In turn, this makes demands on stakeholders and professionals – from public authorities to landscape designers to commercial agents – as well as the public to think differently about how places work and how different place-making disciplines can be integrated for the achievement of sustainable lifestyles.

There is an important idea in the practice of public and stakeholder engagement which says "tell me, I forget; show me, I remember; involve me, I understand". Often engagement practices are either too open, lacking in anchoring principles that govern what is within the scope of debate; or too closed, asking people to endorse a fait accompli.

A shared understanding both of the principles of sustainable development and of their practical application in place-making is essential to building and maintaining support for the vision for the Naas Road. Many of the ideas involved are necessarily complex and interdisciplinary. Therefore genuine community and stakeholder involvement, as well as 'deep collaboration' between professionals, should be at the heart of the implementation plan for the Framework.

One way of achieving this is through 'community enquiry', in which stakeholders and design professionals work together intensively over several consecutive days in public and semi-public forums to evolve a proposal from a framework plan and 'first principles' to a well-resolved design and accompanying strategies for place. This and similar approaches should be encouraged both for the Naas Road Framework and for the adjacent plans to the east in Dublin City. Such exercises should take place at a minimum scale of the neighbourhood and as such will be made easier if there is a partnership between stakeholders and landowners of the kind described above.

Delivery partnerships for sustainable development

Overcoming the fragmentation of land ownership and differing aspirations on the part of different landowners and stakeholders is potentially a major hurdle to the realisation of the potential of the Naas Road. Helping to unite stakeholders behind a common vision and principles for urban transformation of the area is one of the key functions of this Framework. The long-term nature of the transformation and the uneven spread of potential change and likely rewards, geographically and between phases, challenges stakeholders in the Framework to work together across ownership boundaries to realise sustainability outcomes. Specifically:

• to embed many of the characteristics of sustainable place-making outlined in this Framework. The next stage of masterplanning will need to take place at a sufficient scale to embed area-wide principles of sustainable urbanism. Ideally, the minimum scale for this next stage should the whole neighbourhood rather than the block, site or plot; and

• as set out above, the optimal very-low-carbon energy strategy is likely to be one that works across multiple sites and ownerships. Financing the capital cost of the infrastructure involved and relating this to the overall energy load and phasing across the area is likely to require a formal agreement between landowners and an agreement to share the costs and returns of development across a whole neighbourhood or phase. This is likely to be a prerequisite for the possibility of involving an Energy or Multi-Utility Service Company (ESCo or MUSCo), which is an increasingly popular and often efficient route to securing the design, build and operation of community-scale sustainable infrastructure.

There are many potential vehicles for such partnership. Establishing the principle of collaboration and securing broad agreement to explore specifics is what matters at the outset.

Fine urban grain and adaptability

Example:
Vauban, Freiburg

Vauban is a planned sustainable urban extension of around 5,000 inhabitants to the German city of Freiburg. In addition to employing Passivhaus sustainable building technologies and 'car free' living for some households, Vauban has made good use of opportunities for integrated ecological design including green roofs, rainwater capture for use in buildings, green facades and the ecological design of green spaces.

The implementation of the Framework should over time create a fine urban grain throughout the Naas Road that encourages vibrancy and diversity within and between neighbourhoods. The aim is to create a place that can easily adapt and evolve to meet the changing needs of its residents. To help achieve this, a number of basic rules should be applied to all future development (and, if appropriate, written into planning policy or design codes):

• All blocks will be kept short to create a legible layout and provide multiple direct connections.

• A wide range of plot sizes will be included in each neighbourhood to encourage a variety of architecture (including one-off buildings and self-commissioned homes) and uses within and between character areas.

• All buildings on primary streets will have active frontages and adaptable ground floors to encourage diverse visual experiences, provide overlooking, encourage street life and promote local vibrancy and public safety.

• Buildings will, wherever possible, be designed and constructed to be adaptable to enable change of use as the Naas Road matures and evolves (e.g. from light-industrial to residential use, or to accommodate active uses on the ground floor of residential buildings on key routes).

• Ensure all public spaces will be defined, enclosed and overlooked by the buildings that front them.

Total urban ecology

The concept of 'total urban ecology' recognises that the role of urban environments as habitats for humans is as important as the role of natural and semi-natural habitats for wildlife, and that literally 'greening' city environments can soften urban spaces and make them more colourful, atmospheric and appealing. It embraces the incorporation into place-making and design of integrated, multifunctional solutions to:

• protection and enhancement of biodiversity and habitats;

• varieties of green amenity space for different kinds of recreation and leisure activities;

• implementation of a 'green grid' for access and movement on foot and by bike;

• creation, rehabilitation and use of waterways and wetlands;

• opportunities for local horticulture and agriculture; and

• measures to adapt the urban environment to already inevitable climate change (and the more extreme weather events it will bring) including sustainable urban drainage systems, living roofs and walls and large-canopy trees for shelter.

The Naas Road Framework provides for a significant upgrading of the quality and quantity of managed open space, wetlands, 'green' routes and a new edge to the canal. This alone will help to achieve a significant ecological enhancement. To increase the potential for a 'total urban ecology' to emerge in the Naas Road Gateway and contribute to the creation of a softer, greener environment, consideration should also be given to:

• encouraging widespread use of living roofs and walls (planting along building frontages in strategic locations to create continuous habitat) for habitat creation, water retention and food production;

• incorporating into design codes or development briefs a minimum permeable surface area requirement for development;

• design of homes to allow direct connection with private and public outdoor spaces;

• integration of bird and bat boxes into design of buildings at appropriate locations;
• balcony planting and window boxes;

• extensive street tree planting to allow species movement at canopy level and provide shade and shelter against the effects of inevitable climate change;

• private gardens to be used for food and wildlife gardening through provision of information, education and materials via community growing projects. In some cases, restrictions on private garden uses and landscaping may be applied (for example, extensive hard surfacing);

• encouraging a 'continuous productive urban landscape' through the planting of food crops such as fruit trees and herb plants in the public realm as well as the incorporation of more formal productive land such as allotments;

• encouraging opportunities for wildlife and gardening education through local community centres and schools; and

• through the waste strategy that will need to be developed for the area, encouraging the separation of food and other wastes for composting and local use as part of a 'closed loop' food and waste plan.

• any future plans for this area will ensure that adverse impact on the habitats and species present are avoided and that biodiversity is retained and enhanced as per the National Biodiversity Plan and Ireland's responsibility to halt loss of biodiversity by 2010

Planning for very-low-carbon energy

Depending on the definition applied, energy use in the built environment accounts for up to half of the average person's carbon footprint. Given the relative ease and cost-efficiency of achieving deep reductions in built environment carbon emissions in new development, it is a prerequisite for development in the Naas Road Gateway to be considered sufficiently sustainable that it supports very-low-carbon energy transformation.
The basis for this is the familiar energy hierarchy:

• reducing demand – by encouraging responsible and conservative energy use on the part of the residents and users of buildings;

• improving efficiency – by designing well-insulated, efficient buildings with good thermal mass and low u-values, and installing low-energy appliances as standard;

• greening the energy supply – by supplying development with renewable energy or, as a last resort, non-sustainable energy using very-low-carbon technologies.

At the stage of framework planning it is not possible to prescribe specific solutions for very-low-carbon energy transformation. However, the Naas Road Gateway plan supports the implementation of low-carbon energy through an intense land-use plan, a localised mix of uses, and the phased redevelopment of the area which should ensure a steady and predictable energy load through transformation. Given these conditions, it should be possible to ensure that development at Naas Road supports a range of sustainable energy supply options

As set out before, development in the Naas Road Gateway should aim to reduce carbon emissions from energy use in the built environment to a minimum. An important element in this, alongside energy efficiency and demand management measures, will be supplying developments with very low carbon, ideally renewable, sources of energy. A detailed energy strategy is not part of the Framework; however, in order to illustrate the issues involved in planning for energy a 'Carbon Mixer' tool has been used to consider, based on the development quantums and land-use mixes proposed for Phase 1 2010-2016, possible options for supplying the development with very-low carbon energy. NB this analysis is not based on technical studies of the area and disregards any existing energy services that may be available; it is not to be considered a guide to or substitute for the outcomes of full technical study.

Based on the development quantum and mix for 2010-2016, the chart 0 below shows the assumptions of energy load for the development across the calendar year. This indicates that based on the envisaged mix of uses, demand for heating will be uneven across the year and that therefore, depending on the energy mix chosen, there will either be a need for additional heat supply in winter or an opportunity to supply excess heat offsite or to adjacent development (e.g. industry) in summer.

The analysis also assumes that new development in the Naas Road will be built to high standards of insulation, without being super-insulated; and that the baseline energy supply (which serves as a counterfactual to the carbon reduction and energy use comparisons below) is electricity from the grid combined with modern, standalone gas boilers of relative efficiency.

Five scenarios for energy mix have been considered. These are summarised in the table i.

The charts i, ii and iii summarise the five options above compared with a "Naas Road Phase 1" baseline for (i) carbon emissions (ii) non-renewable energy consumption and (iii) capital costs (in sterling).

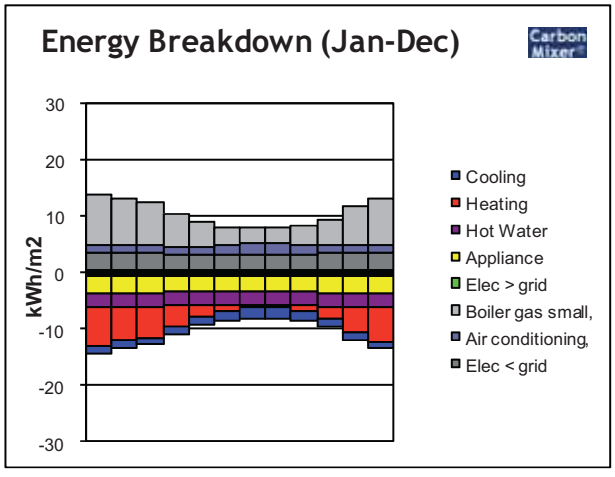


chart 0

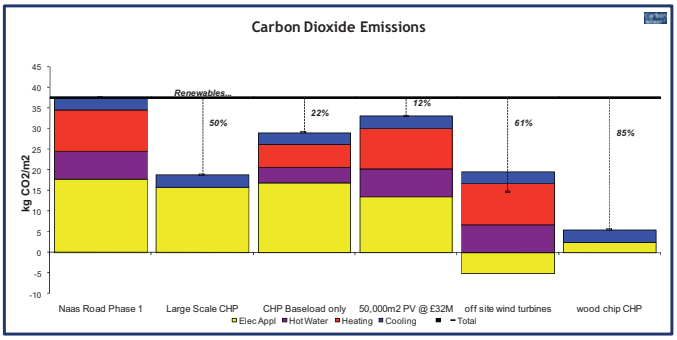


chart i

On the basis of this analysis, there are several issues that need to be given early consideration in planning the implementation of the Framework. In particular:

• the need to consider the relationship to the planned mix of uses, possible demand from existing development, development off-site and later phases of redevelopment in working out a low-carbon energy mix;

• the need to plan energy infrastructure across multiple site ownerships;

• the additional capital costs of low-carbon technologies compared with simply 'plugging in' to the grid and these need to finance and spread these effectively (recognising that low-carbon energy is nonetheless one of the most efficient and cost-effective ways of achieving carbon reductions in development); and

• the early need for appropriate technical studies to inform implementation planning.

Option	Carbon reduction	Non-renewable energy demand reduction	Issues
Large-scale gas-fired combined heat and power (CHP)	50%	-23%	Sized to meet peak development heat load and 50% of the electrical load. Generates a significant heat surplus in summer and would need to find an off-site customer for this so as to be generating sufficient electricity to provide a return on costs. Note non-renewable energy use increase (natural gas for the CHP engine).
Baseload gas-fired CHP	22%	-10%	Sized to run at near 100% of capacity year-round by meeting the base load of heat demand i.e. additional winter heat demand would need to be met from other sources.
50,000m2 photovoltaics	12%	6%	Photovoltaics are unlikely to be an attractive solution but the option is illustrated, based on estimated available roof space, to give an idea of relative cost and impact. Currently the payback period on PV is around 35 years, which makes them unattractive despite the low maintenance and zero running costs. Availability of feed-in tariffs may make PV more attractive.
Off or near-site large-scale wind	61%	30%	8 x 2Mw wind turbines would meet 95% of net electricity demand over the year. Obviously dependent on suitable site, good wind and planning acceptability.
Large scale woodchip CHP with solar hot water	77%	83%	Same heat distribution issues as gas CHP; also chip delivery, storage and sourcing issues over time. Probable price stability over gas but sourcing needs to be guaranteed over 20 years to ensure realistic viability. Solar thermal should be included wherever possible, even where it appears to be at odds with the higher heat load required by the CHP systems, particularly when wood chip CHP is in use because of the environmental pressures placed on agricultural land due to biomass production.

The charts below summarise the five options above compared with a "Naas Road Phase 1" baseline for (i) carbon emissions (ii) non-renewable energy consumption and (iii) capital costs (in sterling).

table i

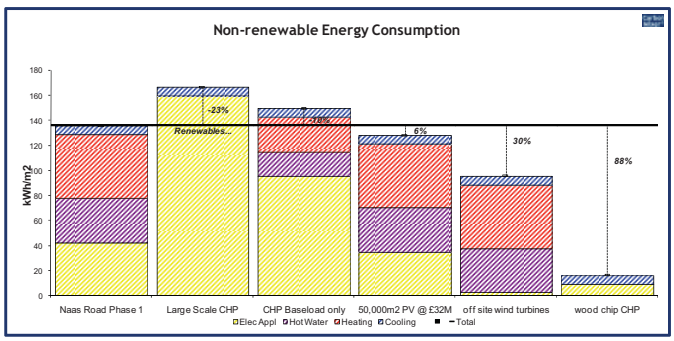


chart ii

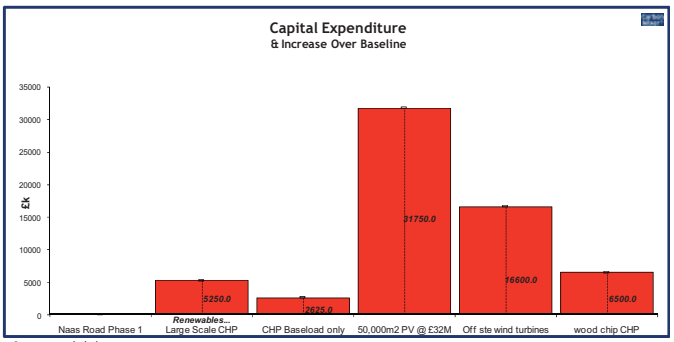


chart iii