ECO TEMPLATE

a framework for increasingly environmental and socially responsible logistics development

GAZELEY

AT THE HEART OF LOGISTICS

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The Team

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The Team

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The Carbon Trust
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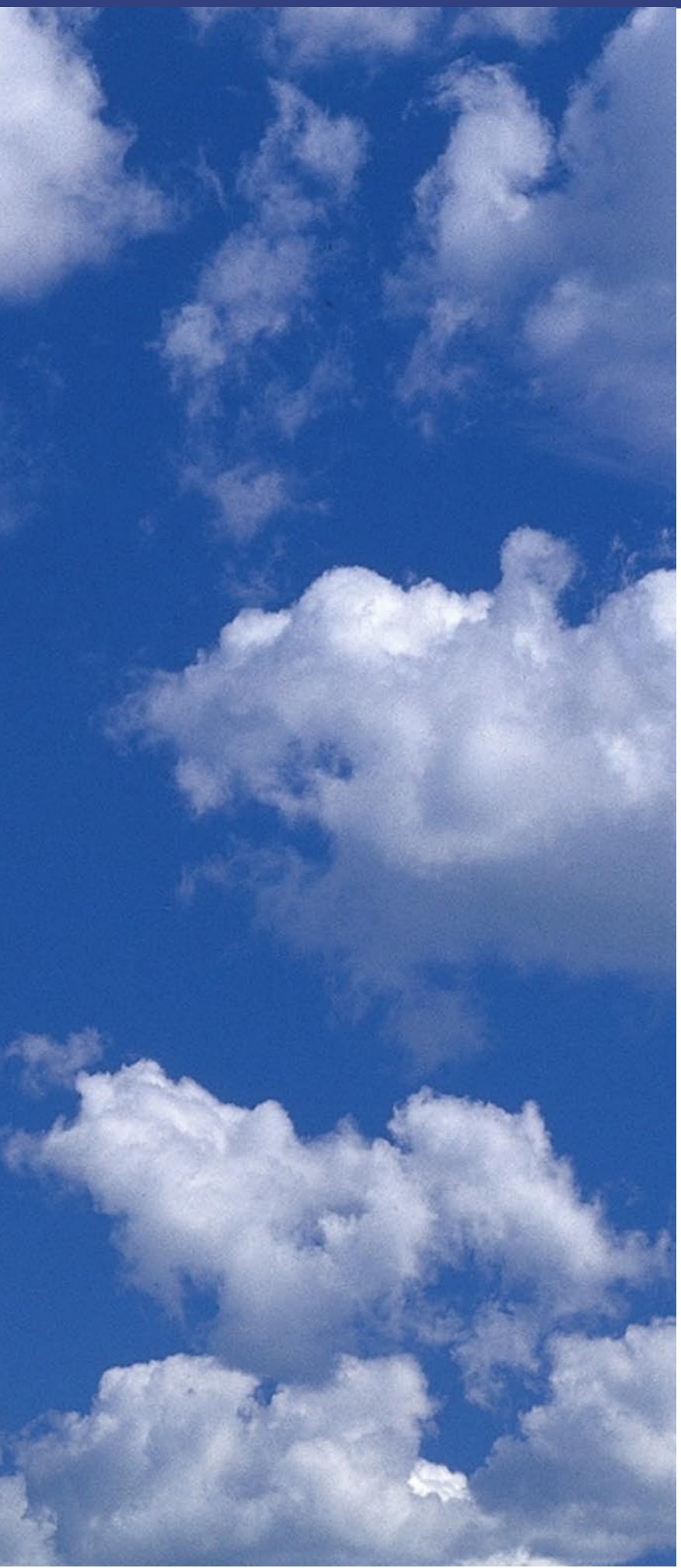
Preface



This project is the result of a growing realisation that much of the world's energy use, resource depletion, and environmental degradation are produced in the creation of buildings and infrastructure. Remedies to global warming and other stresses on the planet can be most effective when targeted at industries with the greatest potential to make a difference.

The construction industry has tended to assign a low priority to these impacts, largely because market rates do not reflect hidden environmental costs. Thus, the pursuit of environmental sustainability is viewed by many as an altruistic endeavour pursued solely by those with the inclination and financial resources.

In order to remain competitive, however, companies in the industry will be compelled to adopt a larger agenda; driven not only by moral and ethical responsibility, but also by a changing economic climate. Rising energy and regulatory costs will force the integration of new practices.

An urgent need for action...

In 1987, the Brundtland Commission released a statement that has become the most authoritative definition of environmental sustainability:

> *"Sustainable development is any development which meets the needs of the present without compromising the ability of future generations to meet their needs".*

Subsequent adaptation has resulted in a more succinct definition:

> *"Treating the world as if we intend to stay".*

All sustainability must begin with planetary health. That health is endangered by a number of factors:

World population: By 2050 the World population is estimated to reach 9.3 billion; an increase of 3.5 billion from 1950. The population is generally young and poor in the developing world and ageing in the first world.

Health and Disease: There are presently 40 million people estimated to be living with HIV and the number is increasing rapidly. Water shortages are becoming more common, and with them increasing pollution of the water supply.

CO2 concentrations: Carbon dioxide concentrations in the atmosphere have increased by 28% since pre-Industrial times. This increase is largely responsible for the climate change evident today.

Global Resources: Presently only 14% of energy generated Worldwide (including hydropower and biomass) is from renewable sources.

Energy consumption: 20% of worldwide energy consumption is accounted for by the transportation of people and goods.

Vegetation: Presently 10% of the plant species on our planet are threatened with extinction.

Because of environmental changes already experienced, there is a drive by governments to impose new laws to restrict companies in any damaging future operations. Additionally, incentives are being created to accelerate environmentally responsible action. The following is a brief summary of some key policies enacted or pending. A full list is included in the appendix.

Waste Electrical and Electronic Equipment Directive (WEEE Directive): Voted in by the European Parliament in 2001 to restrict waste and encourage re-use and recycling.

Action and the Environment, Environment 2010 – Our future, our choice:
Goals:

- Global emission cuts of 20% - 40% by 2020
- Bio-diversity of natural habitat
- Environment and Health
- Sustainable use of natural resources and waste

Kyoto Protocol: A worldwide emissions reduction plan to lessen global warming.

Greenhouse gas 'trading': A scheme for trading greenhouse gas emissions within the European Union by 2005, imposing penalties of 100 Euros per excess tonne or twice the average market price during a pre-determined period, whichever is the higher. In the period prior to commitment period of the Kyoto Protocol, this penalty would be 50 Euros per excess tonne or twice the avereage market price during a pre-determined period, whichever is the highest.

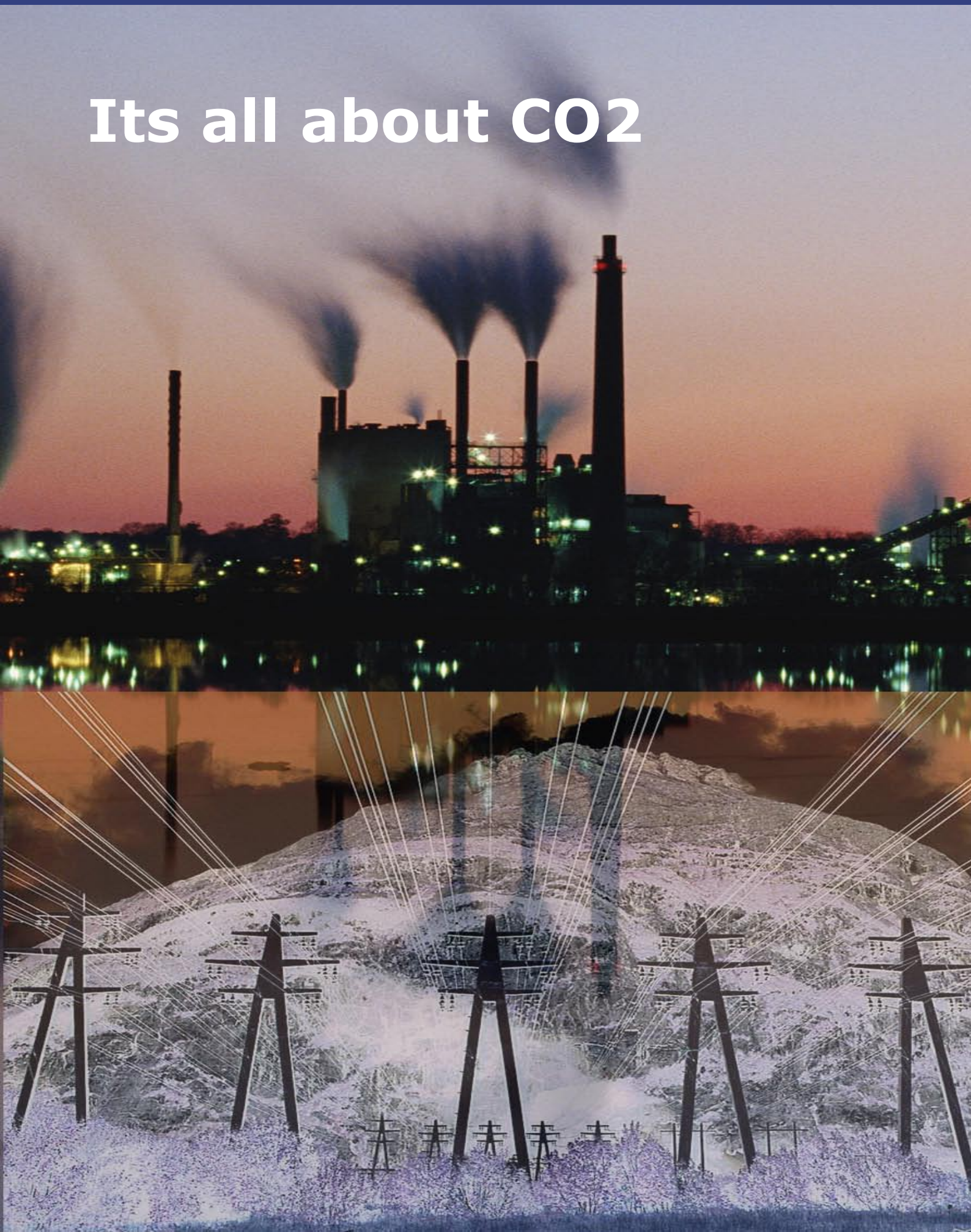
Government funding for implementation of Environmental technologies.

Government Incentives schemes: **for green roofs and solar technologies.**

Although many of these regulations have yet to be introduced, they will have a major impact on industry in the future.

Gazeley has started work.
Our Eco Template is a framework for increasingly environmental and socially responsible logistics development, and sets out a timetable for increasing levels of implementation.

Its all about CO2



1.0 Executive Summary

The Eco-effective approach...

In considering the potential impacts that our buildings have on the environment, Gazeley have taken an Eco-effective approach to chart a road map for the future within Europe.

Initial steps involved a re-examination of the essential functional requirements and current construction practices for Gazeley distribution buildings. This included a pan European benchmarking exercise, the results of which are contained in full later in this document.
Next, key concepts and metaphors were identified that would capture the essential aspirations of the Eco-effective paradigm:

Building as Habitat: How can we replace the natural habitat lost in the making of a building; to integrate the building and site to provide a home for displaced plant and animal species? A compelling measure of success is the number of birds that return to the site.

Some areas of consideration include:
- Adding habitat through the use of green (vegetated) and brown (rubble) roofs and site landscaping.
- Providing swales and retention ponds for ground water recharge.

Building as a Power plant: How can we optimise the building and site to produce and export energy, to maximise solar and wind power generation and offset global CO2 emissions?

Some areas of consideration include:
- Using renewable resources such as solar photovoltaics and wind turbines
- Employing natural ventilation and daylighting

Building as Umbrella: How can we protect materials and goods from the negative effects of weather whilst maximising human comfort - without fully enclosing and conditioning the entire building?

Some areas of consideration include:
- Investigating insulation alternatives and thermal mass properties
- Examining building form and orientation to take advantage of natural daylight and site wind flow patterns

Using these metaphors as a foundation, the purpose and environmental compatibility of every building component incorporated within a Gazeley building was challenged. Furthermore, buildings across Europe, were studied in the same way.

The investigation...

1. Site and Landscape
2. External Yard
3. Envelope
4. Structural frame
5. Warehouse slab
6. Offices
7. M&E (Mechanical & Electrical)

Within these categories, each building component was assessed for current performance and future viability (a full description is included in the appendix). Recommendations are made within this document for materials, technologies or systems compatible with the environmental agenda.

Opportunities have been arranged within the context of time; anticipating future viability in terms of technological application, commercial availability and cost effectiveness. The timescales have been divided into three categories, viewed as progressive stages of development, and structured in the following way:

At Marsh Leys: A Gazeley project already underway and immediately deliverable within six months.

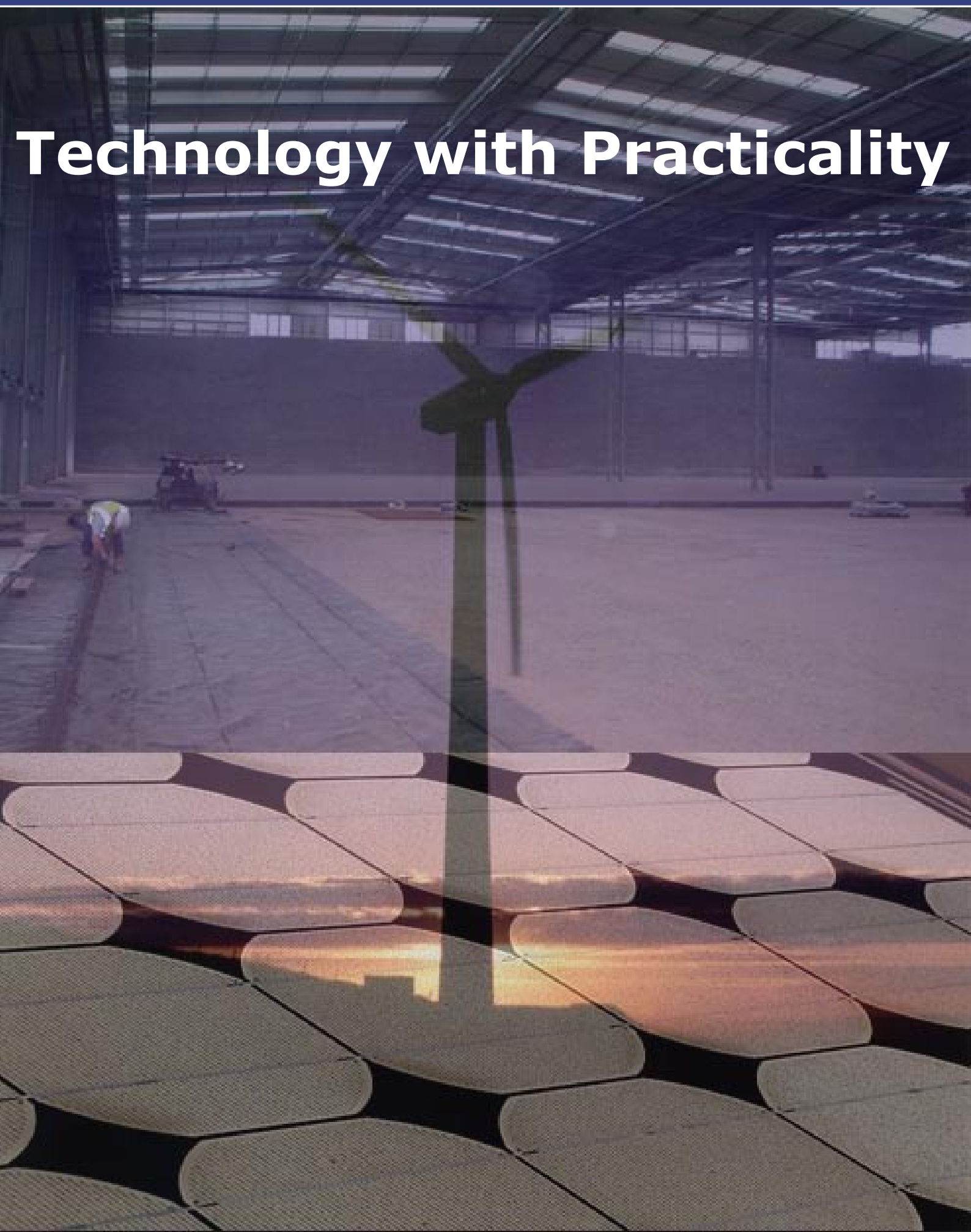
The Optimised Scheme: Short to medium term opportunities, deliverable after six months.

The Revolutionised Scheme: A long-term proposal deliverable within ten years.

Goals and trajectory...
The overall aim of this project is to demonstrate the potential for delivering environmentally sustainable initiatives in the development of logistics buildings.

Executive Summary

Technology with Practicality



...at Marsh Leys
Although Gazeley had already secured a planning approval on their Marsh Leys site at Bedford it was still important to maximise the Eco Template proposals which could be delivered possible within the terms of the planning approval, and signal a clear intent for the future:

- The site has been designed to encourage habitat restoration and groundwater recharge by using pervious paving, swales and water features.
- Alternative energy sources such as solar photovoltaics and wind turbines will be implemented at a small scale.
- In the offices the use of interior finishes that are environmentally preferable has been maximised,and in the warehouse energy requirements have been reduced by increasing the area of rooflights.
- There will be increased use of pre-fabrication and improved building technologies.

...the Optimised Scheme
The Optimised scheme is not site specific, and considers viability across Europe. The opportunities with this model are achievable using current products and technologies, whilst complying with all relevant statutory requirements. The study also highlights the varying grant and funding opportunities available. The opportunities suggested for the Marsh Leys project were expanded with the Optimised Scheme to include:

- Tilt-up concrete panels (at low level), for the entire warehouse perimeter.
- Reduced building height to avoid the need for in-rack fire sprinklers.
- A green roof, above the entire dock area where it will help to reduce the visual impact of the building.
- Maximising daylight and natural ventilation in the offices.
- A post-tensioned warehouse floor slab.
- Increased renewable energy generation.

...the Revolutionised Scheme
The Revolutionised scheme projects a new vision for logistics buiding that is responsive to the environment. It assumes the increased commercial viability of some new technologies that, if successful, may change the nature of the way in which such buildings are designed and built. Innovative design proposals include:

- Inflated fabric roof panels that serve as roof lights whilst also generating photovoltaic electricity.
- Concrete rainwater troughs filled with vegetation between which the fabric panels are suspended.
- An automated racking solution that eliminates the need for a structural floor slab.

...and beyond
Finally, the study demonstrates that an environmentally sustainable agenda can be implemented incrementally over time. Some measures are immediately viable without compromising Gazeley's commercial position in the market place. Others will become more viable as technologies adapt and availability is improved through economies of scale. Most importantly, this is a plan that delivers immediate benefits to the environment and envisages a framework and timetable for constant improvement.

'Treating the world as if we intend to stay'.

Primary Research Completion

Marsh Leys - key strategies investigated

Storm water

- Assessment of site planning to determine if the land is used for best value.
- Pervious paving to facilitate storm water percolation.
- Swales and retention ponds to provide habitat and retain storm water on site.
- Green and brown roofs to retain storm water, create habitat, provide building insulation and roof protection.
- Roof drainage techniques to slow the rate of discharge and cleanse stormwater.

Site Temperatures

- Reflective roofing materials to reduce microclimate temperatures.
- Vegetated and light coloured cladding to reduce microclimate and building temperatures, and to provide habitat.

Site Habitat

- Light pollution reduction to protect dark sky conditions and migratory bird pathways.
- Restoration of native species vegetation.

Water Use Reduction

- Roof water collection and storage to provide grey water for non-potable requirements in the building.
- Low-flow toilets, sensor controls and waterless fixtures to reduce the use of water for sewage conveyance.

Natural Energy Flows/ Energy Use Reduction

- Underfloor air delivery
- Improved insulation strategies
- The use of natural ventilation
- The use of solar gain to provide space and thermal mass heating.
- Control of building form and orientation to best respond to solar gain within the site constraints.
- The use of natural daylight and associated strategies to reduce the use of energy derived from fossil fuels.

Alternative Energy Production

- Solar photovoltaics
- Wind turbines
- Solar thermal

Resource Use

- The use of materials containing recycled, recyclable and rapidly renewable content, and the use of sustainably certified wood products.

Indoor Environmental Quality

- Establishment of effective natural ventilation, daylight and views.
- The use of low toxicity and low offgassing materials to improve air quality

3.0 Marsh Leys Scheme

Site Aerial View

3.1. Introduction

Planning permission has been granted for the development of a 400,000 sqft logistics building at Gazeleys G. Park Marsh Leys, Bedford. The site lies on the A421 approximately 7 miles east of J13 on the M1, which is the main North-South arterial motorway in the UK. Construction commences in April 2004 and the programme is due to complete in October 2004.

Some of the strategies that were identified require further development, detail design, and product research, and cannot be concluded before the programmed date for the initiation of construction. Therefore, on the 'timeline' these have had to be located within the Optimised or Revolutionised scheme proposals. However, there are many others are clearly viable on the site and have been proposed whilst still observing the following;

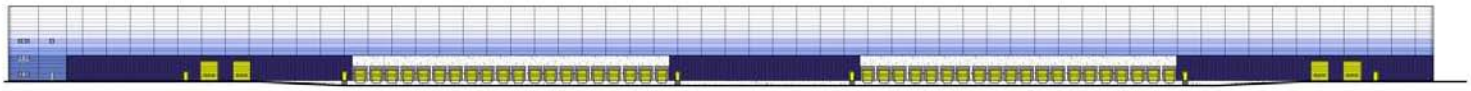
- Parking standards have been dictated by the planning permission, as have access to the site and the size and location of the building.
- The planning permission has also determined the general massing and aesthetics of the building which has a height to haunch of 15m.
- Local planners have approved the landscaping proposals as part of an overall master plan, including neighbouring completed developments. Planning restrictions were established within the current 106 and 278 agreements.
- Current UK Legislation and building code restrictions.

The intent has been to be ambitious whilst also being realistic, aimed at introducing 'real' improvements into the first 'Eco Template'.

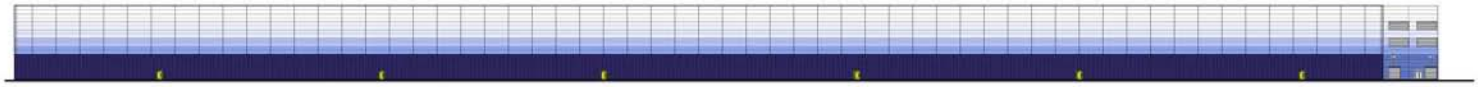
The following section identifies the initiatives to be introduced at Marsh Leys, along with the benefits associated to them.

Marsh Leys Scheme

Site Plan



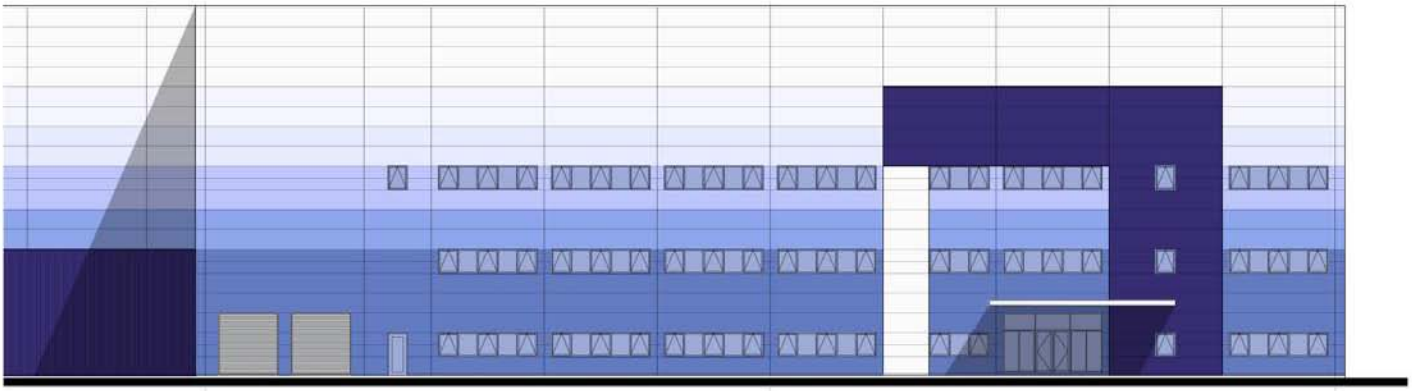
West Elevation



East Elevation

North Elevation

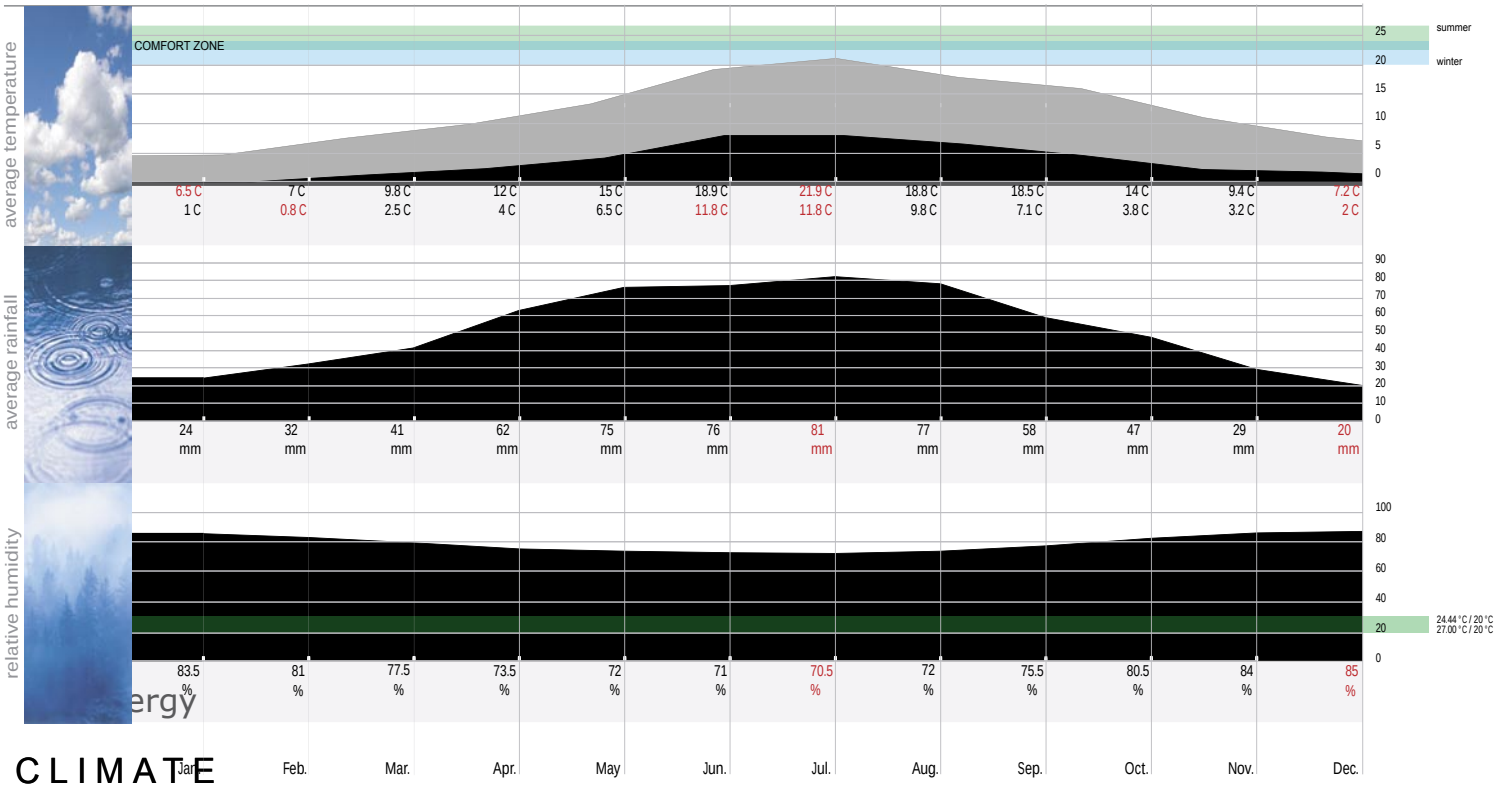
South Elevation



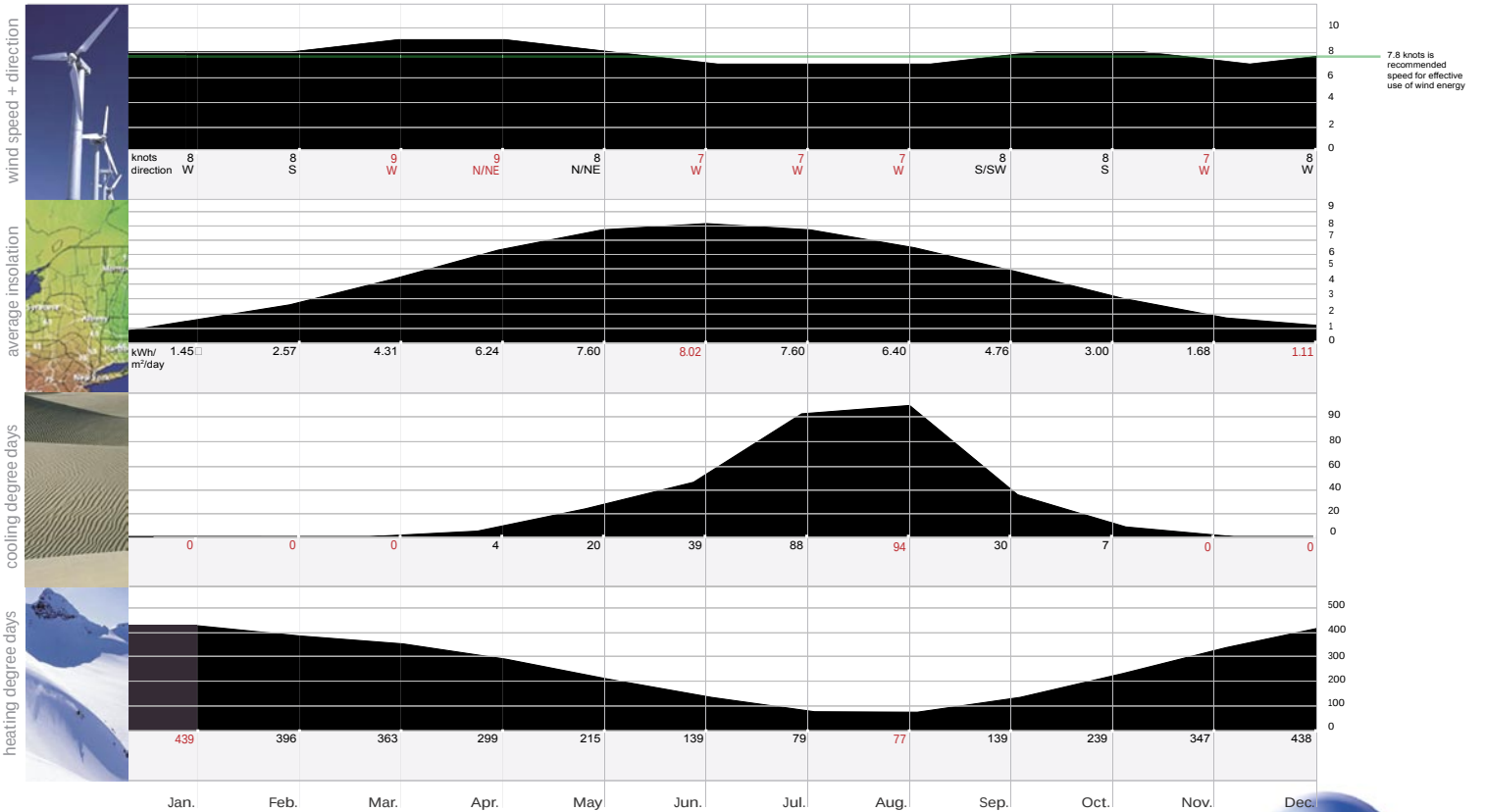
North elevation enlarged

Data

CLIMATE
DATA



CLIMATE
ENERGY

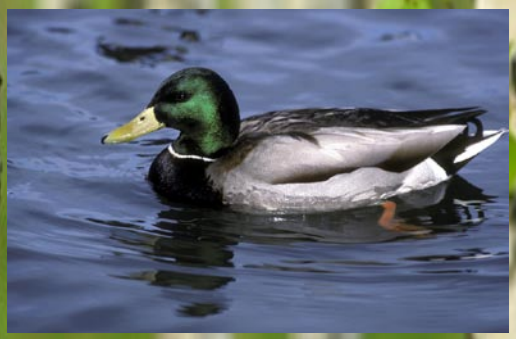


Perspective View

Marsh Leys - Features

1	**Landscape**	
	Planting	Maximised use of vegetation for habitat re-creation.
	Native Vegetation	Maximised use of local provenance seed.
	Wall Vegetation	Selective wall areas planted with trellises and vegetation.
2	**External Yard**	
	Site Density	Site density minimally reduced at Marsh Leys.
	StormH2O Management - Paving	Porous paviours in 3,350m2 area of car park with additional areas of compacted gravel.
	StormH2O Management - Wetlands	Wetlands used for stormwater retention.
3	**Envelope**	
3a	**Warehouse Cladding - High Level**	Micro-rib aluminium composite panels with factory installed insulation, installed to a steel frame.
	W.h. Cladding - Low Level	Vertical profile composite panels as above.
	W.h. Cladding - Low Level - Docks	Insulated pre-cast concrete wall panels.
	Walls - Office Cladding	Micro-rib aluminium composite panels with factory installed insulation installed to a steel frame.
3b	**Warehouse Roof**	Composite panels with factory installed insulation.
	Office Roof	Composite panels with factory installed insulation.
	Warehouse Roof Lights	Continuous polycarbonate roof lights over 15% roof area.
	Roof Drainage	Syphonic drainage to all roof areas
4	**Structural Frame**	
	Warehouse Structure	Steel portal frame. Slope of 6 degrees.
	Office Structure	Steel frame with metal decking and in-situ concrete, pre-cast steel stairs.
5	**Internal Floor**	
	Warehouse Internal Floor	Fibre-reinforced slab. 200mm thickness.
6	**Office Environment**	
	Daylighting	Maximised daylight to office-
	Recycled/Rapidly Renewable Materials	Interior finishes to include recycled products.
	Low-Toxicity Materials	Interior finishes to include low-toxicity materials
	Lighting	Ambient/task solution using fluorescent fixtures.
7	**M&E Services**	
	Warehouse Heating & Ventilation	No heating provided until end user is identified. Propose to use a forced air jet nozzle system.
	Office Heating & Ventilation	Openable windows and low temperature hot water system
	Energy Sources - Photovoltaics	14.22 kW power polycrystalline array.
	Energy Sources - Solar Thermal	Evacuated tube collectors installed on office building towers.
	Energy Sources - Wind Turbines	20 kW propeller turbine installed at the site entrance.
	Water Use - Fixtures	Low/ no -water use fixtures and timing controls.
	Water Use - Rainwater Harvesting	Roof water collection and storage for toilet use.
	Fire Protection - Warehouse	Fully charged wet-type suppression system proposed. Fit out item by end user.

VEGETATION



SITE VEGETATION

Provide opportunities for vegetation to colonize the site where land and surfaces of structures are available.

Ecological Benefits

- Habitat is created for birds, insects and other species.
- Woodland planting will strengthen the Marston Vale Community forest.
- Vegetation will absorb rainfall.
- Plant roots help to reinforce the soil and prevent erosion.

Aesthetic Benefits

- Shelter planting will create a site amenity and improve the site appearance.

Energy Use and Carbon Impact

- Planting will moderate the surrounding temperatures and assist in the building energy performance.
- The plantings will create a carbon sink, offsetting the CO2 emitted on the site. On the Marsh Leys site the proposed 3ha. woodland will offset carbon emissions from the offices for 4.5 - 9 years.

Cost impact

- No additional cost is anticipated for the landscaping scheme proposals.

Pan-European Perspective

- Vegetation strategies will vary by site and climate zone.

LOCAL PROVENANCE VEGETATION

Use local provenance seed to re-establish native habitat to link with nearby habitats.

Ecological and Aesthetic Benefits

- Allows the site to blend in both aesthetically and ecologically with the surrounding landscape.
- Supports local animal populations. Creates habitat for birds, insects and other species.
- Enhances biodiversity.

Cost impact

- No additional cost is anticipated for local provenance plants.

Marsh Leys Scheme

Recommendation and Business Case

WALL VEGETATION

Provide lightweight trellises to support vegetation on the building walls.

Ecological and Aesthetic Benefits

- Provides habitat for birds and insects.
- Assists with stormwater uptake.
- Vegetation helps to cleanse the air of particulates.
- Reduces the visual impact of the building.
- Assists with stormwater uptake.

Energy Use and Carbon Impact

- Vegetation provides shade, helping to reduce solar gain on building walls in the warmer months.
- Reduces overall site temperatures.

Cost impact

- Additional cost for trellises and vegetation £ 24,100 (37,400 €).

WETLANDS/ SWALES/ PONDS

Provide on site stormwater retention.

Ecological and Aesthetic Benefits

- Facilitates drainage of rainwater back into the soil on the site.
- Phosphorous and nitrogen from fertilisers are neutralised.
- Vegetated surfaces help to cool the site.
- Landscape maintenance is reduced.
- Reinforces the opportunity for habitat creation.
- Enhances the appearance of the project.

Cost impact

- No additional cost implications.

Pan-European Perspective

- Such stormwater treatment measures are required in much of Germany in order to meet local ordinances and secure planning consent. (See European Future Environmental Regulations in the Appendix).

Marsh Leys Scheme

Recommendation and Business Case

Encouraging Alternative personal transportation

Enhanced Surface filtration Improved Aesthetic

SITE DENSITY/ PARKING CAPACITY

Minimise the areas of car parking provision. The potential for reduction at Marsh Leys is minimal due to the requirements of the existing planning permission. Parking areas have been integrated with the planting, drainage and overall landscaping scheme and kept to the minimum statutory requirement.

Ecological Benefits

- Reduces the impact of site grading and the disruption of landscaped areas.
- Reduces drainage requirements.
- Integrates the parking areas with the overall landscape, enriching the biodiversity of the site.
- Reduces the amount of petroleum products used for the manufacture of paving material.

Energy Use and Carbon Impact

- Encouragement can be given to alternative transportation policies including car pooling, car sharing, mass transit and cycling and thus by extension reduces carbon emissions.

Cost impact

- No additional cost implications.

Pan-European Perspective

- Support of reductions will be dependant upon local authority regulations and policies, land use strategies and specific client requirements.

PERVIOUS PAVIOURS

Pervious paviours to be installed in car park aisles to allow under drainage to assist an area of 3,350m2. This does benefit the overall site, however the ground conditions present at Marsh Leys do not allow maximum reduction of underground drainage to be introduced.

Ecological and Aesthetic Benefits

- Facilitates drainage of rainwater back into the soil on the site.
- Lessens the burden on municipal stormwater drainage systems.
- Eliminates the need for piped below-grade drainage to the car parking areas.
- Reduces the visual impact (from hardscape) for the car park areas.
- Becomes an integral part of the site 'water story'.
- Reduces the amount of petroleum products used for the manufacture of paving material.

Cost impact

- Cost increase of £40,000 (64,714 Euros).

Pan-European Perspective

- Such stormwater treatment measures are requires in much of Germany in order to meet local ordinances.

Marsh Leys Scheme

Recommendation and Business Case

composite panel

WAREHOUSE WALLS (high level)

Micro-rib composite panels with factory installed insulation secured to a steel frame.

Construction Sequencing Benefits

- Preinsulated panels reduce site installation compared with built-up panels.

Life Cycle Benefits

- Anticipated life expectancy of 40 years.
- 25-year durability to first maintenance.

Energy Use and Carbon Impact

- Provides good thermal performance, achieving a U Value of 0.35 and reducing energy use in the building, M&E plant size and emissions.
- Exhibits good air leakage performance, complying with Part L, UK regulations.
- Insulation is non-ozone depleting.
- The panels can be recycled.

Aesthetic Impact

- High quality of Gazeley brand is maintained on the proposals.

Cost impact

- No cost variation from conventional proposals.

Pan-European Perspective

- There is potential for global procurement.
- Opportunity for more standardization and buildability of the product.

Marsh Leys Scheme

Recommendation and Business Case

precast dock walls

WAREHOUSE WALLS (low level)

Vertical profile composite panels with factory installed insulation, secured to a steel frame. Benefits as previously illustrated.

WAREHOUSE WALLS (docks at low level)

Pre-cast concrete wall cladding system

Low-level dock walls to be insulated pre-cast concrete panels attached to a steel frame. Panels to be 4.0m wide and 250mm depth including 80mm insulation. Overall combined panel heights to be 6.3m.

Construction Sequencing Benefits

- Can be erected quickly, reducing the impact of weather.
- Allows high-level cladding to proceed in continuous sequence, not interrupted by low-level construction.
- Low level cladding rails can be omitted.

Life Cycle and Resource Use Benefits

- Concrete has a low embodied energy over its life cycle.
- Standardisation and pre-fabrication allows for formwork to be reused and maximises efficiency in production.

Energy Use and Carbon Impact

- Provides a good level of air tightness.
- Provides good thermal mass.

Cost impact

- Cost for precast panels £41,000 (66,332 Euros) which is offset against the cost of composite.

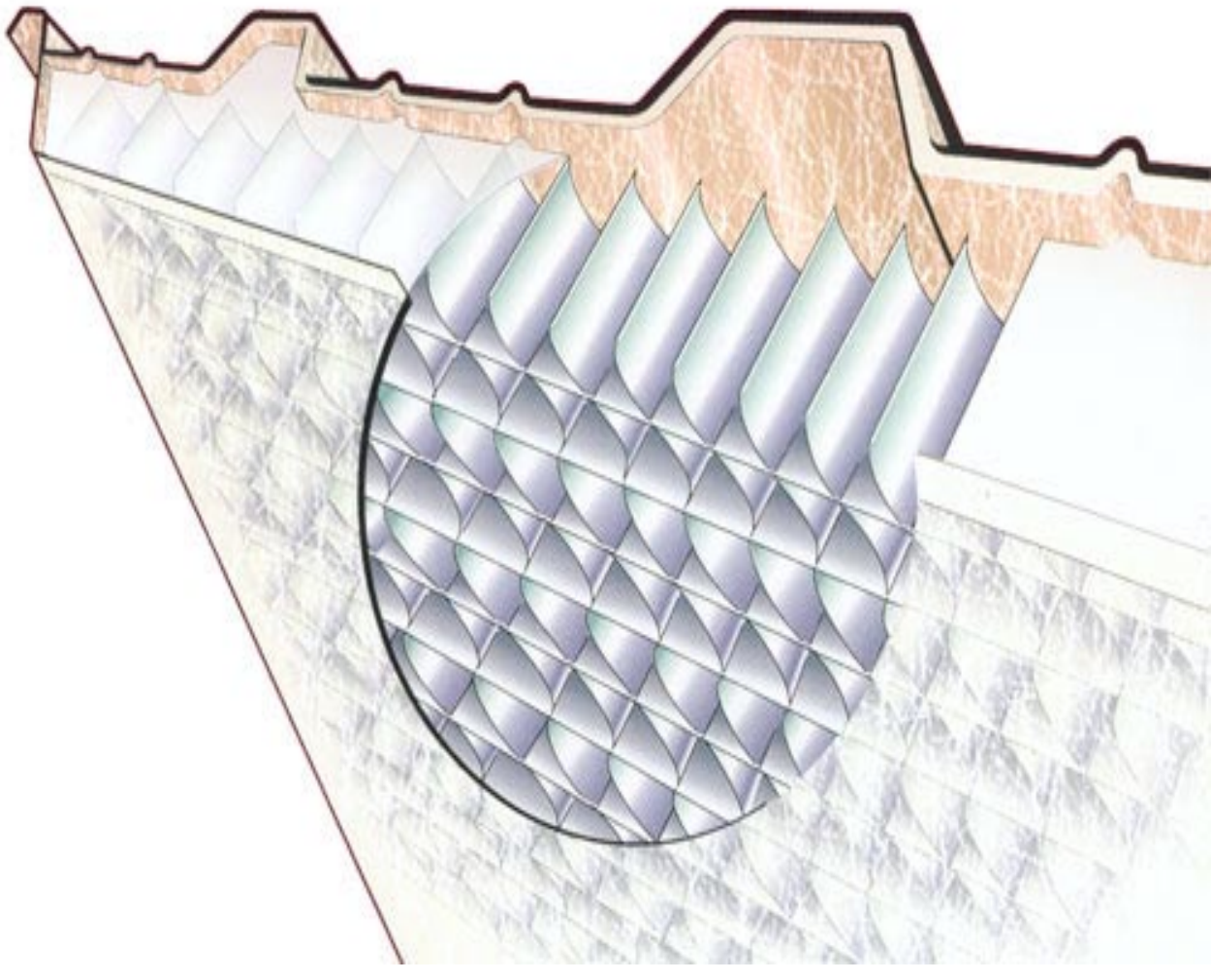
Pan-European Perspective

- Pre-cast construction is known and well used in mainland Europe.
- There is potential for global procurement.

OFFICE WALLS

Micro-rib composite panels with installed installation secured to a steel frame. Benefits as previously illustrated for high level warehouse cladding.


15% rooflights
5% more than institutional standard



WAREHOUSE ROOF LIGHTS

Roof lights are proposed to cover 15% of the warehouse roof area. Roof lights to consist of 688 triple-wall polycarbonate units, each unit to be in 1.0m x 8.650m long lengths, layed in continuous strips to each slope. The rooflights provide a light transmission of 64%. The translucent surface reduces glare from direct sunlight.

Construction Sequencing Benefits

- Continuous roof lights reduce the number of waterproofing details and thus reduce the installation time to achieve a waterproof enclosure.
- Rooflights are integrated with the roofing system.
- Provides 5% more rooflights than institutional standard.

Energy Use and Carbon Impact

- Provides increased daylighting to the warehouse floor, reducing the need for electric lighting.
- Provides an average daylight factor of 5.6% at ground level assuming a wide aisle arrangement. This is increased from the 3.73% currently achieved for 10% roof lights.
- Based on the building being operated 24 hours a day 7 days a week the 15% rooflights and photo cell controls provide an energy saving of 240,047Kw/h per annum.
- Saves 103,000 Kg CO2 (103 tonnes) per annum.

Aesthetic and Productivity Benefits

- Can improve employee productivity by providing a visual connection to the out-of-doors, and more natural lighting.

Cost Impact

- Additional cost of £45,000 (72,803 Euros).
- Payback of less than 5 years.

Pan-European Perspective

- Additional measures may be required to minimise solar heat gain in Southern Europe.
- Number of roof lights (15% of roof area) are considerably more than the current norm in mainland Europe and 5% more than the current institutional standards in the UK.
- Predictive light modelling to be completed for each location to determine the optimum roof light aperture, and the necessary detailing required.

Marsh Leys Scheme

Recommendation and Business Case

‘U’ value 0.25 w / m2/K composite

WAREHOUSE ROOF

Composite Roofing Panels

Construction Sequencing and Performance Benefits

- Easy incorporation of rooflights into the roof finish.
- Speed of installation on site.

Life Cycle and Ecological Benefits

- Manufactured with recycled content and can be recycled in the future.
- Insulation is non-ozone depleting

Energy Use and Carbon Impact

- Roof achieves 0.25 W/m²/K (U value).
- Light coloured reflective surface reduces the urban heat island effect.
- Effectively controls air leakage to meet new energy efficiency regulations of no more than $10m^3/hr/m^2$ of building envelope surface for a pressure differential of 50 Pascal

Cost impact

- No additional cost impact compared to the conventional roof.

Pan-European Perspective

- Widely available product commonly used in mainland Europe.
- Design guidelines and standards are established within the Gazeley Design Guide, allowing consistent delivery accross Europe.
- Most cost effective construction methodology in the UK however membrane roofing more competitive within mainland Europe.

Marsh Leys Scheme

Recommendation and Business Case

Composite roof panels

OFFICE ROOF

Composite panels with factory installed insulation secured to a 6° steel frame roof construction.

Construction Sequencing Benefits

- Pre-insulated panels reduce site installation time compared to other roofing methods.

Life Cycle and Ecological Benefits

- Manufacturerd with recycled content and can be recycled in the future.
- Insulation is non-ozone depleting.

Energy Use and Carbon Impact

- Effectively controls air leakage to meet new energy efficiency regulations.
- Provides good thermal performance - 0.25W/m2k (U-Value)
- Light coloured reflective surface reduces the urban heat island effect.

Cost impact

- No additional cost impact compared to the conventional roof.

Pan-European Perspective

- Used throughout central Europe, however a single-ply membrane roof is the more common solution. This is more commercially viable in Mainland Europe than the UK, and offers improved environmental characteristics. (see Optimised Scheme)

Marsh Leys Scheme

Recommendation and Business Case

WAREHOUSE - PORTAL FRAME

Warehouse structure to be a steel multi-pitched portal frame with a 6° roof pitch. Paint for steelwork to have volatile organic compound (VOC) content below the Environmental Protection Act requirements.

Construction Performance Benefits

- Simplest, most economical long-span structural system.

Ecological Benefits

- The use of recycled content in the steel will reduce reliance on virgin resources, lessen topsoil degradation and limit energy use for extraction and refining.
- Low VOC paint is used on the steel. High VOC level paints are damaging to the ozone layer.

Cost impact

- A steel frame is the conventional method. No additional cost is incurred.

Pan-European Perspective

- Commonly available structural frame throughout mainland Europe.

WAREHOUSE FIBRE-REINFORCED SLAB

Warehouse floor slab to be 200mm fibre-reinforced jointless concrete. PFA (pulverized fuel ash) or GGBS (ground granulated blast furnace slag) cement replacement to reduce the amount of Portland cement.

Construction Sequencing and Performance Benefits

- Use of fibres within the concrete mix eliminates the need for placing and fixing mesh reinforcement.
- Fibre reinforced slabs are thinner than traditional slabs, therefore reducing the concrete quantities required.
- Jointless floor reduces the amount of sealant required.

Ecological Benefits

- The use of PFA and GGBS reduces the amount of Portland cement used and thus reduces CO2 emissions. Portland cement has a high embodied energy.
- The use of recycled aggregates reduces the amount of primary aggregate extraction.

Cost impact

- This is the conventional method. No additional cost is incurred.

Pan-European Perspective

- As in the UK, slabs in Mainland Europe are designed to accommodate the necessary loading from specific end user requirements.

T5 technology

OFFICE LIGHT FIXTURES

Office light fixtures to be fluorescent systems utilising the latest T5 technology with high frequency balust and control gear.

Productivity and Aesthetic Benefits

- Provides an even ambient light on the ceiling surface and eliminating high contrast light. This will reduce eyestrain.
- T5 technology provides the most energy efficient method of commercial lighting currently available.

Ecological Benefits

- More efficient than older technologies such as T8 systems, or switch start as still widely used.
- Saves 48,000 Kwh compared to conventional T8 technology for the office, based on a 12 hour shift and 80% utilisation, 365 days a year.
- Saves 20,640 Kg of CO2 (20 tonnes).

Cost impact

- No cost impact.
- Saves £1,900 per annum in energy costs.

Pan-European Perspective

- Availability of product may vary by country.

Marsh Leys Scheme

Recommendation and Business Case

OFFICE FINISH MATERIALS

Recycled Content and Rapidly Renewable Content Materials

Interior finish materials to contain recycled and rapidly renewable content. Recycled content ceramic tile to Entrance Foyer, Recycled carpet to open plan office areas / circulation routes, Gypsum board from industrial sources, toilet dividers consisting of chipboard with laminate facing and linoleum to toilet floors.

Ecological Benefits and Life Cycle Impact

- Use of recycled content lessens ecosystem degradation and associated energy costs for extraction of virgin materials.
- Many materials containing recycled content can themselves be recycled at the end of their useful lifespan.
- The use of bio-based content such as in linoleum replaces the use of harmful chemicals such as those found in PVC (polyvinylchloride), the main ingredient in many composite floor tiles.
- Recycled gypsum obtained from industrial smoke stack scrubbers replaces natural gypsum, which must be mined.

FLOOR FINISHES

Carpets

Carpets using 80% post-industrial recycled yarn. Low toxicity material which is water soluble and does not 'off-gas' into the surrounding environment. Carpets certified to meet the three most recognised environmental quality standards.

Marmoleum (Lino)

Using natural recyclable raw materials as listed below. The materials are harvested with relatively little energy consumption. The main energy resource being the sun. The marmoleum includes the following raw materials.

- Linseed Oil: produced by pressing the seeds of the flax plant
- Limeseed: found all over the world, finely ground this is an important ingredient of Marmoleum.
- Pigments: using ecologically responsible pigments that do not contain heavy metals such as lead and cadmium.
- Jute: from the wide variety of materials available for making the floor coverings backing.
- Wood-flour: used for binding the pigments. The wood-flour used is made from timber grain in controlled European forests where every tree felled is replaced.
- Cork-flour: used by grinding the bark of the cork oak. This is peeled every seven to ten years without affecting the tree's growth.
- Rosin: Tapped from pine trees without affecting the trees growth.

Toilet Panelling / Dividers

Wall panelling system and cubicle dividers are formed from chipboard and resin content, faced with laminates, which consist of paper. The pulp used to manufacture the paper comes from a replenishable source and no rain forest timber is used. Melamine based resis does not include asbestos, heavy metals, bromine or chlorine compounds and as such is non-hazardous.

Paint

Using organic paints from plants and minerals. The paints are produced from high quality dehydrated castor oil, chalk, beeswax and linseed standoil as a binding material. The beeswax also reduces static charging.

Marsh Leys Scheme

Recommendation and Business Case

Plasterboard

Ceilings

The bulk of the product is made from stonewool, a natural, abundant resource

- Including the recycled materials in the core stonewool production, the total share of recycled stonewool amounts to 30%.
- The waste materials from the manufacturers process and other industries are used as raw materials for their products.
- Clean waste from site installations can be returned to the manufacturers plant and made into farmstores. These then become part of the raw materials in their manufactuing process.
- The products can be recycled at the end of their life and used again in the manufacturing process.
- Paint used in the product made of approximately 95% of the natural materials chalk and calcium. Binder of water based acrylpolymer.

Partitions

Using Desilphogypsum (DSG) which is a by-product of Powergen Industry, combined with recycled paper generators investment in environmental technology, the inert by-product DSG which would otherwise be a waste material is being used to supplement the natural gypsum in the plasterboard.

The production of DSG is the result of Gas Desulphurisation (FGD) equipment, this is capable of reducing sulphur dioxide emissions from the power stations by upto 90%.

The recycled paper is made exclusively from paper, collected from major stores, super-markets and local authority sources.

Scrap recycling plants are also used to handle process waste, damaged stock, and redundant material which allows the material to be re-introduced into the managability process.

Cost impact of all recycled materials

- Cost premium of £10,000 (16,179 Euros) on these items.

Pan-European Perspective

- Availability of products may vary by country.
- Products being more widely available.

Low Toxicity materials

Interior finish materials to contain ingredients which do not off-gas and are not detrimental to indoor air quality. Affected items include: paints, adhesives, sealants and carpets.

Ecological Benefits

- Reduces irritating and potentially harmful air contaminants from the indoor working environment.
- Ensures fresher air for occupants, potentially increasing productivity.

Cost impact

- Cost premium of £10,000 (16,179 Euros).

Pan-European Perspective

- Availability of products can vary by country.

Marsh Leys Scheme

Recommendation and Business Case

Jet Nozzle heating

WAREHOUSE HEATING AND VENTILATION

A jet nozzle system will be incorporated at a later date.

Jet nozzle heating

Performance Benefits

- Delivers heated air quickly.
- Ensures that fire sprinkler piping remains functional during times of freezing exterior temperatures.

Cost impact

- Most cost-effective method of providing tempered air to the warehouse in terms of its unique de-stratification capability.
- This is the conventional solution, with no additional cost impact.

Pan-European Perspective

- Heating solution is climate dependent.

Marsh Leys Scheme

Recommendation and Business Case

Monocrystalline Photovoltaic Panels

solar conversion efficiency - 14%

PHOTOVOLTAICS

The high level photovoltaics will be mounted above the office elevation and project beyond the front elevation of the offices. These will provide 94m2 of glass / glass type panels, angled at 20 degrees giving 11.34 Kw peak output.

The low level units will be a glass / glass system frame located on the pedestrian walkway approaching the offices from the car park. These will provide approximately 24m2 of photovoltaic arrays giving an output of 2.88Kw peak.

Energy Use and Carbon Impact

- Provides energy from a renewable source, minimising the use of fossil fuels.
- Reduces reliance on the electrical grid distribution system.
- Energy produced is free of carbon emissions.
- High level PV saves 3,720Kg of CO2 per year (3.7 tonnes) based on Government average figures of 0.43Kg CO2 produced from electricity generation. Based on average CO2 figures which excludes power generation through Hydro and Nuclear power of 0.7Kg CO2 per Kwh a saving of 6,056 Kg CO2 (6 tonnes) can be saved per annum.
- Low level glass / glass features save 774Kg of CO2 (0.7 tonnes) based on government figures of 0.43Kg CO2 produced from electricity generation. Based on 0.7 Kg CO2 per Kwh this equates to 1,260 Kg CO2 (1.26 tonnes).
- Total CO2 saving of 4,494Kg of CO2 per year (4.5 tonnes pa).
- Worst case average of 1Kg of CO2 per Kwh is applicable for 'dirty' coal fired power generation.

Performance Benefits

- Has an iconic presence that signifies environmental responsibility.
- Monocrystalline panels have a solar conversion efficiency of 14% and a glass surface that is UV resistant and relatively self-cleaning.
- Produces 14.22 Kw peak including high level photovoltaic producing 11.34 Kw peak with low level 2.66 Kw peak.
- Total of 10,452 Kwh of energy, provided by 8,652 Kwh for the high level array and 1,800 Kwh for the low level features.

Cost impact

- Cost of approximately £100,000 (161,785 Euros) based on both high and low PV arrangement. A Department of Trade and Industry Grant for 40% of the cost associated with the building mounted high level PV array has been secured through the Energy Savings Trust.
- Provides 20% of the power for external lighting.
- Major PV Demonstration Programme has two types of grant available. See future European Environmental Regulations in the Appendix for the complete list of incentives.

Pan-European Perspective

- See Appendix for list of incentives in various European countries.

Marsh Leys Scheme

Recommendation and Business Case

Wind Turbine 20kw output

WIND TURBINES

A 20 kW propeller type wind turbine is to be installed at the site entrance, adjacent to the office building. The wind turbine will power the office yearly lighting requirement.

Energy Use and Carbon Impact

- Reduces fossil fuel consumption and carbon emissions.
- Has an iconic presence that signifies environmental responsibility.
- Harvests 50,000 Kwh of energy based on a 6.5m/second average wind speed which is based on historical data from the Bedford site.
- Saves approximately £2,000 worth of electricity per year (based on 4p per unit).
- Saves 21,500Kg CO2 (2 tonnes) (based on 0.43 CO2 per kg per year Government average figures).
- The wind turbine is 18m high with a rotor diametr of 7m.

Aesthetic Benefits

- Provides a highly visible demonstration of environmental responsibility.

Cost impact

- £80,000 (129,428 €) installed cost for a 20 kW turbine.

Pan-European Perspective

- Favoured in Northern Europe due to landform and proximity to coastlines where greater wind speeds are found.
- Incentives and grants vary by country.

Marsh Leys Scheme

Recommendation and Business Case

Solar heat recovery

Grey water recycling

SOLAR THERMAL HOT WATER HEATING

An evacuated tube solar thermal collector is to be installed on the office building roof. The hot water will be used to preheat water for wash hand basins and showers to 25 degrees. The system has an output of 12 Kw.

Energy Use and Carbon Impact

- Provides energy from a renewable source, avoiding the use of fossil fuels.
- Will harvest 15,300Kw per annum of primary heat source.
- Reduces cost of operations in the long term.
- Reduces reliance on the electrical grid distribution system.
- Energy produced is free of carbon emissions. Will save 2.9 tonnes of CO2 annually based on 0.19Kg CO2 per Kwh for gas power generation, and save approximately £300 in annual fuel costs.
- Has an iconic presence that signifies environmental responsibility.

Cost impact

- Cost of solar thermal system is £ 12,000 (19,400 €).

Pan-European Perspective

- Solar thermal efficiency is related to sunshine availability and is therefore favoured in Southern Europe. Barcelona requires that a percentage of hot water for all residential projects be provided by a solar thermal system.

ROOF WATER COLLECTION

A 10 cubic metre capacity cistern for collection of rainwater from the roof is to be installed. The water collected will be reused within the building for grey water recycling into the WC's and toilet areas.

Ecological Benefits

- Reduces use of potable water and the pressure placed on the water supplies
- Lessens the burden on municipal water treatment systems.
- Reduces the amount of distribution piping.
- The release of chlorine into the environment is reduced commensurate with the reduction in quantities of potable water.
- Harvests 400,000 litres per annum.
- Saves 89% of the WC water requirements.
- Saves water equivalent to approximately 89,000 flushes or if purified 25,000,000 cups of tea per annum.
- The building requirement is 450,000 litres per annum, based on 4.5 litre WC cisterns.

Cost impact

- Cost: £17,000 (24,300 €).

Pan-European Perspective

- Financial benefits will vary depending on water scarcity, site density, municipal water costs, and political factors.

Marsh Leys Scheme

Recommendation and Business Case

PLUMBING FIXTURES

All WC's will be fitted with low flush volume (4.5 litre) cisterns. Hand wash basins will be fitted with spray taps and a central timed control to prevent water wastage. Waterless urinals will be installed. Low-flow showers will be installed for use by staff if required by the customer.

Ecological Benefits

- Use of low-flow and waterless fixtures reduces the amount of water needed for sewage conveyance, lessening the burden on municipal water treatment systems.
- The release of chlorine into the environment is reduced commensurate with the reduction in quantities of potable water and sewage.
- Spray pattern taps, based on a reasonable level of hygiene standards reduces water requirement. Should save approximately 63,000 litres over conventional fittings.
- Waterless urinals save approximately 158,000 litres over conventional fittings.
- Low flush volume 4.5 litres cisterns saves 150,000 litres over a more conventional 6 litre cistern capacity installation
- A total of 371,000 litres of water is saved over a conventional toilet arrangement.

Cost impact

- Additional cost of £5,000 (8,089 Euros).
- Lowers water charges.
- Has a 5 year payback.

Pan-European Perspective

- Financial benefits will vary depending on water scarcity, site density, municipal water costs, and political factors.

WAREHOUSE FIRE PROTECTION

Sprinklers will not be installed as part of the base build specification however, a fully charged water filled fire suppression system is recommended, the specification of which will depend on customer requirements..

Fire Suppression system

Construction Benefits

- Wet type system provides quick response and ensures that water for fire suppression is available at the source of combustion.

Cost impact

- This is the conventional solution. There is no additional cost impact.

Pan-European Perspective

- Fire suppression requirements vary by locality.

Marsh Leys Scheme

1

2

Vegetation, Trellis and wildlife ....

Protect local wildlife

Provide new habitat and enhance biodiversity

Incorporate indigenous species of plants into surrounding area

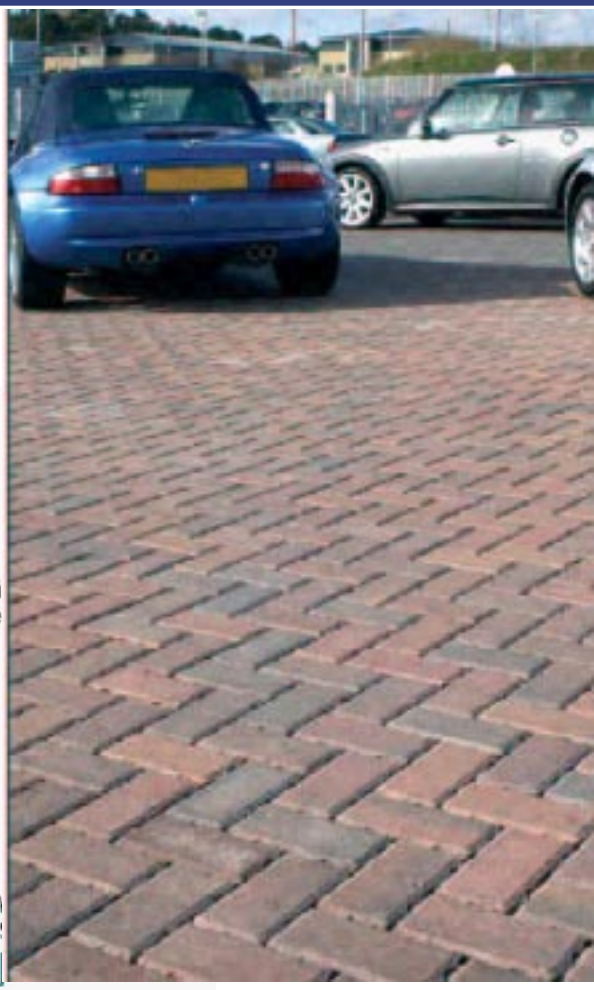
Purposeful integration of built form into natural environment

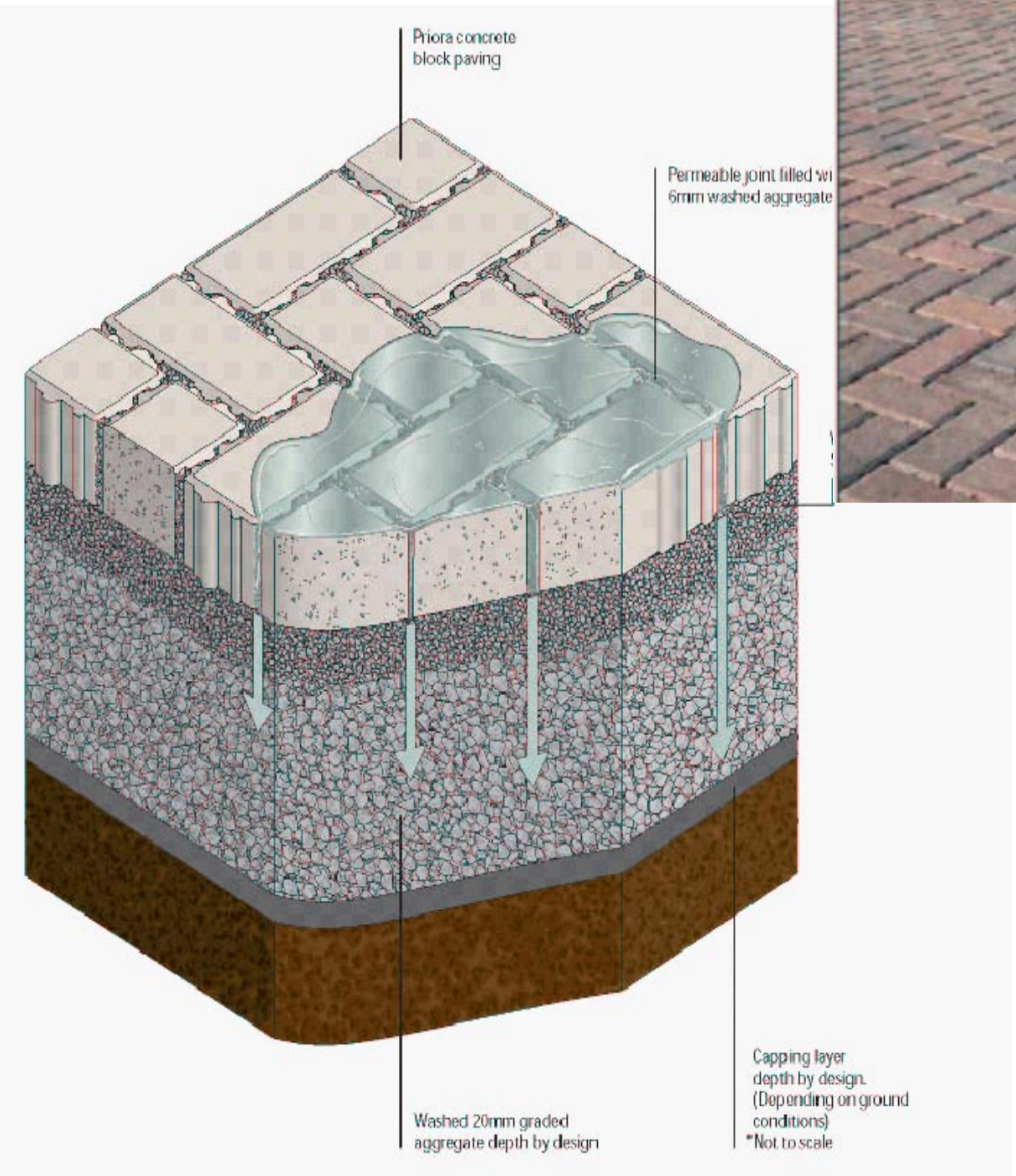
Woodland created **offsets C02** from the offices.

Enhance building aesthetic by trellis.

Reduce solar heat build up on building fabric

3




Priora concrete
block paving
Permeable joint filled wi
6mm washed aggregate
Capping layer
depth by design.
(Depending on ground
conditions)
*Not to scale
Washed 20mm graded
aggregate depth by design

Pervious Paving

Reduces peak flows into sewer system avoiding first flush contamination.

Filters hydrocarbons which break down naturally in subbase - heavy metals remain trapped at low concentrations

Major spillages contained in small area - avoiding channelling into local river ecosystems

3300m2 used at Bedford

4

Precast Concrete Dock Faces

Concrete has low embodied energy

All formwork can be re-used / re - cycled for other projects

Good thermal mass

Design for deconstruction

5

Rooflights

15% of roof area used

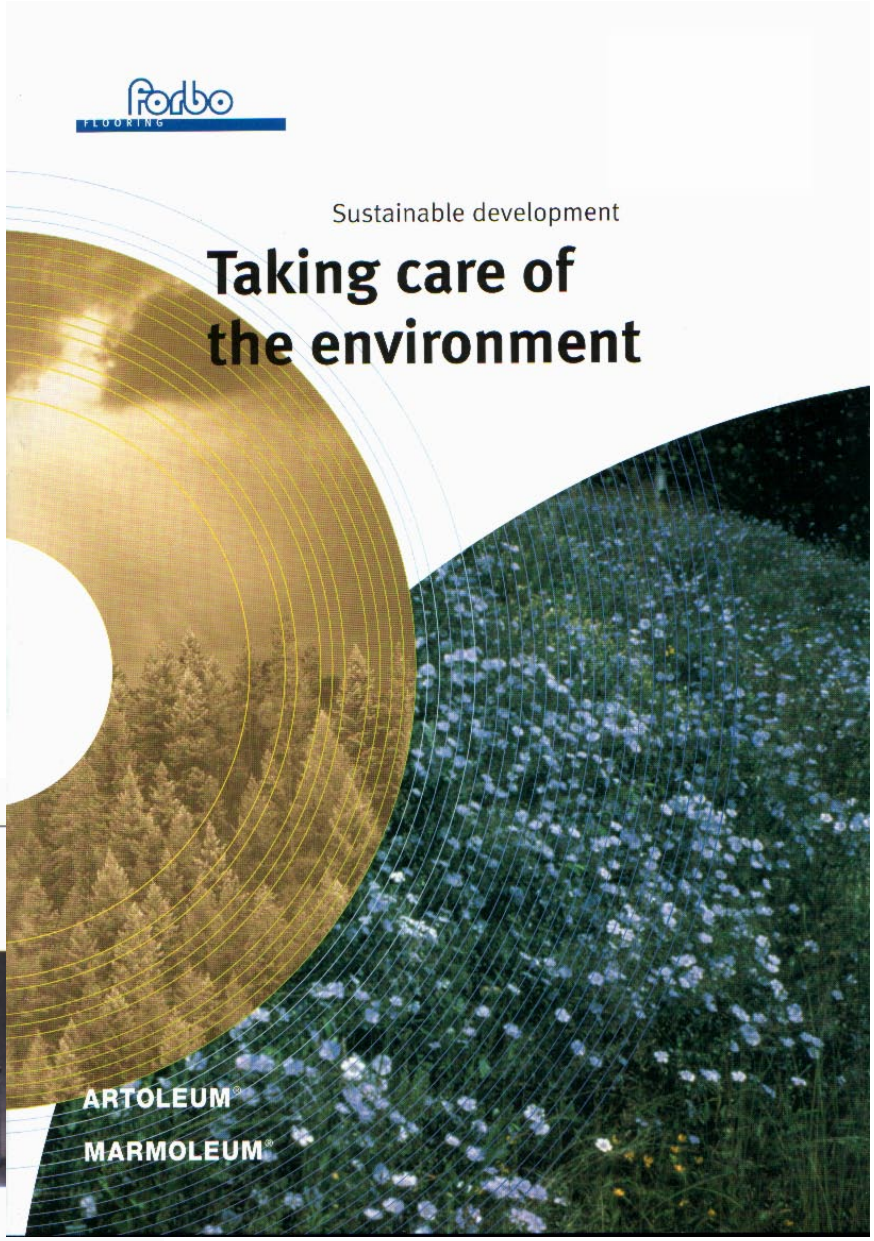
5% more than institutional standard

240,047 kw/h electricity saved per year (with Photocell control)

Saves **103,000 kg** CO2 annually

688 polycarbonate triplewall units - each 1m x 8.65m long

6



Beyond the power of any wallpaint: DUBRON Wall Paint (Natural Oil).

DUBRON?

This means in the Celtish language, water: DUBRON is a waterbased emulsion with a high covering capacity. For pre-coats it can be mixed with water.

Where to use DUBRON Wall Paint?

On interior surfaces:

Plaster	Plasterboard
Concrete	Clay
Brick	Hardboard
Woodchip wallpaper	Existing matt-emulsion surfaces

What is DUBRON Wall Paint made from?

It is produced from high quality dehydrated castor oil, chalk, beeswax and linseed standoil as binding material. And cellulose allows the surface to breathe and give a high absorption capacity.
The reason for the ease of use is the consistency of the raw materials. Even so, it can be diluted in water, and does not drip or run.

In which colour tones?

DUBRON Wall Paint c
Pastes to produce a wi

- Ochre
- Red Ochre
- English Red
- Persian Red
- Cream

How to use DU

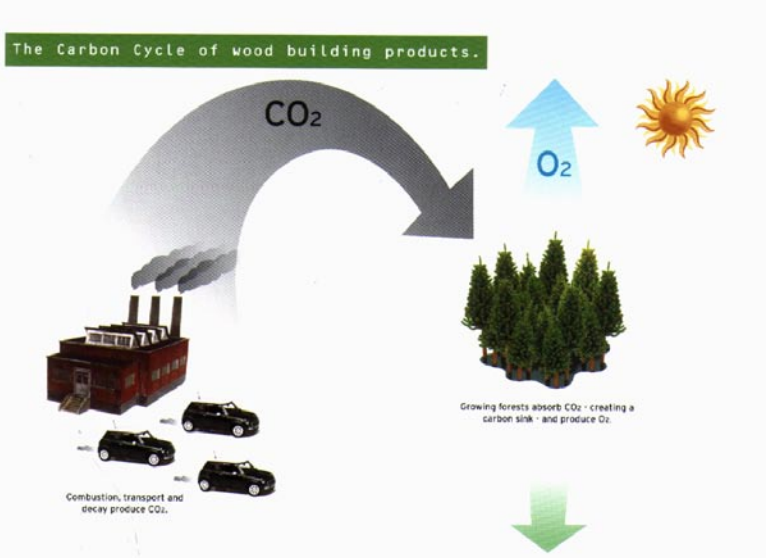
DUBRON Wall Paint i
Use on, for example,
plaster.

- The surface must be
- Strongly absorbant su
  Sealer. Allow 24 hou
- One coat is generally
  fully, uncoloured, on
- Clean working tools

How much is r

0.75 litre ... covers
5.00 litres ... cover
12.50 litres ... cover

What makes th
And what do
Natural Emulsi



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Internal Office Components

Carpets - **Recycled** yarn 80%

Rockfon ceilings - natural mineral fibre

Paint - naturally **organic**

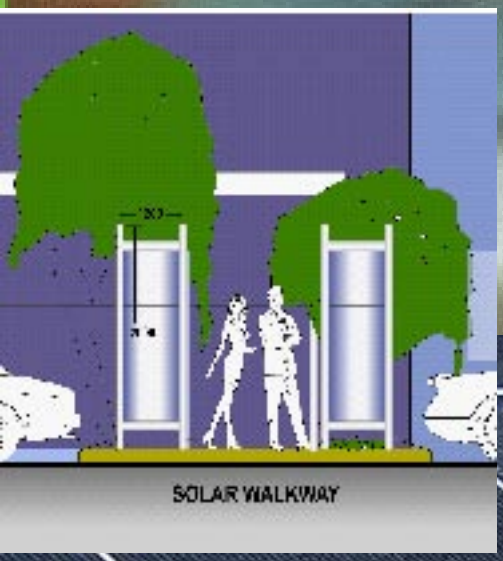
Sustainable laminate - organic

Marmoleum (lino) - uses natural **recyclable** raw materials

Partitions - use of DSG (Desulphogyp-sum - by product of Powergen Industry) and recycled paper

Low -flush WCs , auto spray taps , time controls and waterless urinals.

7



Photovoltaic Installation

94m2 at roof level **24m2** at low level facing South.

Rating **14.22 Kw peak** producing **10,452** Kwh per year

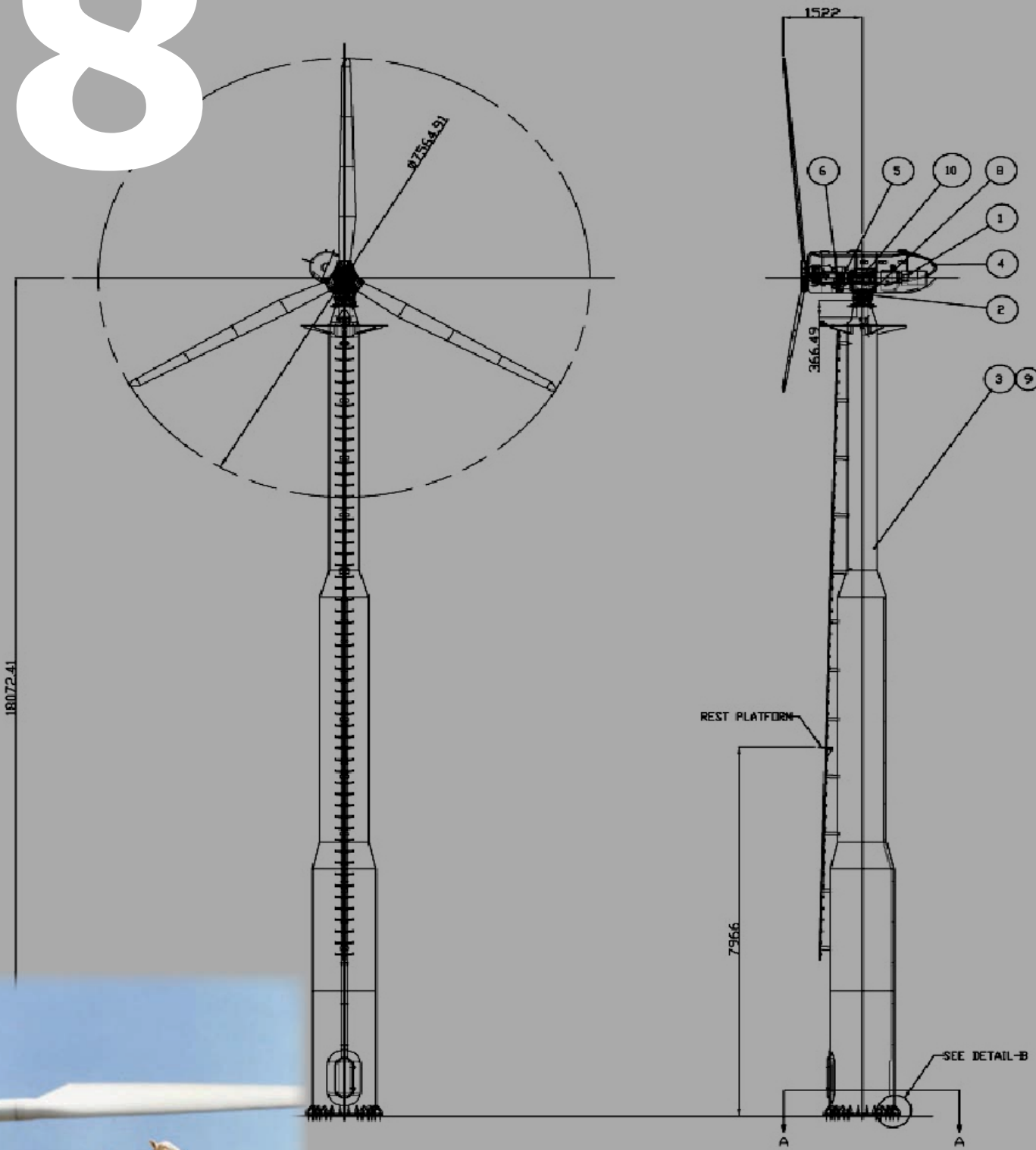
- this averages ***4,494 kg of CO2** saved annually.

This provides **20%** of overall external light power

* note - based on 0.43kg CO2 per Kwh

Marsh Leys Scheme

8



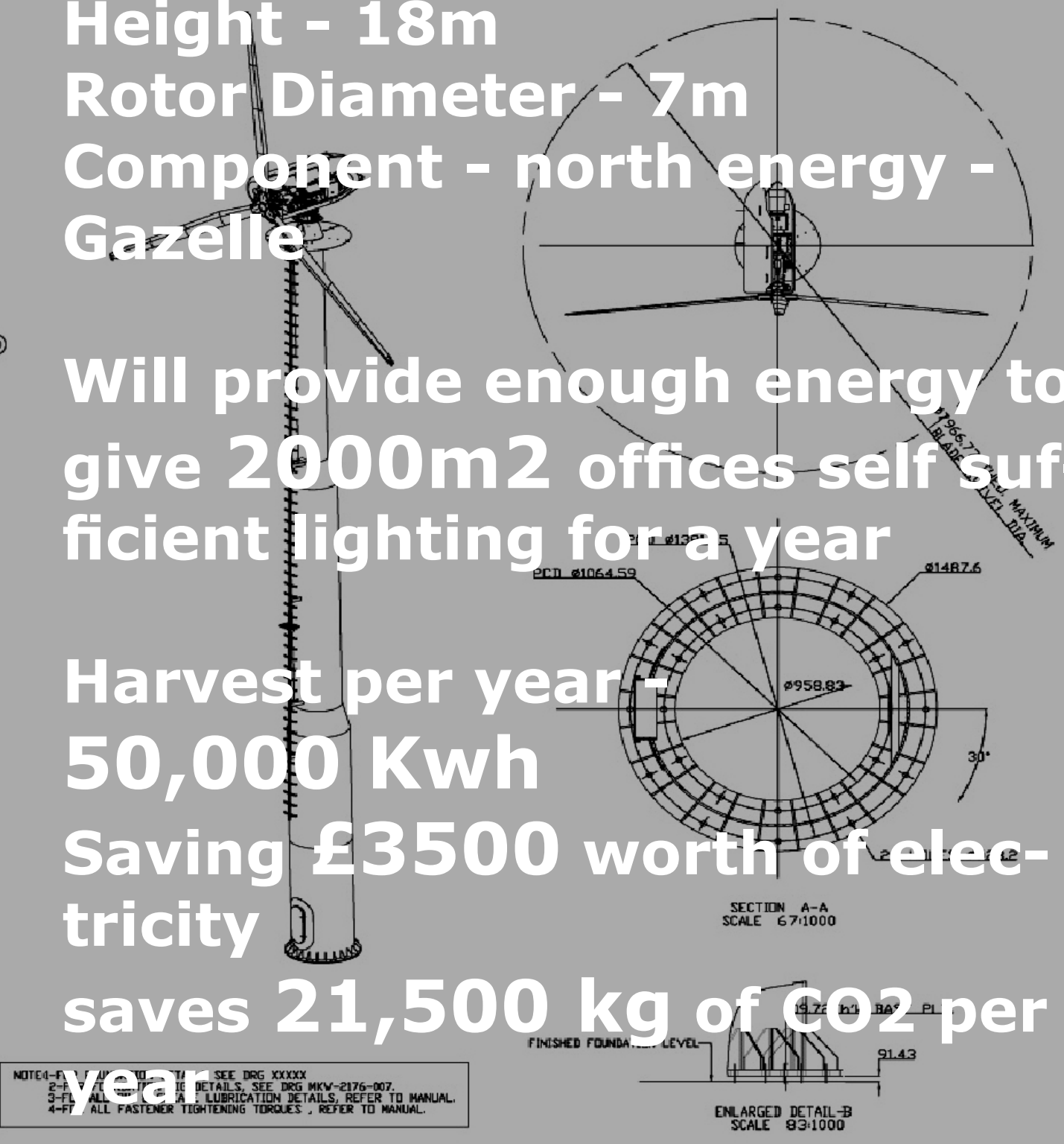
Wind Turbine - 20 KW

Weighs - 1 Tonne
Height - 18m
Rotor Diameter - 7m
Component - north energy - Gazelle

Will provide enough energy to give 2000m2 offices self sufficient lighting for a year

Harvest per year -
50,000 Kwh
Saving £3500 worth of electricity

saves 21,500 kg of CO2 per year



9

10

Solar thermal hot water heating modules

Rated at **12kw**

Will harvest **15,300 Kw** of primary heat source

Has facility to preheat to 25 degrees for toilet, sinks and showers

Will **save 2.9 tonnes on CO2** annually

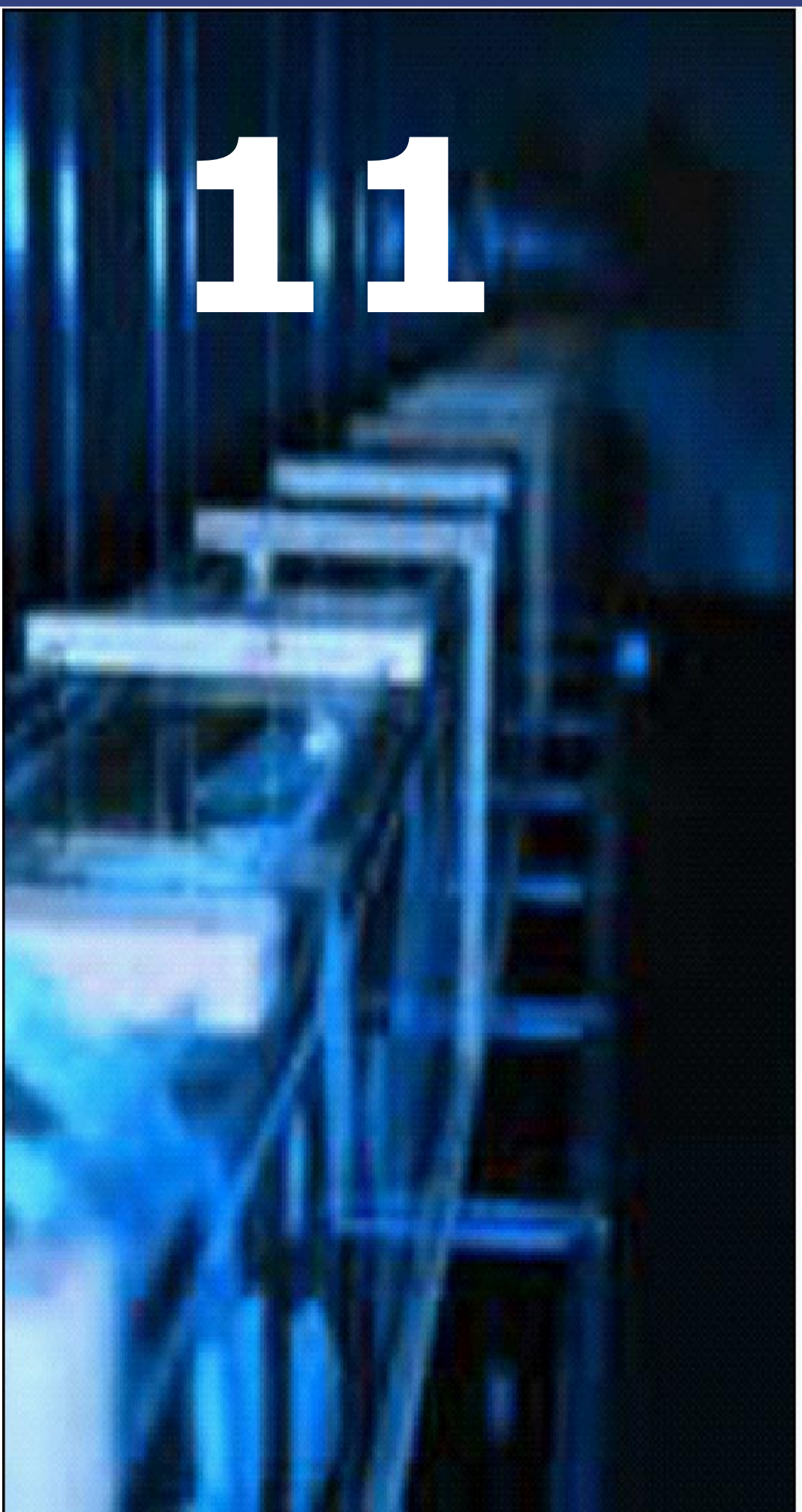
Roof water collection

Grey water recycled into WC flushes

Harvests **400,000 litres** per annum

Equivalent to **60,000 toilet flushes** or .... if purified 25,000,000 cups of tea

Plus
Reduced chlorine input into environment


11

Low water use appliances

371,000 litres per annum of water saved in toilet areas

Low volume 4.5litre WC Cisterns save 150,000 litres of water per annum

158,000 litres water saving from waterless urinals

63,000 litres water saving from spray taps

(All figures are compared to a 'conventional' 400,000sqft unit with approximately 2,000sqft office)

Marsh Leys Scheme

Eco Template savings total

6.2% saving in overall power requirement to the building

(Normal building requirement of 5,879,850kwh)

156,413 kg CO2 saved per annum (156 tonnes)

£14,530 cost saving per annum in energy

771,000 litres of water saved per annum to the offices

Saving of 45% of the overall office requirement

Marsh Leys Scheme

COST UPLIFT VALUES

(over and above conventional practice)

1 - Local provenance vegetation	**£zero**
2 - Wall vegetation	**£24,100**
3 - Pervious paving to car park	**£40,000**
4 - Precast dock faces	**£41,000**
5 - 15% rooflights	**£45,000**
6 - Recycled and rapidly renewable finishes to office	**£20,000**
7 - Photovoltaic panels	**£100,000** (40% Grant)
8 - Wind Turbine	**£80,000**
9 - Solar thermal hot water system	**£12,000**
10 - Roof water collection	**£17,000**
11 - Low flush volume products in WC areas	**£5,000**

a step further

4.1.Introduction

The Optimised scheme proposals take the Eco Template a step further, looking at the opportunities that could be delivered in the short to medium term, i.e. from six months time.

These proposals are based on a generic site, anywhere within Europe, taking into account current European guidelines and legislation.

The opportunities include some strategies that will require further research and development.

The proposals are not limited by site-specific restrictions and will accommodate cross dock arrangements and rail freight loading, therefore improving the flexibility of transit connections. The scheme also includes some aspects that require further discussions with insurance and funding bodies. The strategies identified show an incremental improvement in the Environmental credentials of the building, and include technologies that are available now.

Within this scheme certain decisions have been made which have a significant impact to the building form. These include:

- The building height has been reduced to allow a maximum clear height of 13.4metres (12 metres clear to haunch). This height is the maximum permissable before in-rack sprinklers are required. Thus, fit-out costs are lower for the end user, and the building mass is reduced.

- Some measures are introduced which will not reduce the construction costs, but will benefit a Life cycle cost analysis. Costs in use will be lower for the customer and energy will be saved.

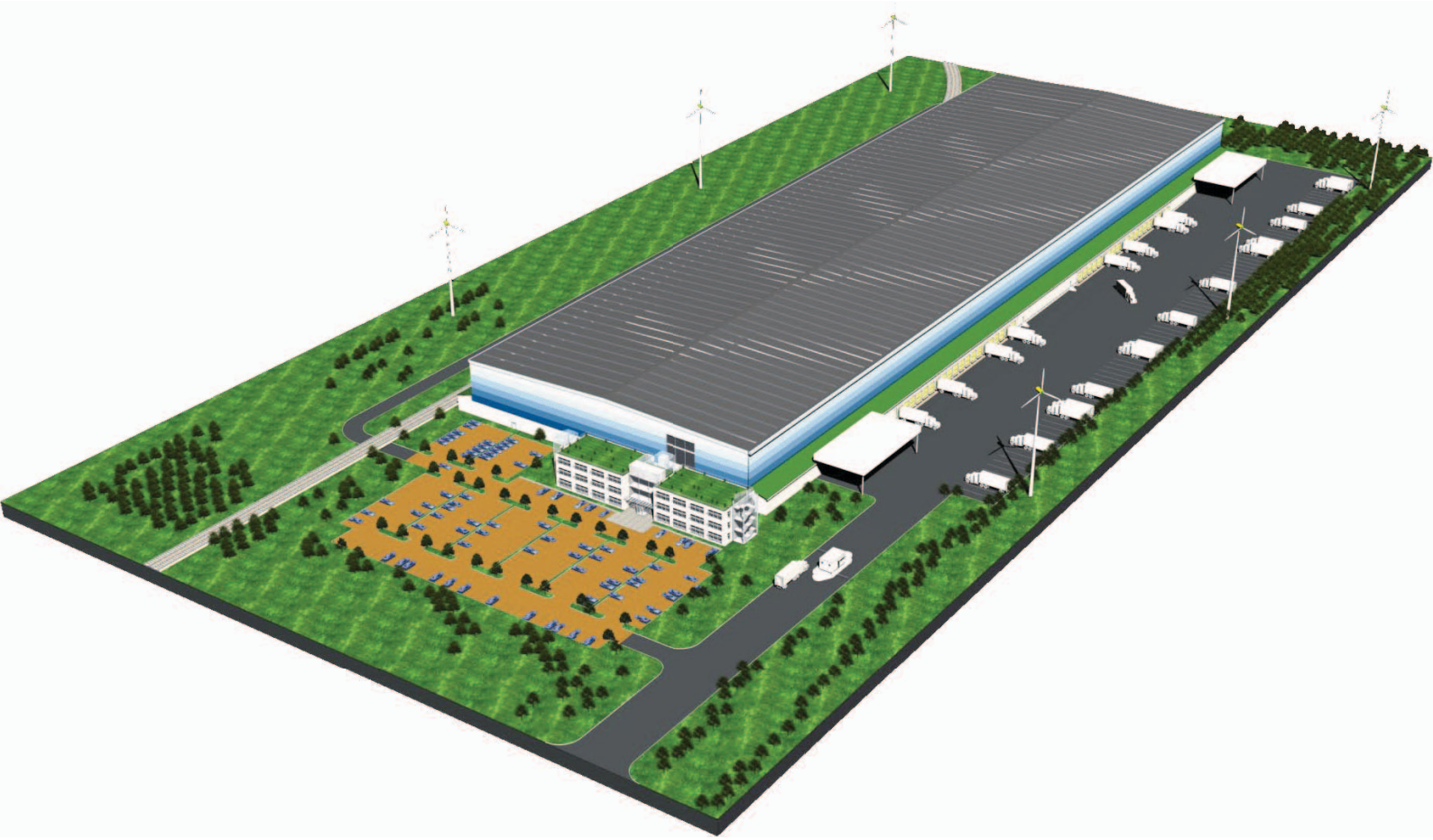
- It is proposed to reduce the height above the dock area, a space that in most current buildings is utilised. Stepping the building in this area allows for a green roof to be incorporated; reducing the visual impact of the building.

- Although the proposal is based on a generic site, its size is still similar to Marsh Leys.

- Anticipating design (or future proofing) has been considered so that the proposals allow for future technologies to be introduced when cost-effective. For example, the membrane roof finish accommodates increased green roof or photovoltaic technology on the warehouse roof. Without funding assistance these are not cost effective, however our research shows that incentives in some countries make them immediately viable. These are illustrated in the document.

This scheme develops the strategies further towards the revolutionised vision.

Optimised Scheme



Axonometric View

4.2. Summary table of recommendations

Optimised scheme initiatives - Summary

Landscape

Planting	Maximised use of vegetation for habitat recreation.
Native Vegetation	Maximised use of local provenance seed.
Wall Vegetation	Wall surfaces planted with trellises and vegetation.

External Yard

Site Density	Parking areas reduced to allow for stormwater retention.
Stormwater Management - Paving	Porous paviours and compacted gravel in car park areas.
Stormwater Management - Wetlands	Wetlands increased for stormwater retention.

Envelope

Warehouse Cladding - High Level	Profile metal composite panels with factory installed insulation, installed to a steel frame.
Warehouse Cladding - Low Level	Tilt-up concrete insulated cladding panels.
Warehouse Clad. - Low Level - Docks	Insulated tilt-up concrete panels.
Walls - Office Cladding	Insulated pre-cast panels with applied insulation.
Warehouse Roof - Membrane Roofing	Single-ply APAO modified bitumen membrane.
Office Roof - Membrane Roofing	Single-ply APAO modified bitumen membrane.
Office Roof - Green Roof	Extensive green roof with planters for shrubs.
Warehouse Roof - Green Roof	Extensive green roof to be maximised as commercial considerations allow.
Warehouse Roof Lights	Continuous polycarbonate roof lights over 15% roof area.
Roof Drainage	Gravity flow with gutters and downpipes.

Structural Frame

Warehouse Structure	Steel portal frame. 2 degree pitch (reduced height over marshalling areas)
Office Structure	Concrete slabs on steel column frame, precast stairs

Internal Floor

Warehouse Internal Floor	Post-tensioned slab.

Office Environment

Daylighting	Office building location may vary by solar orientation of the site and geographical location. Natural daylighting to be maximised.
Recycled/Rapidly Renewable Materials	Interior finishes to include recycled products.
Low-Toxicity Materials	Interior finishes to include low-toxicity materials
Lighting	Ambient/task solution using pendant fixtures - exposed underside of slab. Natural day lighting maximised.

M&E Services

Warehouse Heating & Ventilation	Forced air jet nozzle heating system.
Office Heating & Ventilation	Natural cross ventilation with perimeter heating.
Energy Sources - Photovoltaics	Photovoltaic array to be maximised as per local incentives.
Energy Sources - Solar Thermal	Evacuated tube collector installed on office building towers.
Energy Sources - Wind Turbines	Wind generation to be maximised as per local incentives.
Water Use - Fixtures	Low/ no -water use fixtures and timing controls.

vegetation
parking
hard landscape
water

SITE VEGETATION
Provide opportunities for vegetation to colonize the site where land and surfaces of structures are available.

Technology and benefits as illustrated within Marsh Leys section.

LOCAL PROVENANCE VEGETATION
Use local provenance seed to re-establish native habitat and link with nearby habitats.

Technology and benefits as illustrated within Marsh Leys section.

WALL VEGETATION
Provide opportunities for vegetation to grow on building walls:

Technology and benefits as at Marsh Leys

WETLANDS/ SWALES/ PONDS
Provide stormwater retention areas on available site. Portions of roof to drain directly into retention areas.

Stormwater retention and wetlands to be maximised on the site.

Technology and benefits as at Marsh Leys

SITE DENSITY/ PARKING CAPACITY
Reduce car-parking areas in order to increase available space for on-site stormwater retention and habitat restoration. Parking areas to be fully integrated with the planting, drainage and overall landscape scheme.

Technology and benefits as illustrated within Marsh Leys section.

The Optimised scheme is planned to provide the flexibility for a cross-docking arrangement. This will also deliver rail connections to one elevation. The rail service yard requires a 10 metre wide platform adjacent to the building and immediately adjacent to the rail line.

Additional Benefits of Rail service

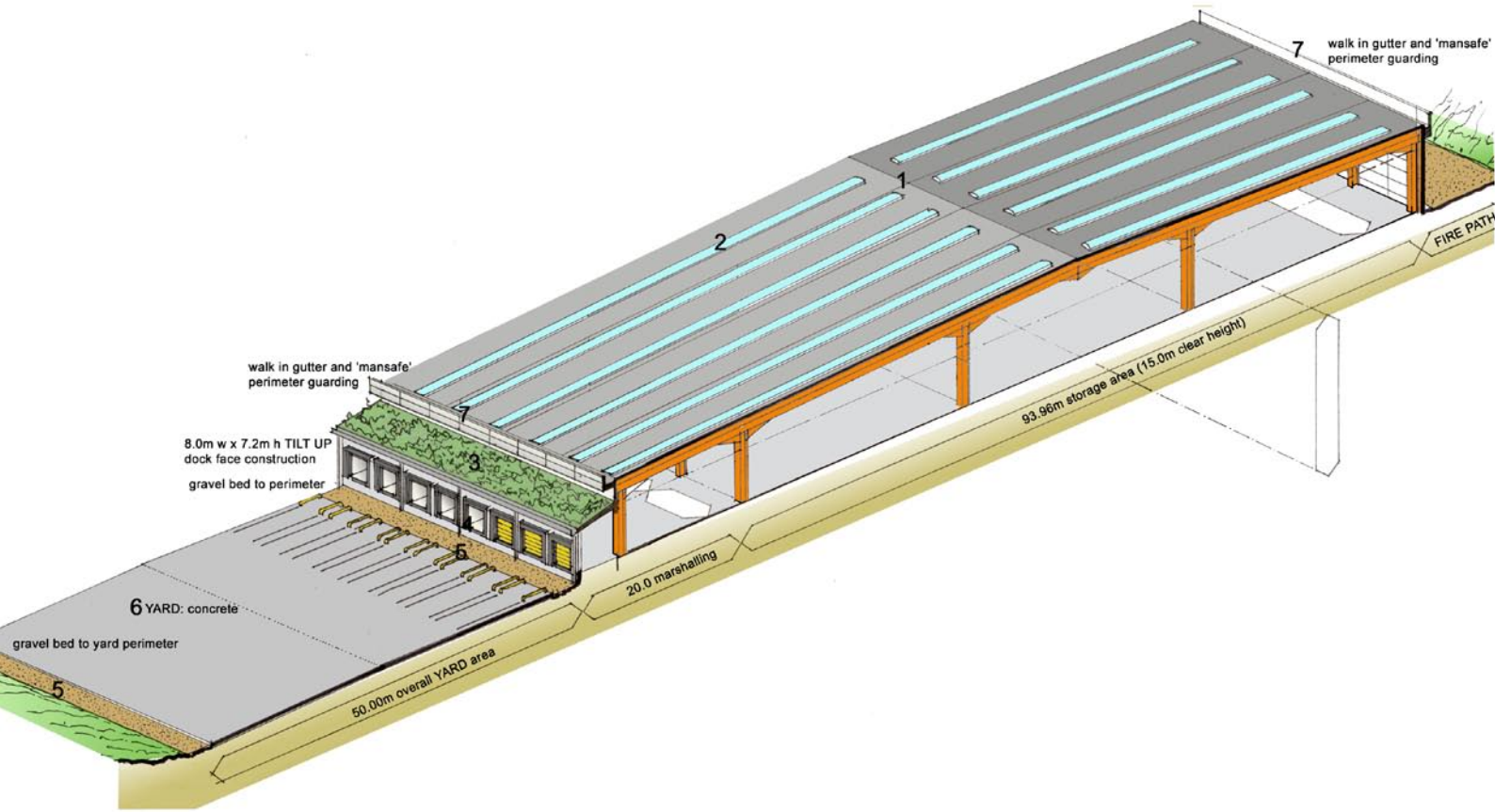
- Rail connection reduces the impact of energy use and emissions on the local environment.
- Rail connection improves the volume of freight to the building.
- Service yard requirements are reduced.
- Flexibility of delivery is increased by providing for multiple modes of transport.

PERVIOUS PAVIOURS
Pervious paviours to be installed in car park aisles to allow under drainage. Compacted gravel to be utilised in car park parking spaces.

Pervious paving to be maximised on the site.

Cost Impact

- Reduced below-grade piping offsets additional cost of site work £46,000 (74,421 Euros) additional cost for drainage and collection tank.
- Additional cost comapred to tarmac : £24/m^2



1. 2 degree pitched single ply membrane roofing system on insulation on 1200 gauge vapour barrier lapped and sealed.

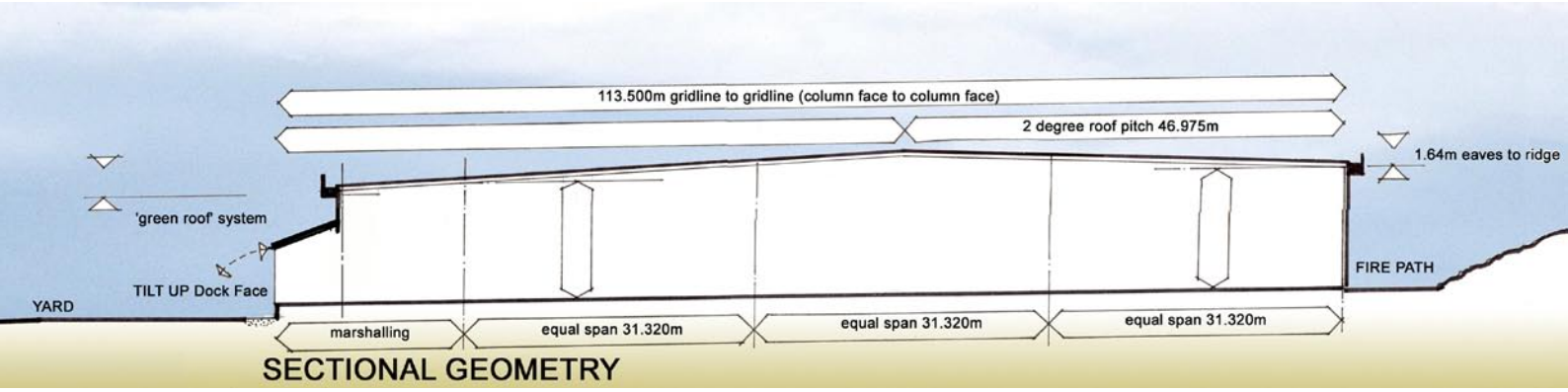
2. 0.9m wide continuous rooflights @ 5.333m centres to achieve 15% density.

3 & 4. Intensive green roof at 15 degree slope over TILT UP dock face construction.

5. Gravel surface water collection zone to warehouse perimeter with 150mm diameter RWP's at 8.0m centres (dependant on ground conditions).

6. Concrete yard slab falls to perimeter gravel zones.

7. External walk in 'gravity' gutter and 'mansafe' perimeter guarding.



Warehouse

Sectional Geometry

WAREHOUSE WALLS (high level)

Micro-rib composite panels with factory installed insulation. Secured to a steel frame (above the 7.2 m height of the tilt up panels). Panels to incorporate mineral fibre insulation in place of the conventional polyisocyanurate insulation.

Composite Insulated Metal Panels

Technology and benefits as at Marsh Leys.

Additional benefits of the mineral fibre include:

- Mineral fibre insulation contains post-industrial content and has a low embodied energy (13.57 - 27.28 Mj/kg)
- Insulation type complies with Montreal and Rio Summit protocols.
- Insulation is CFC and HCFC free and thus non-ozone depleting.
- Improved insulation can reduce climate change levy.

Cost impact

- Additional cost for mineral fibre insulation compared to standard PUR: £22.50m^2

Optimised Scheme

Recommendation and Business Case

tilt-up low level

WAREHOUSE WALLS (low level)

Tilt up concrete insulated cladding panels at low level for the entire external envelope, including dock areas. Panel height to be a maximum of 7.2 metres and spaced on an 8.2 metre grid. Panels to be 200mm thick, load bearing, supporting 140mm thick concrete slab on 1.2mm ribbed decking to support a green roof above dock areas, weighing 330 kg/m². Concrete will be specified to use pulverised fuel ash and recycled aggregates.

The dock area is reduced in height from the Marsh Leys scheme. The green roof will have a 15° slope and be planted with shrubs and grasses.

Construction Sequencing Benefits of tilt-up panels

- Sequencing advantages: external cladding panels and steel frame can be constructed independent of the tilt-up dock areas.
- Overcomes current sequencing and buildability issues with different trades requiring access to the same building areas.
- Tilt-up elements do not affect other elements in terms of sequencing.
- Assists with the design and procurement lead-in times, the panels being cast in-situ on site.
- Several panels can be poured on top of each other for each "pouring bed" on site.

Life-cycle and Resource use benefits

- Concrete has a low embodied energy over its life cycle.
- Use of pulverised fuel ash minimises the use of virgin materials (this will be specified in its manufacturing).
- Partial use of recycled aggregates reduces mineral extraction.
- Standardisation can allow formwork to be re-used throughout the site and recycled on other sites.

Energy Use and Carbon Impact

- Provides improved air tightness compared to composite panels.
- Provides good thermal mass.

Cost Impact

- Additional cost for tilt-up panels to dock areas compared to standard composite panels: £100m^2

Pan-European Perspective

- Tilt-up construction is known in Mainland Europe, but not commonly used. This is a method used more in the USA.
- Can be built on-site using locally available materials, reducing transportation costs and supporting local economies.

Additional Benefits of lowered dock height

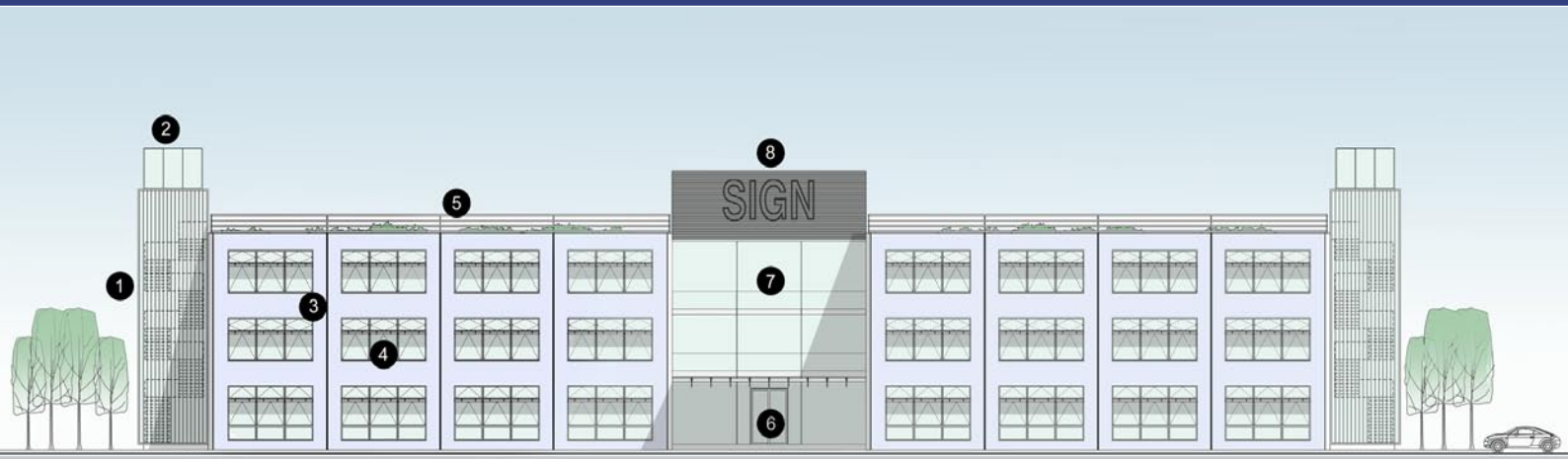
- Reduces the height above the dock areas, minimising unusable space that would unnecessarily be heated and ventilated.

Ecological and Aesthetic Benefits of green roof

- Helps to partially screen the upper portion of the warehouse, reducing the visual impact of the building and potentially easing the planning consent process.

Optimised Scheme

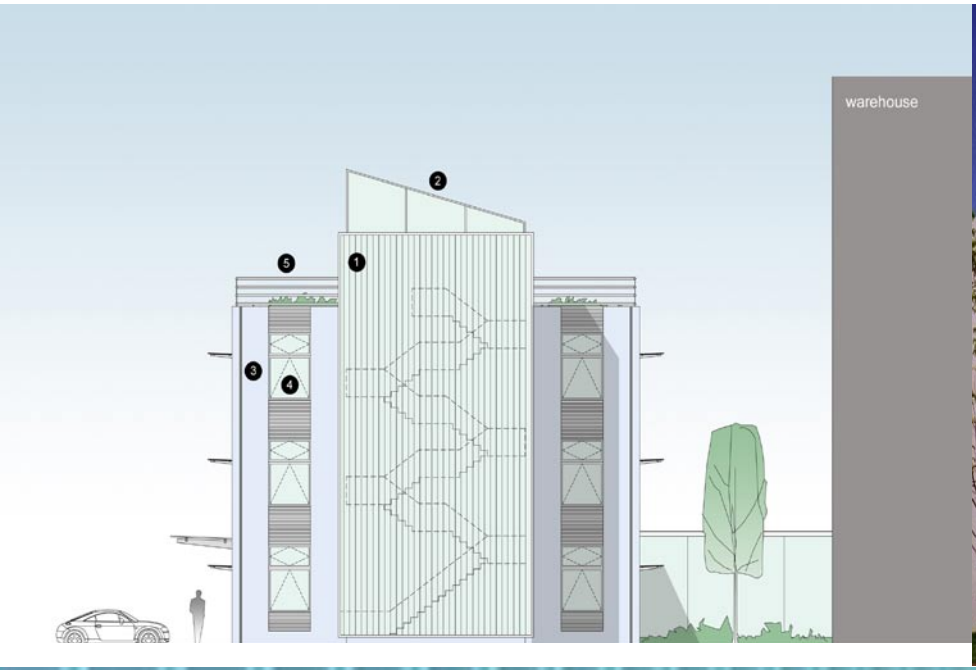
Recommendation and Business Case



Front Elevation

Office Building

1 Glass plank structural staircores with concrete stairs within.
2 Thermal chimney maximising opportunitties for natural ventilation whilst minimising heat gain.
3 Pre-cast concrete wall units. Finishes can be render, timber and render & timber.
4 Openable windows maximise ventilation and natural lighting into the main office. Solar gain controlled by light shelves where required.
5 Roof terrace. Protected roof area with extensive green roof and areas of intensive green roof within planters.
6 Main entrance with canopy above.
7 Main entrance void. Glazing central feature. Main central core is flexible to meet end user requirements.
8 Branding and signage location.



OFFICE WALLS

Pre-cast Concrete walls

Pre-cast concrete uninsulated panels with applied insulation and external rendering. Options are shown for incorporation of wood cladding to allow customisation by the customer.

Construction Sequencing Benefits

- Can be erected quickly, reducing impact of weather on the construction sequence.
- Not part of critical path construction sequencing.
- Because the office building is not on the critical path construction schedule, more time is allowed for the design process.
- Eliminates the need for the usual fire protection wall between the warehouse and offices.

Life Cycle and Resource Use Benefits

- Use of pulverised fuel ash minimises the use of virgin materials.
- Partial use of recycled aggregates reduces mineral extraction and reduces the Aggregate levy.
- Concrete has a low embodied energy over its life cycle.
- Allows disassembly and re-use.

Energy Use and Carbon Impact

- Provides good thermal mass and insulation allowing air conditioning to be eliminated.
- Can be easily made airtight, exceeding the requirements of Part L of the UK Building Regulations.

Cost impact

- Cost increase for pre-cast panels anticipated to be £42/ m². (68 €) over the cost of composite metal panels.
- Total cost increase of £ 170,000 (275,000 €). (This cost includes the additional cladding required by detaching the offices from the warehouse).
- Savings by the elimination of air conditioning are excluded from above
- Lighting costs are reduced because daylighting is increased. Savings are excluded form the above figures

Glass Plank stair walls

Office stair walls constructed using glass planks. The glass towers serve as thermal chimneys, assisting with the passive ventilation of the office building. Hot air builds up within the enclosure and rises to the top where it escapes. The draw of the air movement pulls fresh air through the body of the office building.

Life Cycle Benefits

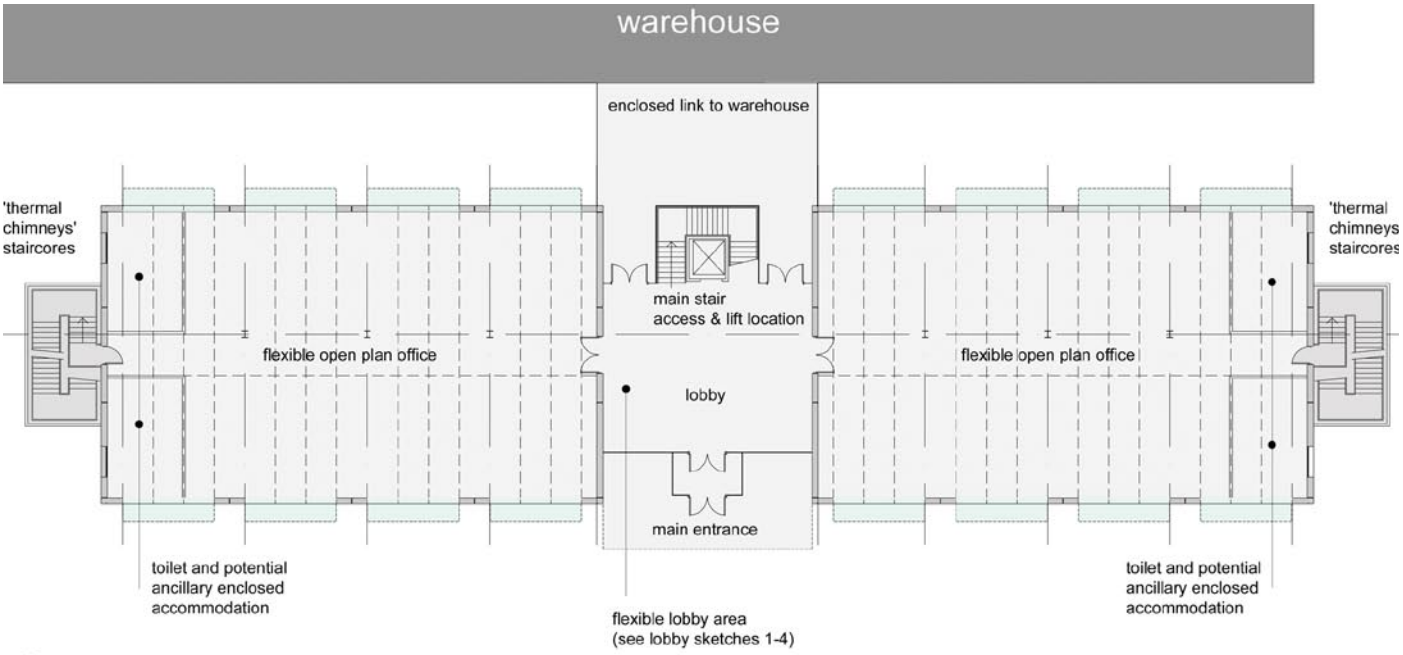
- Glass will be specified to contain recycled content and be recyclable.
- A window frame is not required to contain the glass; lessening resource and embodied energy impact.
- Self-supporting glass channels do not require wind bracing, providing a structurally stable wall.

Energy Use and Carbon Impact

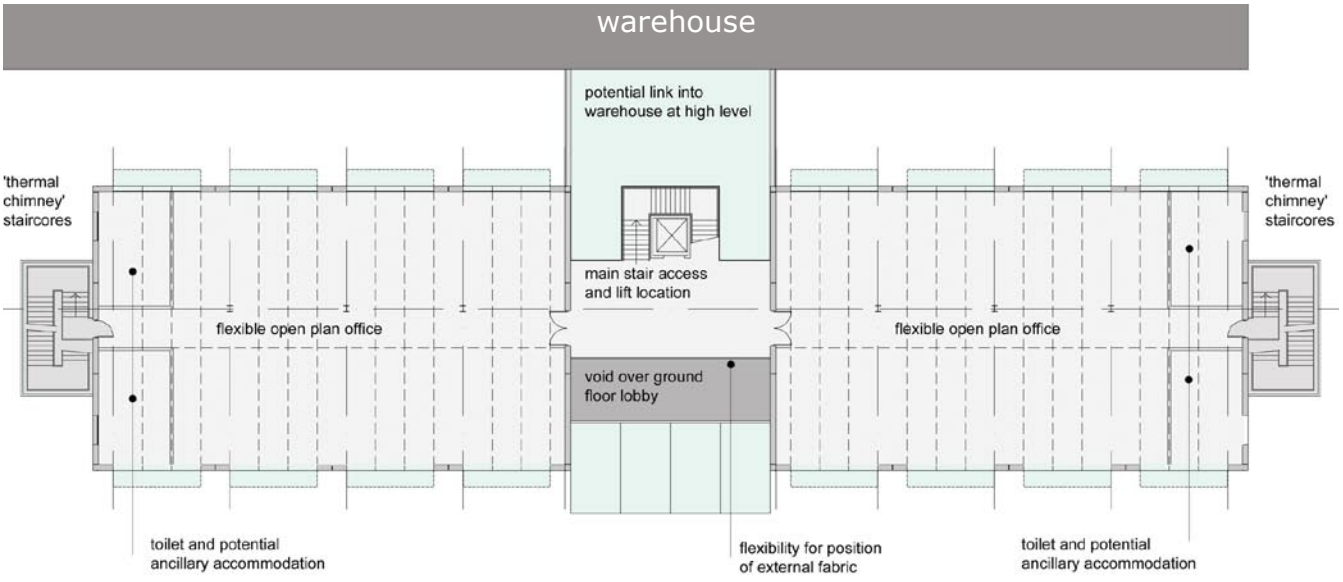
- Provides illumination to stair towers during daylight hours, reducing energy use and therefore carbon emissions.
- Energy to run ventilation fans is reduced.

Cost Impact

- Additional cost of glass plank construction is £324 /m². (534 €) over the cost of the conventional concrete panel construction.



Office Building — Typical Floor



Office Building — Ground Floor

Reception Study

Office Detail

Office Elevations with Different Cladding

Optimised Scheme
Recommendation and Business Case

Reduces heat island
Lightweight
Minimal raw material usage

WAREHOUSE and OFFICE ROOF

Single-ply Roof Membrane

Single-ply roof membrane with 2° pitch installed over warehouse and office roofs. Roof membrane build-up to comply with LPC Standards. Make-up to be APAO (amorphous poly alpha olefin) modified bitumen membrane, heat welded, with mineral fibre insulation. The APAO product is approved by the FLL (Research Society for Landscape Development and Landscape Construction) in Germany as being a durable roof resistant membrane. Where no 'green' roofs are poposed a roof membrane is to be provided which can accommodate thin film photovoltaics.

The warehouse roof membrane can easily accommodate either a photovoltaic roof or a green roof depending upon available incentives.

Construction Sequencing and Performance Benefits

- Assembly and seaming is rapid and of low energy input.
- Reduces the number of fixings required for roof attachments and the number of penetrations through the roof panel, increasing protection against water infiltration.

Life Cycle and Ecological Benefits

- Has self-welding sealing laps allowing assembly mechanically without polluting adhesives or solvents.
- Proven record; continues to meet DIN Standards after 20 years.
- Can be manufactured with recycled content and be recycled in the future.
- Minimal raw material usage, reducing transport energy and enabling use of lightweight roof structures.
- Lower capital costs in mainland Europe when compared with other roofing methods.
- Easily repaired, modified and refurbished.

Energy Use and Carbon Impact

- Roof achieves 0.2 W/m²/K (U value).
- Light coloured reflective membrane reduces the urban heat island effect.
- Effectively controls air leakage to meet new energy efficiency regulations.

Cost impact

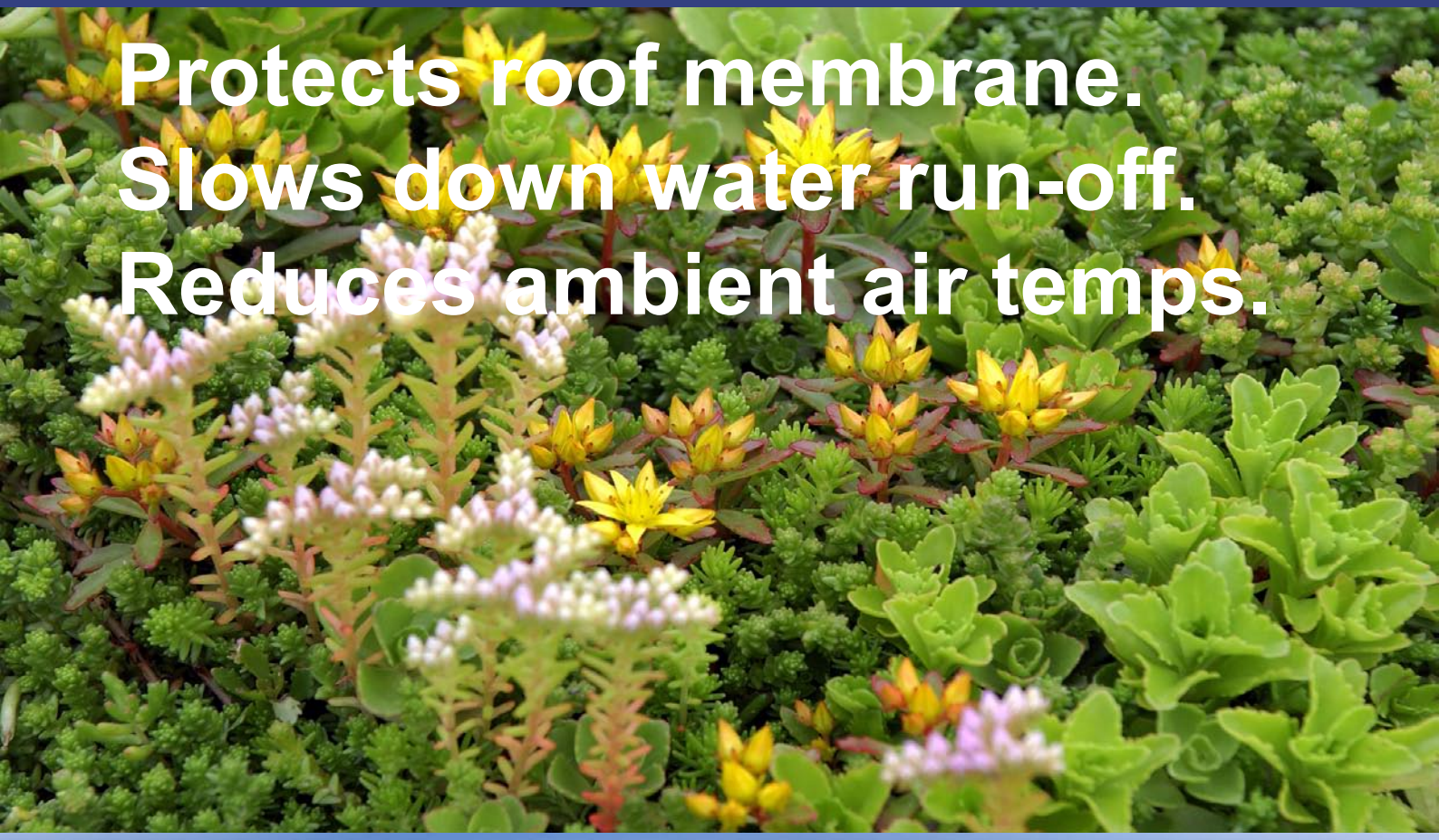
- Higher cost in UK than conventional composite roof. Extra cost for membrane roof type APAO and mineral fibre (compared to standard composite panels: £ 7.80/m² (12.66 €).
- European cost for a membrane roof is: £ 18/m² (29 €) compared to £ 38/m² (61.5 €) in the UK.
- Additional cost for steel frame to be 2° and support the membrane and insulation: £5.75m²

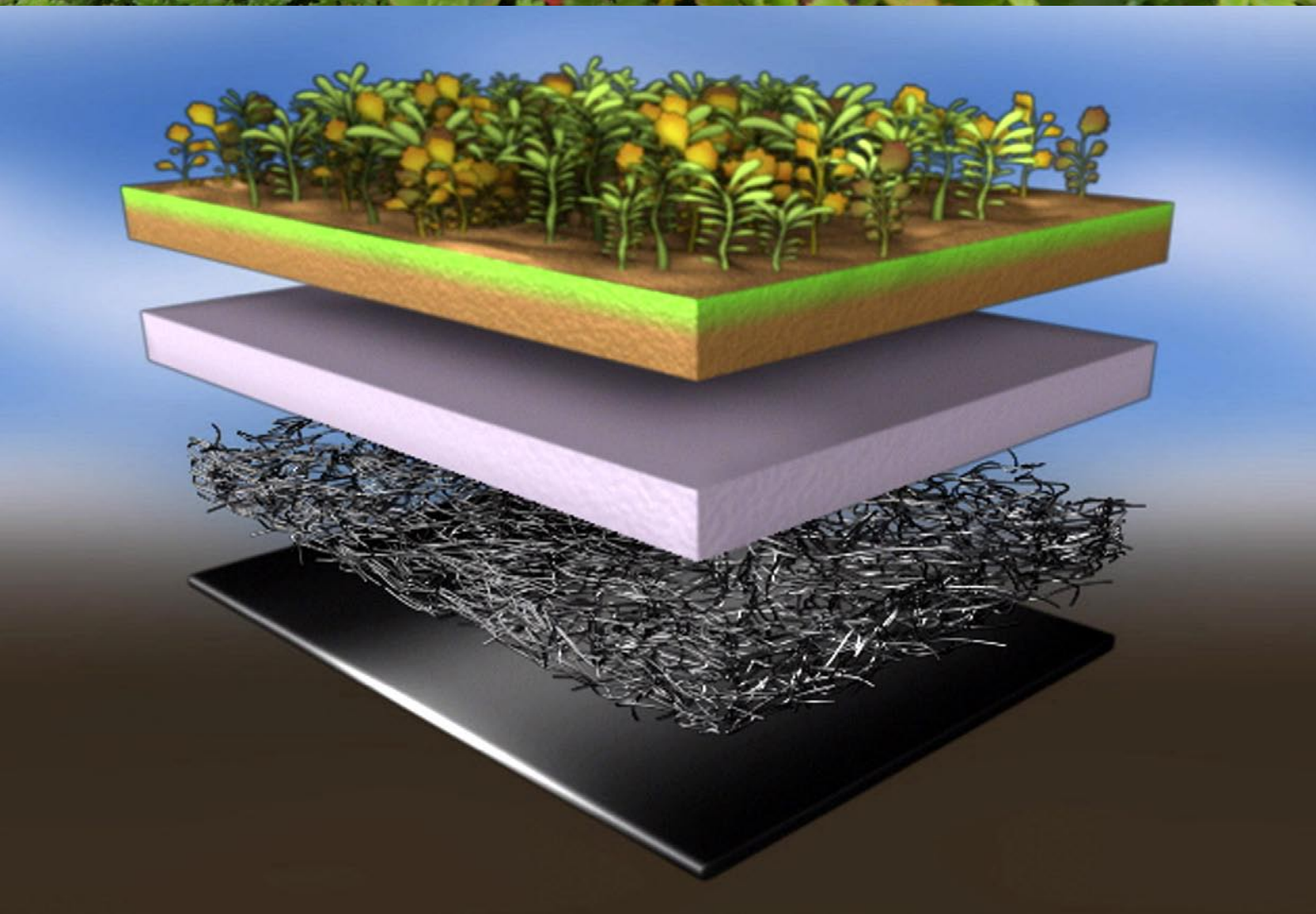
Pan-European Perspective

- Widely available product commonly used in mainland Europe. More cost effective solution in mainland Europe than in the UK.

Optimised Scheme

Recommendation and Business Case





Green Roof

Extensive (shallow soil, 75-100 mm) green roof installed over majority of office building roof. Planters provided at selective locations on roof containing an intensive green roof (deep soil, 330 mm) planted with shrubs.

Intensive green roof at 15° pitch provided over the Marshalling area, planted with shrubs and tall grasses. This minimises the visual impact of the building.

The roof can accommodate an extensive green roof as appropriate for different climates.

Construction Sequencing Impact

- Does not impact construction sequencing.

Life Cycle and Ecological Benefits

- Increases the life span of the roof membrane, potentially from 25 to 50 years, by reducing thermal shock and UV degradation.
- Creates habitat for birds and insects
- The extensive green roof absorbs approximately 40% of annual rainfall falling on it, reducing demand on the stormwater infrastructure.
- Reduces ambient air temperatures within and surrounding the building.
- Vegetation cleanses the air of dust and pollutants, anticipated to be 1700 kg/ year for the office roof and 2000 Kg for the Marshalling area roof.
- Water retention for the extensive roof over the warehouse will be 330-360 1 litres/sq. m. Water retention for the intensive roof over the Marshalling area is anticipated to be 450,000 litres/ year.

Energy Use and Carbon Impact

- Reduces heat gain in the building, thereby helping to eliminate the need for air conditioning.

Aesthetic and Productivity Benefits

- Occupiable roof provides an amenity for building occupants.

Cost impact

- Extensive green roof (125mm depth) adds £48 /m² (77.6 €) to the cost of the structure and roof assembly. The cost includes the membrane.
- Intensive green roof (330mm depth) adds £ 97.2 /m² (157.3 €) to the cost of the structure and roof assembly (at planter locations).
- Total additional cost for intensive green roof planters for an area of 25 m² is £2500 (3930 €).

Pan-European Perspective – Incentives in Germany*

- Thirteen cities allow a reduction of 50% - 80% of the stormwater discharge utility fee when a green roof is used.
- Twenty-nine cities provide grants to developers ranging from 0.42€ /sq ft. to 5.06€ /sq ft. up to 10,000€.
- See appendix for additional incentives in Germany

*Euro figures converted from DMs, current incentive rates to be verified at time of each proposed development.

Optimised Scheme

Recommendation and Business Case

5 % more rooflights saves 240,000kw/h per annum

Warehouse Roof Lights

Roof lights are proposed to cover 15% of the warehouse roof area. Roof lights to consist of triple-wall polycarbonate gable roofed units, continuous from one metre below roof ridge to two metres above eaves. The roof lights provide a light transmission of 64%, the translucent surface reduces glare from direct sunlight.

Construction Sequencing Benefits

- Continuous roof lights reduce the number of waterproofing details and thus reduce the installation time to achieve a waterproof enclosure.
- Rooflights are integrated with the roofing system.
- Provides 5% more rooflights than conventional UK buildings, and institutional standards.

Energy Use and Carbon Impact

- Provides increased daylighting to the warehouse floor, reducing the need for electric lighting.
- Provides an average daylight factor of 5.6 % at ground level assuming a wide aisle arrangement (an increase from 3.73% for 10% roof lights).
- Based on the building being operated 24 hours a day 7 days a week the 15% rooflights and photo cell controls provide an energy saving of 240,047Kw/h per annum.
- Saves 103,000 Kg CO2 (103 tonnes) per annum.

Aesthetic and Productivity Benefits

- Can improve employee productivity by providing a visual connection to the out-of-doors.

Cost Impact

- Additional cost for triple skin roof-lights to be fixed on a 2 degree pitch £55m^2 (for the area of rooflight only).

Pan-European Perspective

- Additional measures may be required to minimise solar heat gain in Southern Europe.
- Number of roof lights (15% of roof area) are considerably more than the current norm in mainland Europe and 5% more than the current funding standards for the UK.
- Predictive light modelling to be completed for each location to determine the optimum roof light aperture, and the necessary detailing required.

Optimised Scheme

Recommendation and Business Case

Warehouse Roof Drainage – Gravity Flow & Exterior Gutters

Gravity flow roof drainage achieved by 2° pitched warehouse roof, exterior gutters and downpipes at eight metre centres. Downpipes drain to soak-aways within easily accessible gravel trenches located below the dock areas, and draining to swales. Part of the main warehouse roof runoff water will soak into the green roof above the marshalling area. Some excess runoff water will be collected in cisterns for use within the office building others will be directed to water features which then flow into swales and ponds.

Construction Performance Benefits

- Eliminates the requirement for syphonic high-speed drainage technology.
- No internal gutters reducing risk of water ingress.
- Minimal risk of water penetration into warehouse (risk of product damage minimised).
- Easy access to drainage components and maintenance, all external to warehouse.
- Gutter provides safe maintenance access to the roof area.
- Removes the requirement for drainage under the service yard.
- Assists with construction sequencing.
- Reduces costs for the drainage piping infrastructure.

Ecological Benefits

- Slows the speed of rainwater runoff, allowing it to be directed to swales and wetlands for natural absorption, reducing the impact on the drainage system.

Energy Use and Carbon Impact

- Single ridge 2° roof pitch allows a reduced height within the building, providing savings to structural steel and lower energy costs for heating the warehouse.

Cost impact

- Drainage solution to the service yard Less expensive than normal surface water pipes by £60m^2.
- Savings for the gravity roof drainage to be £5m^2 (savings include the costs of the 3 further valleys on the syphonic system requirements). The specific drainage solution to be taken into account on a site by site basis.

Pan-European Perspective

- Dependant upon local land-use requirements and utilities pricing. Municipalities (particularly in Germany) may lower utilities rates for on-site stormwater treatment. Also dependant on the specific site characteristics and ground conditions.

Optimised Scheme

Recommendation and Business Case

post tensioned slab

WAREHOUSE STRUCTURE

Portal Frame

Warehouse structure to be a steel portal frame with a 2° roof pitch. Paint for steelwork to have low volatile organic compound (VOC) content. The height of the frame is lowered to 12 m clear (internal height at the haunch) and limited to a maximum height of 13.4 m such that ESFR sprinklers can be utilised.

Cost Impact

- Savings of £ 2.02/ m² (3.27 €) due to lowered building height.

Technology and benefits as at Marsh Leys

WAREHOUSE SLAB

Post-tensioned Slab

Warehouse floor slab to be post-tensioned concrete construction.

Construction and Sequencing Benefits

- Does not delay the construction sequence.
- Post-tensioned slabs are thinner than both traditional and fibre reinforced slabs.
- Less prone to cracking and have fewer movement joints; therefore maintenance costs are reduced.
- Steel content is reduced when compared with traditional slab construction.

Life Cycle and Carbon Impact

- Because less concrete is used, embodied energy and CO2 emissions are reduced through reduced materials and reduced concrete transported to site.
- Cement replacement and the use of recycled aggregates can also be used in PT slabs.

Cost Impact

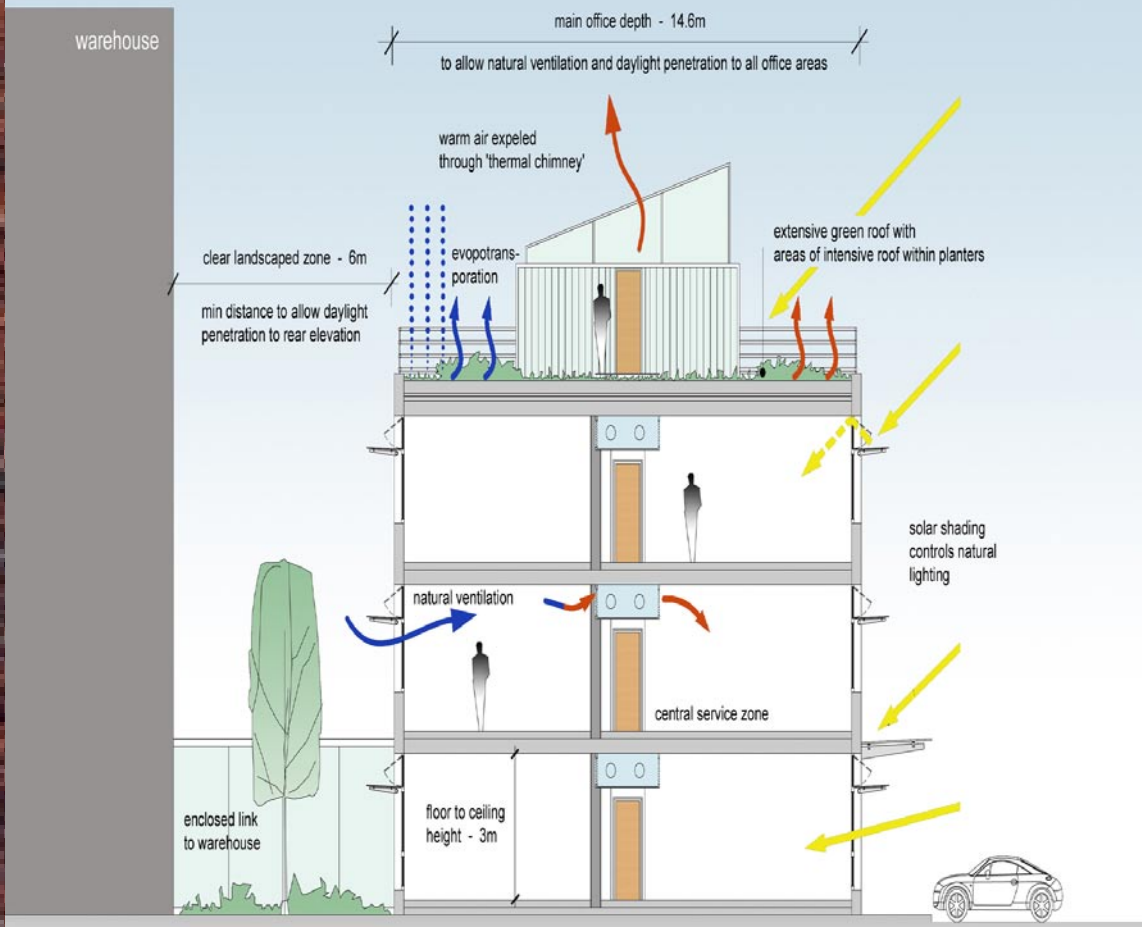
- Savings of £ 2.82/m² (4.56 €) compared to a 200 mm fibre-reinforced concrete slab.

Pan-European Perspective

- This floor slab option can be considered a Pan-European opportunity

Optimised Scheme

Recommendation and Business Case



Section A

DAYLIGHTING STRATEGIES

Office building constructed external to the warehouse envelope and detached from it to allow daylight penetration on all sides. Office windows are constructed with light shelves at windows receiving direct solar exposure. Light shelves provide shading and also reflect light onto the office ceilings.

The distance from the office building to the warehouse and the orientation of the office building on the site may vary in order to benefit from optimum solar orientation.

Energy Impact and Productivity Benefits

- Reduces energy consumption and CO2 emissions by 31624 Kg CO2 (3 tonnes) per annum more than the savings shown at Marsh Leys based on 50% glass transmittance and 60% per elevation.
- Improves employee productivity through visual connection to the out-of-doors.
- Saves 7,358 KWh more energy than the Bedford Marsh Leys Scheme.

Cost impact

- Additional cost of £ 20,885 (33,792 €) includes the cost of light shelves and low-emissivity glazing.
- Reduces cost for electric lighting by £294 per year in lighting costs.

Pan-European Perspective

- Daylighting strategies may be implemented differently in southern Europe due to increased solar heat gain.

OFFICE LIGHT FIXTURES

Office light fixtures to be fluorescent, suspended in order to reflect light onto the ceiling. Systems to utilise latest T5 technology.

Technology and benefits as at Marsh Leys

OFFICE FINISH MATERIALS

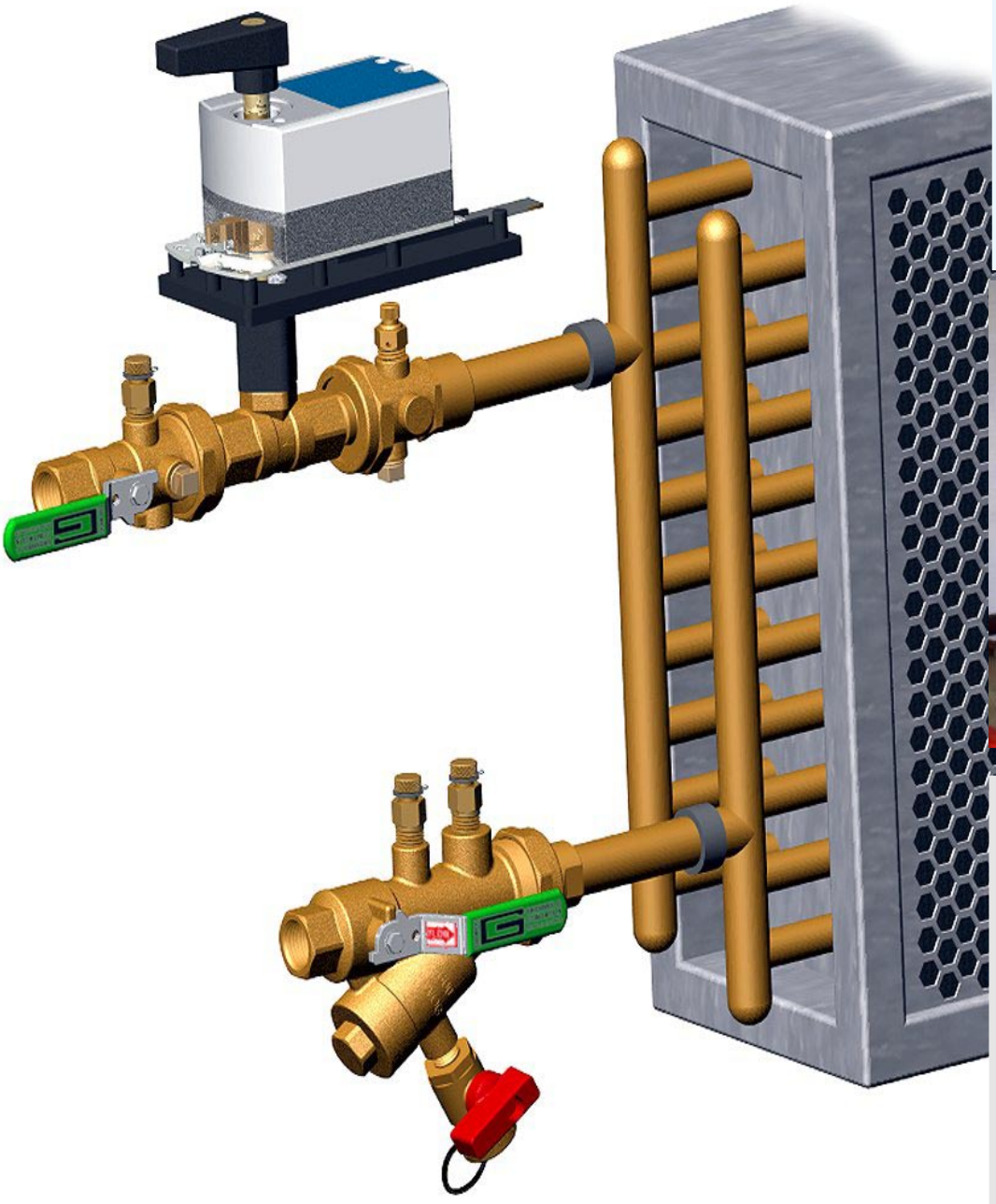
Recycled Content and Rapidly-renewable Content
Interior finish materials to contain recycled and rapidly renewable content. Affected items: Recycled content ceramic tile to Entrance Foyer, Recycled carpet to open plan office areas / circulation routes, Gypsum board from industrial sources, toilet dividers consisting of chipboard with laminate facing and linoleum to toilet floors.

Low-toxicity materials
Interior finish materials to contain, ingredients which do not off-gas and are not detrimental to indoor air quality. Affected items include: paints, adhesives, sealants and carpets. Copiers, printers and other emitting office equipment are promoted to be isolated, and provided with dedicated exhaust vents once installed by the end-user.

Optimised Scheme

Recommendation and Business Case

Simple Technology applied



WIND TURBINES

It is proposed that the number of wind turbines installed be increased from the single unit located at Marsh Leys to potentially six turbines, to take advantage of the local available wind. Incentives will vary by location. The extent of wind turbines is limited by available unobstructed site area and acceptance by local planning authorities.

Technology and benefits as at Marsh Leys

SOLAR THERMAL HOT WATER HEATING

An evacuated tube solar thermal collector is recommended for the roofs of the stair towers on the office building. The hot water will be used to preheat water for wash hand basins, sinks and showers. The recommended size of the system is 12Kw.

Technology and benefits as a Marsh Leys

ROOF WATER COLLECTION

A 30 – 50 cubic metre (size may vary by location) capacity cistern for collection of rainwater from the roof and reuse within the building will be provided. This will provide more than 100% of the water required for the offices toilet areas.

Technology and benefits as at Marsh Leys

Additional benefits over and above the 10 cubic metre cistern at Marsh Leys.

- This will provide more than 100% of the sanitary water requirement for the office toilet areas.
- Will harvest 1.2 million - 2.0 million litres of water per annum.

PLUMBING FIXTURES

Low-flush volume toilets to be installed in all toilet areas based on 4.5 litre cisterns.

Hand wash basins will be fitted with spray taps and a central timed control to prevent water wastage .

Low-flow showers are recommended to be provided for use by staff. This is dependant on end-user requirements; the showers providing further encouragement for staff to use bicycles.

Technology and benefits as at Marsh Leys

WAREHOUSE FIRE PROTECTION

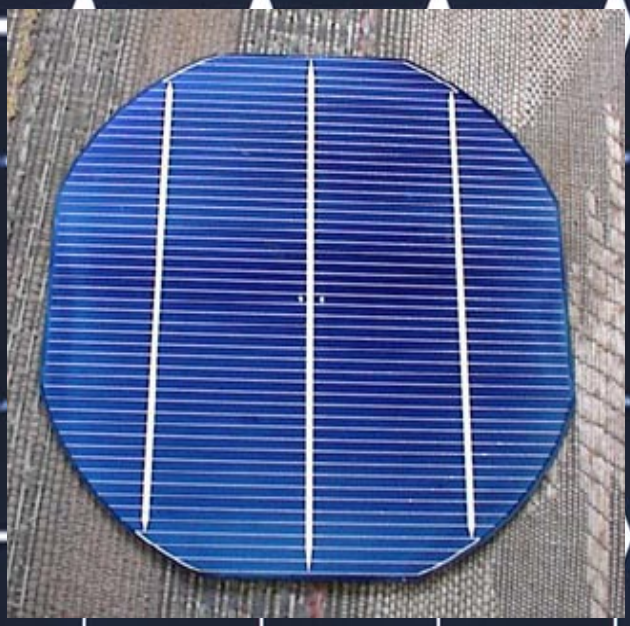
This will be dependant on Customer requirements. However, the reduction in height allows for ESFR sprinklers to be utilised.

Construction Benefits

- Due to the reduction in the building height below a maximum height of 13.4 metres, the requirement for in-rack sprinklers is eliminated.
- Reduces cost for Customer fit out.

Optimised Scheme

Recommendation and Business Case



OFFICE HEATING AND VENTILATION

Create cross ventilation with small openable windows placed above the light shelves. Night time air will be drawn into the space by the stack effect generated in the stair cores, pass over the concrete where it is warmed, be drawn into a central duct and ejected through the stair cores. Perimeter trench heating is provided. This is accommodated within the depth of the raised floor. This allows space for fan coil cooling to be retrofitted in specific areas such as server rooms if necessary.

WAREHOUSE HEATING AND VENTILATION

Provide a jet nozzle heating system for the warehouse.

Technology and benefits as at Marsh Leys

PHOTOVOLTAICS

The photovoltaic array can be maximised on the warehouse roof according to optimum available solar energy and available incentives. Both polycrystalline and thin film PVs can be attached to the surface of a membrane roof with adhesives without the need for anchored supports and fixings.

Solar panels to be installed on office building canopy if the site offers Southern exposure.

Monocrystalline solar array Technology as at Marsh Leys

Thin –film solar array

Performance Benefits

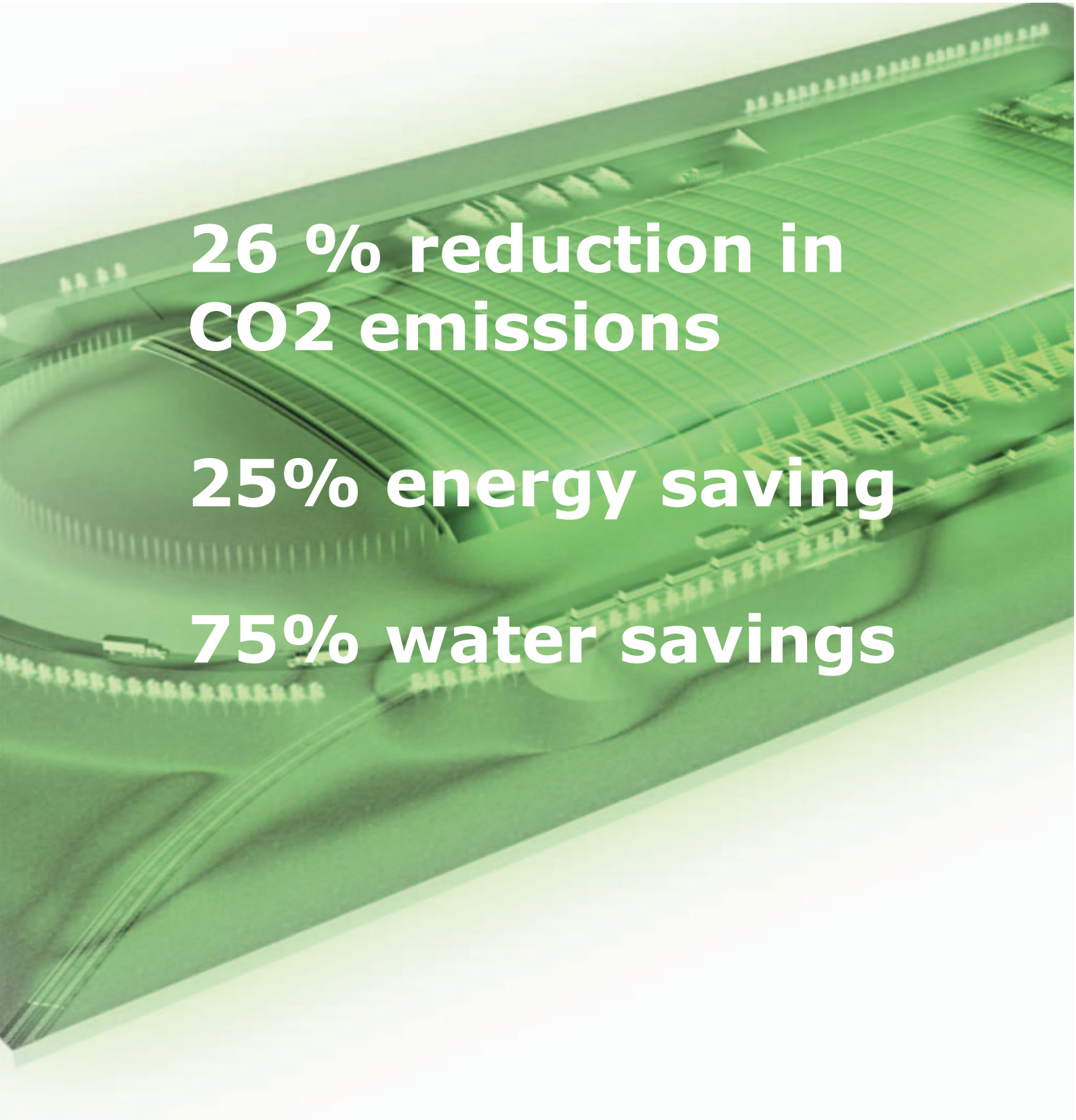
- Thin film can receive solar energy in cloudy and low light conditions. Due to the triple junction, layering it can receive solar energy from multiple angles.
- Solar conversion is 5 – 7% efficient.
- Thin film panels can be adhered or laminated to the roof membrane.

Cost Impact

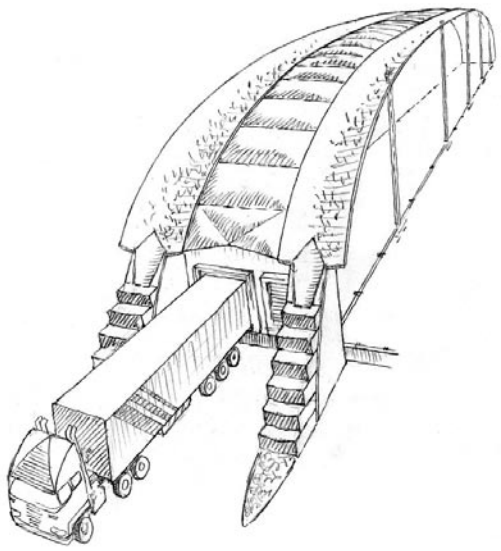
- Approximately £ 4000/ kWN (5800 €) for approximately 8 m² of photovoltaic roof area.

Pan-European Perspective

- Incentives are identical to those for polycrystalline panels. See appendix for specific incentives by country.


26 % reduction in CO2 emissions
25% energy saving
75% water savings

5.1. Introduction



The Revolutionised scheme is the vision of the future for logistics buildings.

Strategies have been developed using products currently available, although some are still undergoing development. For others, manufacturing costs must be reduced to make them commercially viable. The goal is that the vision should be deliverable within a 5 to 10 year period.

The Revolutionised scheme allows for the following assumptions;

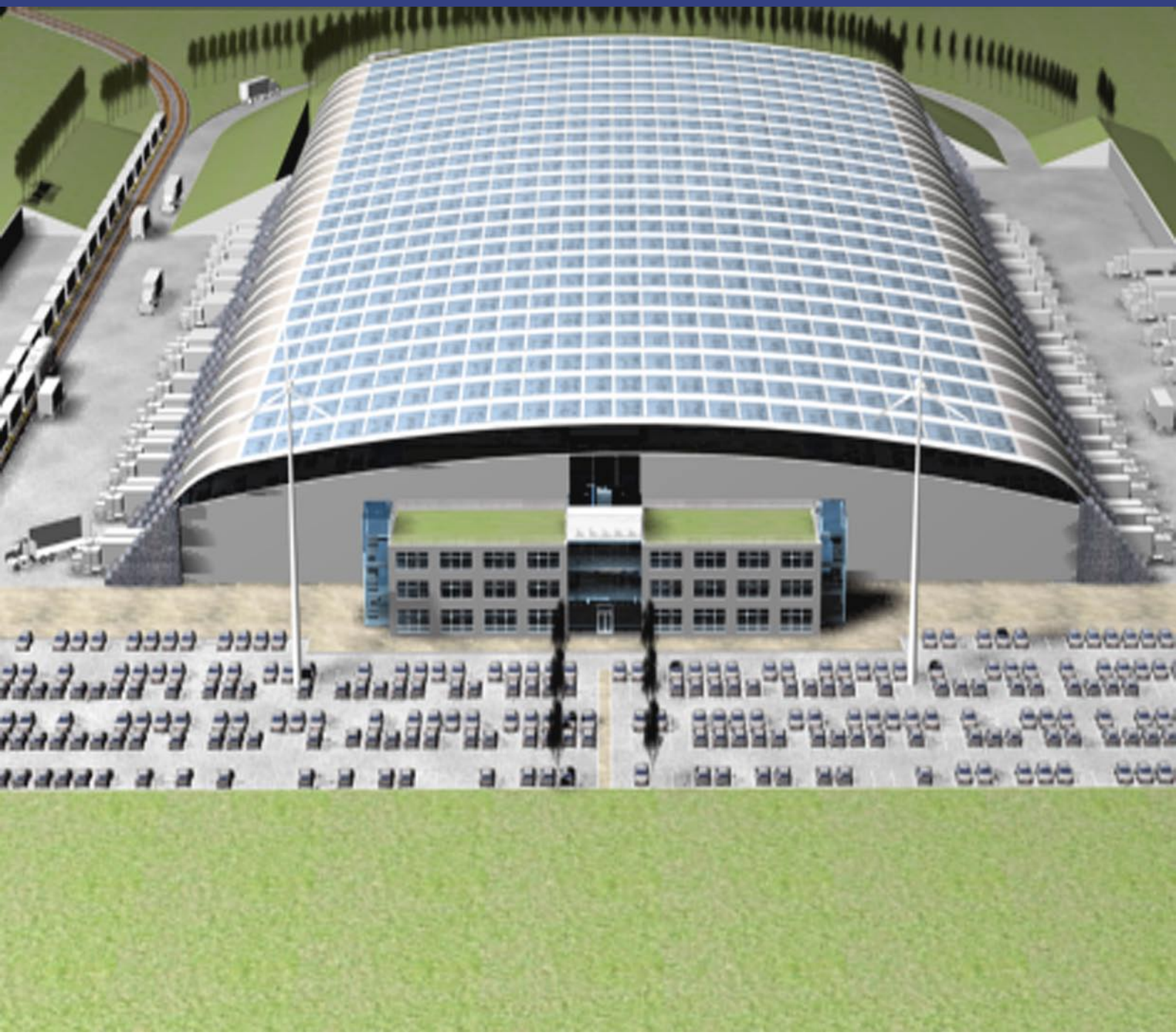
- Rail freight still proves to be cost effective and viable in the future, reducing the impact on the environment and relieving traffic congestion and pressure on the transport infrastructure.
- Present day products and technologies that are currently costly prove to be more cost effective.
- Insurance company and institutional Funds take more account of environmental issues.

The Revolutionised Building furthermore delivers the Eco-Template concepts:

Building as Habitat
Building as Power plant
Building as an Umbrella

The basic concept for the Revolutionised Scheme is derived from a structural system that accommodates heavyweight and lightweight elements. The columns support a green roof – located over the part of the building best able to hold it. Lightweight fabric inflated pillows are suspended between concrete shells that carry the green roof. The fabric is translucent, serving as a roof light, with applied thin film photovoltaic.

Revolutionised Scheme

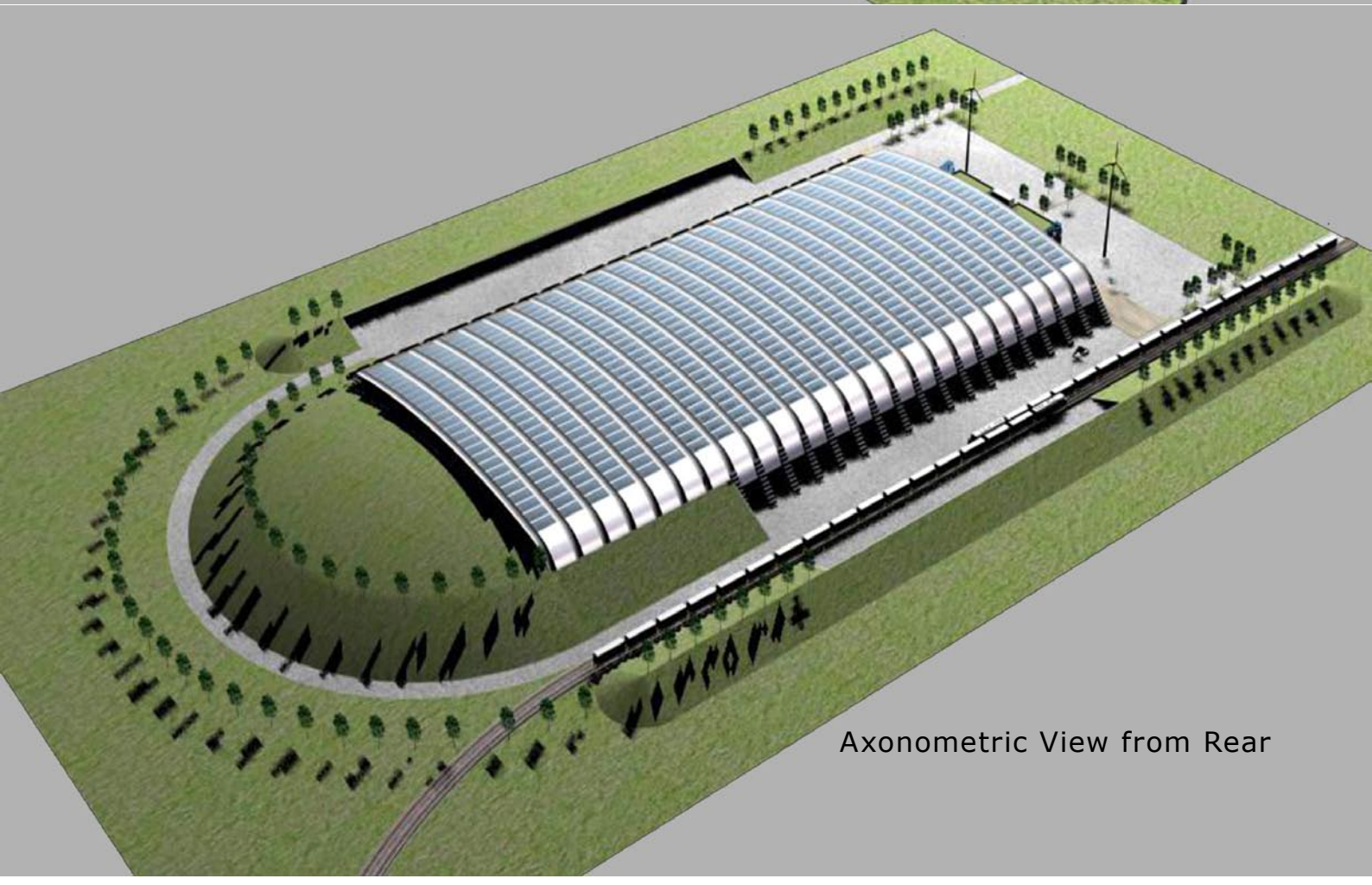


View of revolutionised logistics building

5.2. Summary table of recommendations

Landscape	
Planting	Maximised use of vegetation for habitat re-creation.
Native Vegetation	Maximised use of local provenance seed.
Wall Vegetation	Wall surfaces planted with trellises and vegetation.
External Yard	
Site Density	Parking areas reduced to allow for stormwater retention.
Stormwater Management - Paving	Porous paviours and compacted gravel in car park areas.
Stormwater Management - Wetlands	Wetlands increased for stormwater retention.
Envelope	
Warehouse Cladding - High Level	End walls to be tilt-up concrete.
Warehouse Cladding - Low Level	Tilt-up concrete insulated cladding panels.
Warehouse Clad. - Low Level - Docks	Uninsulated tilt-up concrete panels.
Walls - Office Cladding	Pre-cast concrete panels with applied insulation.
Warehouse Roof - Membrane Roofing	See Roof Lights below.
Office Roof - Membrane Roofing	Single-ply APAO modified bitumen membrane.
Office Roof - Green Roof	Extensive green roof and a few planters for shrubs.
Warehouse Roof - Green Roof	Intensive green roof planted above concrete shell structure.
Warehouse Roof Lights	Lightweight, translucent, air-inflated fabric.
Roof Drainage	Gravity flow to gabion walls.
Structural Frame	
Warehouse Structure	Concrete shells supported on primary structural columns.
Office Structure	Concrete slabs on steel column frame, precast stairs
Internal Floor	
Warehouse Internal Floor	Rail mounted automated MHE to eliminate slab.
Office Environment	
Daylighting	Office building location may vary for solar orientation. Maximises natural daylight.
Recycled/Rapidly Renewable Materials	Interior finishes to maximise use of recycled products.
Low-Toxicity Materials	Interior finishes to to maximise use of low-toxicity materials
Lighting	Ambient/task solution using pendant fixtures. Natural lighting maximised.
M&E Services	
Warehouse Heating & Ventilation	Warehouse heating to be eliminated.
Office Heating & Ventilation	Achieved through natural cross ventilation with perimeter heating.
Energy Sources - Photovoltaics	Translucent PVs integrated with fabric roof covering.
Energy Sources - Solar Thermal	Evacuated tube collector installed on office building towers.
Energy Sources - Wind Turbines	Wind generation to be maximised as per local incentives, and site characteristics
Water Use - Fixtures	Low/ no -water use fixtures and timing controls, building self-sufficient for water.
Water Use - Rainwater Harvesting	Roof water collection and storage for toilet use.
Fire Protection - Warehouse	Alternatives to water-based system to be investigated.

Axonometric View from Front



Axonometric View from Rear

- **LANDSCAPE**

  - Purchase additional land to be conserved for habitat restoration.
  - Use local provenance seed to re-establish native habitat.
  - Maximise opportunities for vegetation to grow on building walls.

- **EXTERNAL YARD**

  - Reduce car-parking areas in order to increase available space for on-site stormwater retention and habitat restoration.
  - Maximise pervious paving on the site. heavy-duty porous asphalt and porous concrete used in yard areas.
  - Stormwater retention and wetlands to be maximised on the site. Provide biological waste treatment for grey water and black water.
  - Incentive in collaboration with local authorities to maximise car/access schemes such as car sharing, park and rides in close proximity and other initiatives.

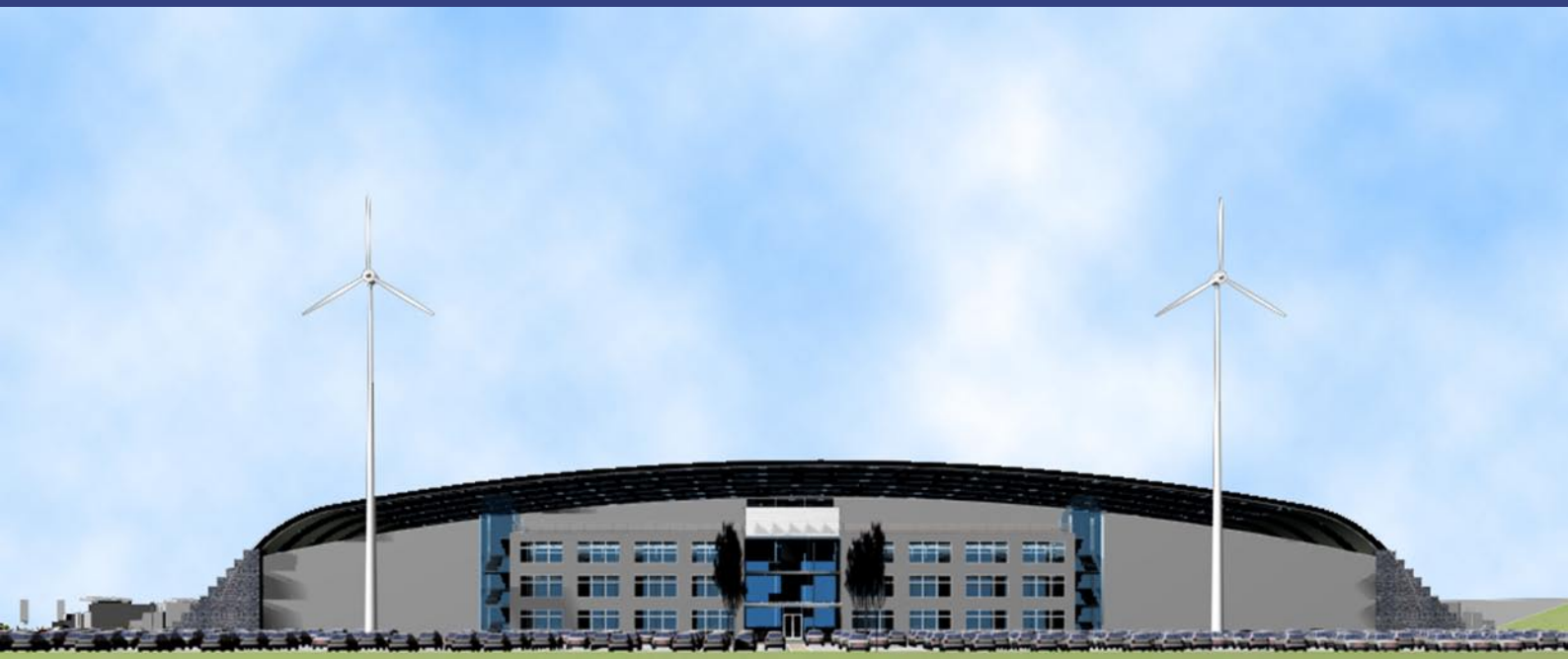
- **ENVELOPE**

  - High and Low-level warehouse end walls to be tilt-up concrete.
  - Low-level dock walls to be tilt-up as shown in the Optimised Scheme.
  - Office cladding to match the Optimised solution.
  - Membrane roofing for offices to match Optimised solution, with green roof above.

- **GREEN ROOF**
  - Extensive (shallow soil) green roof installed over majority of office building roof. Paths and seating areas provided for outdoor use. Planters provided at selective locations on roof containing an intensive green roof and shrubs to match the Optimised solution.
  - Intensive green roof provided on concrete shells set along structural support lines on the warehouse.

- **ROOF LIGHTS**
  - Lightweight, inflated fabric roof covering to be suspended between concrete structural supports. Fabric to be ETFE (ethylene tetra fluoro ethylene), PTFE (flurorethylenepropylene) or preferred Teflon-free alternative. PVs to be integrated on the fabric surface.

- **ROOF DRAINAGE**
  - Gravity flow roof drainage achieved through roof configuration. Water drains from fabric roof covering onto concrete shells containing green roof. Excess water flows from the green roof to rock gabion walls between the docks. Roof runoff water will also be collected in cisterns for use within the building.



Front Elevation

View of Office Building

- **STRUCTURAL FRAME**
  - Warehouse structure to consist of concrete shells supported on primary structural columns. See green roof above.
  - Office structure to consist of poured concrete foundations, floor and roof slabs, steel columns, and pre-cast concrete stair units as shown on the Optimised scheme.

- **INTERNAL FLOOR**
  - Warehouse slab may be eliminated in favour of a rail-mounted automated material handling scheme. If the rail system is not feasible, a post tensioned slab solution (as the Optimised design) is recommended.

- **OFFICES**
  - Office daylighting strategies to be similar to the Optimised solution. The location, distance from the warehouse to the office building, and orientation of the office building on the site may vary in order to benefit from optimum solar orientation dependant on the local characteristics and geography of the site.
  - Interior finish materials to match Optimised solution. Recycled, Recyclable and low toxicity materials to be maximised. The target is to provide 75% recycled, recyclable materials for this scheme.
  - Office light fixtures to match Optimised solution.

- **M & E SERVICES**
  - Warehouse heating to be eliminated. Alternative heating strategies to be pursued: heat HGV cabs, heat picking areas and other isolated locations where people are present. Alternative fire suppression systems to be investigated to avoid necessity of providing freeze-protection to a water filled sprinkler system.
  - Office heating and ventilation to match Optimised solution. Improvements in technology above and beyond those shown in the Optimised scheme will be introduced.
  - Plumbing fixtures to match Marsh Leys and Optimised solution.
  - Rainwater harvesting to match Optimised solution. Further potential for rain water harvesting is possible with the concrete channel on the main warehouse roof.
  - Provide alternative to water charged sprinkler system that does not require freeze-protection.

PHOTOVOLTAICS
- Translucent photovoltaics to be integrated with inflated fabric roof covering. See Warehouse Roof Lights.
- Solar panels to be installed on office building canopy as solar orientation and site geography allows.
- Solar thermal installation to match Marsh Leys and Optimised solution.

WIND TURBINES
- It is proposed that the number of wind turbines installed be maximised to take advantage of available wind and site characteristics.

6.0. Appendix

CONTENTS

The support information summarizes key points of the various technologies presented in the reports section of the appendix. Also included are technologies investigated, but not ultimately chosen for recommendation. Changes in the economics of these strategies may prove their worth for the revolutionized scheme.

SITE VEGETATION

Convention

- Vegetation is typically provided as required to meet minimum regulations of the local planning agency.

Goals

- Consider vegetation as a means to restore habitat on the site, helping to replace food and life support for insects, birds and small animals.
- Take advantage of the cooling effect of plants to reduce site and building temperatures.
- Use plants to cleanse the air, absorb stormwater, and serve as a carbon sink to offset CO2 emissions.
- Use plants as a wind block to protect buildings and people in the winter.

Maximising Vegetation
Vegetation (trees, hanging gardens, and climbers on trellises) can provide shading, improve air quality, mitigate peak summer temperatures and serve as a visual amenity. The use of deciduous vegetation can provide shade during the summer months, while allowing the infiltration of light (and heat gain) during the cooler months when the vegetation loses its leaves.

Trees enhance evaporative cooling in outdoor spaces by channelling breezes, providing wind shelter against winter winds, and reducing infiltration of buildings by shielding the envelope. Large canopy deciduous trees provide the greatest environmental benefits. Each tree absorbs 13-48 lbs of carbon per year. Taking 30 lbs as an average, planting 72 trees will sequester 2160 lbs of carbon annually.

Local Provenance (native) plant species

- Many native perennial grasses stay green almost all year, are less flammable, and recycle minerals from deep in the soils. Their visual texture and beauty suit them for a wide variety of landscapes, both residential and urban, and contribute to sustainable agriculture. Grasses do not require mowing, thus reducing associated lawnmower emissions.
- Restoration of natural plant communities.
- Maintenance of bio-diversity.
- Improved soil stabilization.
- Improved storm water infiltration.

Xeriscaping
Landscape maintenance has the potential to consume significant water within a development unless appropriate design decisions are made. Any landscape design should be conducive to water conservation. Xeriscaping, a landscaping strategy based on reducing dependence on irrigation, incorporates seven basic principles that lead to water savings:

- Planning and design – address plant associations such that water requirements are uniform for the entire site area.
- Soil analysis and improvement – provide a proper soil mix that reduces compaction, and improves the absorption and performance of the plants.
- Appropriate plant selection – use native and adapted plants that withstand periods of low rainfall.
- Minimise use of turf areas.
- Efficient irrigation – implement temporary irrigation systems just until the new plantings take hold, or use programmed systems to deliver water to plants on a demand basis.
- Use mulches.
- Use appropriate fertilisation and maintenance that does not force plants to absorb excess water.

Vegetation on walls

- Reduces radiant heat gain by shading heat-absorbing ground surfaces.
- Reduces solar heat gain in buildings by shading the envelope (windows, walls and roof).
- Mitigates maximum air temperatures through evapotranspiration.
- Slows the growth of atmospheric CO2 levels by absorbing carbon through photosynthesis.
- Reduces airborne agricultural dust through use of landscape features like hedgerows.

SITE DENSITY

Convention

- The site is typically sized to accommodate the building and required parking. Excess site area is viewed as an unwelcome expense unless it can be used to meet local planning requirements for landscaped area.
- Car parking and service yards are sized to accommodate parking during shift changes (maximum occupancy) and seasonal peak usage.
- The amount of car parking spaces is often established by the local planning agency.

Goals

- Purchase additional land for habitat, landscape, and stormwater management
- Reduce the amount of hard surface required for car parking.
- Convince planning agencies that the provision of fewer spaces encourages mass transit (reducing carbon emissions) and preserves more open space.

Within the context of an eco-effective solution, commercial viability remains paramount.
Optimum land use for a logistics building depends on the geographic location, land cost, and the use of adjacent property.

Density components for a distribution centre typically comprise

(a) Storage facility
(b) Associated offices
(c) External yard
(d) Car park area
(e) Landscape

Factors integral to density include:

(a) Regularity of site boundaries and shape
(b) Building proportion
(c) Size of the building
(d) Single / double sided operation
(e) Extent and content of external facilities
(f) Car parking requirement dictated by staffing levels and shift patterns
(g) Requirements for rail access

An ideal solution is a regular site perimeter accommodating a large (50,000m²+) square proportioned single sided structure. This solution minimises the impact on the land, but may be most unrealistic from a logistics standpoint.

Because surface and foul water treatment areas are tied to specific land conditions, it is difficult to generalise on their suitability for a generic site.

Although the strategy is for sustainable foul water treatment areas to be incorporated with the design, the potential will rely heavily on the specifics of a particular site. This approach could ultimately reduce the development's requirements as far as infrastructure and costs are concerned, however it may also lead to a reduction in site density.

In summary, it is not envisaged that site density will differ substantially from current practice, though the component elements and in particular surface treatments can be designed to enhanced unit self-sufficiency, habitat and visual amenity.

CAR PARKING

Convention

- Car parking is typically provided per local planning requirements.
- Parking requirements are also set by the building occupant to accommodate peak demand during shift changes and periods of high seasonal use and are often 40% unused for almost an entire 24-hour period.
- The convention is to install hard surface paving and direct stormwater off the paving with buried conduits.

Goals

- Replace hard surface paving with pervious paving to all rainwater infiltration and groundwater recharge.
- Parking areas used primarily for parking peak numbers of cars will receive softer paving, such as planted rain block.
- Shading should be provided to pavement and vehicles, to ameliorate the heat sinks associated with parking lots.

Pervious Paving

- Concrete or Brick Paviours in Sand

  Tightly fitted, uniform units of either concrete or brick pavers are placed over a sand bed and aggregate base. A wide range of finishes, colours, and shapes are available, and patterns can be used to complement architectural design. Stained or broken units can easily be replaced and typically last for decades.

- Grass Paviours

  The most widely used type of grass paving is cellular paving. This method consists of interlocking "cell" paviours laid on a prepared bedding layer over a sub-base. The cells are then filled with soil and seed. This method is structurally sound, and can handle all but the very heaviest of applications. Low to moderate maintenance is required, as this system was designed such that the grass will grow within and between the paviour cells.

- Gravel, Sand or Cinders

  Gravels most commonly used are in the 6-15mm range, and may be mined, for a more angular unit, or dredged from river beds, yielding a rounder stone. Cinders refer to the burnt fuel from power stations, and are not as readily available as they once were. Paths are typically constructed by layering a 75-100mm sub-base surface of crushed stone with 25-40mm of gravel (or cinders, or sand) over the pervious sub-grade surface. These materials are available in a wide range of colours, but the more unusual or less natural the colour, the more expensive the material.

- Permeable Pavements with Subsurface Stormwater Retention
  The purpose of the subsurface bed is to hold and slowly release the stormwater to a vegetated system, because if the stormwater flows through a wetland quickly it will provide only minimal treatment. The rainwater is then released into vegetated swales for conveyance and treatment.

SERVICE YARDS

Convention

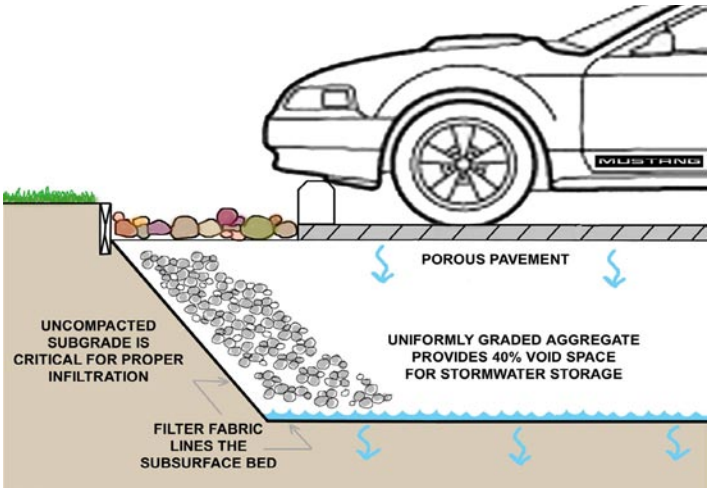
- Operational parking requirements can vary dependent upon the nature of storage and delivery patterns. As with car parking areas this can lead to hard surfaced landscape areas unused for large periods of time.
- Yard surface subjected to considerable wheel abrasion.
- Maintenance to yard surface causes unacceptable interruption to tenant operation.
- Yard construction joints and drainage subject to heavy wear.
- Vehicle required to be virtually level at dock face.

Goals

- Provide unpaved areas within the service yards where vehicle wheels are not in contact with the surface.

In both car and HGV parking areas the identification of zone functions, i.e.: traffic movement, park zone, pedestrian route etc, and differentiation between constant and intermittent parking areas, would permit variation of surface treatment to the benefit of surface water dispersal and visual amenity.

All schemes will take into account the need to provide water-permeable pavement where possible. Due to concerns with the twisting of heavy trucks on soft pavement, porous paving will, for the Marsh Leys and Optimised scheme, be used for car-parking areas only.



STORMWATER MANAGEMENT

Convention

- Ponding of water in the yard is unacceptable.
- Water is typically removed from the site in below-grade structures.

Goals

- Maintain water within the confines of the site where feasible.
- Ensure that water leaving the site travels slowly and does not include sediments.
- Consider water to be a resource for use in the building and on the site.

Surface Vegetated Channels or Swales
Vegetated earthen channels should be sized to hold and slowly convey stormwater while providing biological treatment and removal of sediment and pollutants.

Stormwater Pond Storage Area
An area of land dedicated to stormwater retention/detention that provides peak runoff storage, infiltration of rainfall into the ground to reduce the flows and impacts of runoff downstream, and removal of polluting sediments. These areas may be large depending on the watershed, but are allowed to dry out during summer months providing additional open space.

Subsurface Flow Constructed Systems, also known as "Vegetated Submerged Beds (VSB)"
In a VSB system, wastewater moves below surface through a series of gravel beds or cells that can be planted with vegetation. Systems typically include multiple cells so that a cell can be taken out of service for maintenance.

Vegetated Roof
Vegetated or "green" roofs generally rest above the roofing insulation and waterproofing membrane, and can be employed on flat and moderately sloped roofs. The vegetated roofs can either be "extensive", with shallow soil depths for grasses (sedges and sedums), or "intensive", with deeper depths that can support larger plantings, such as bushes and small trees.

ENVELOPE - WAREHOUSE CLADDING

Convention

- The warehouse walls are typically constructed of composite panels consisting of an insulated core, metal facing and a factory painted finish. The panels are attached to the steel frame of the building. In mainland Europe, the typical construction is a built-up metal panel system.
- The insulated core most commonly is polyisocyanurate insulation.
- Factory painted finishes usually contain polyvinylidene, containing the vinyl chloride monomer, a toxic substance.

Goals

- Replace metal panels with tilt-up concrete construction.
- For short term solutions where metal panels will be retained, replace polyisocyanurate insulation with mineral fibre insulation.

Tilt-up Concrete Construction

- Tilt–up construction offers an environmentally sensitive solution, as concrete has a relatively low embodied energy value, with all the manufacturing effectively on site. Care needs to be paid to the concrete 'recipe', and on-site dust pollution.
- Concrete panels may exploit thermal mass strategies to mitigate maximum summer and minimum winter temperatures. Thermal mass strategies entail the use of materials that have good thermal conductivity and storage capacity that serves to slow down the building's response to changes in external conditions and reduce internal temperature swings.
- A concrete solution would also offer good durability against the wear and tear expected within such buildings. This system can also be used throughout mainland Europe, with a number of suppliers providing the same end product, and reducing the energy costs of delivering a standard product from specific manufacturing locations.
- Speed: Fast start, fast build, pre-planning. Minimal lead-in required.
- Low cost commitment prior to start of construction on-site.
- Ease of Construction: Factory process on site
- Durability: Good
- Security: Good, used on prisons etc
- Fire Resistance: 2+ hours resistance

PRE - FABRICATION FOR OFFICES

Convention

- Office walls and structure are assembled on-site.
- The office functions are often contained within the volume of the warehouse, but as a separate fire compartment and as a 2-storey element surmounted by a plant deck.

Goals

- Remove the office building from the warehouse so that it becomes a distinct building.
- Use pre-fabricated concrete cladding in place of metal panel cladding.

Pre-fabricated Concrete Cladding

- Office building is assembled as a modular kit of parts. Components are pre-assembled to the greatest degree possible. More pre-assembly requires less transportation, less site construction rubbish, and pollution, and greater intrinsic value of materials.
- Insulation can be provided as a component of a concrete sandwich panel.
- Different types of modularisation are:
  - Pre-assembled components and sub-assemblies: e.g. window frames or complete windows, including glazing and ironmongery
  - Non-volumetric pre-assembly: pre-assembled units that do not create usable space, e.g. building services ductwork or cladding
  - Volumetric pre-assembly: pre-assembled units that create usable space and are usually fully factory-finished internally, e.g. toilet pods, plant rooms or modular lift shafts
  - Modular building: a building comprising one or more volumetric units which form the actual structure and fabric of the building, e.g. motels or classrooms
- Cost savings can be realised at every level of the supply chain.
- Faster return on investment. Reduced construction programme means earlier handover.
- Less materials and labour to manage on site resulting in reduced wastage, lower inventory control requirements and reduced capital tied up in stock.
- Potential for space savings through integrated design.
- Improved quality control achieved within a 'manufacturing environment' as opposed to 'ad-hoc' site arrangements.
- Potential innovation and investment opportunities for the manufacturing sector.
- Encouragement of manufacturing and team-working ethos for construction.

DOCK FACE DESIGN

Convention

- Precast concrete elements up to the floor slab level with metal cladding on a steel structure above.
- A combination of level access or raised docks at approximately 1300 mm above the yard level.

Goals

- Install pre-designed precast elements to docks and general building perimeter.
- Improve sequencing, buildability and critical path issues.

Tilt-up Concrete Dock Face

- The use of load bearing tilt-up construction provides an opportunity to minimise the restrictions of the loading areas on the main structure.
- If the tilt-up construction is external to the primary structure, there is an improved opportunity to relocate them, if required later by changes in the end user requirements.
- Reduces programme implications, with the dock areas being off the critical path.
- If the dock areas are at a reduced height, and sit away from the primary structure, the need for the structural steelwork at the dock face is eliminated. This also assists buildability, speed and sequencing.
- In some countries, unloading areas are classed as non rentalised spaces. Therefore reducing the height above these areas.

GREEN ROOF

Convention

- Roof surfaces are typically exposed to the sun's UV rays and temperature extremes due to weather.

Goals

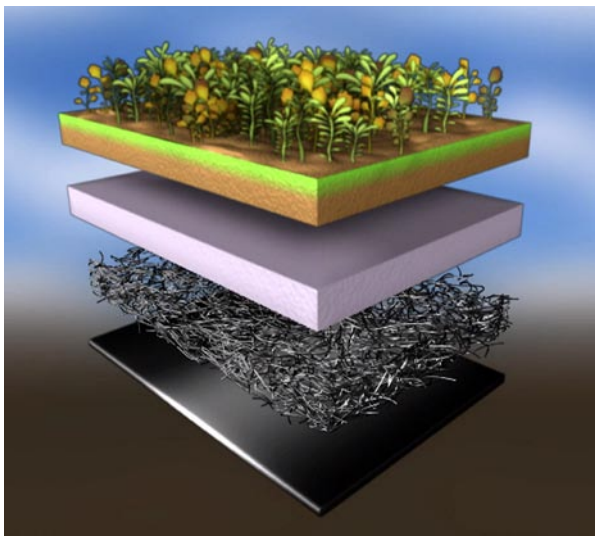
- Provide vegetated roofs to protect the roof surface and provide habitat.

Green Roof

By shading a building's fifth façade (the roof), a green roof will reduce radiant heat transfer into a building by replacing heat absorbing roofing materials (e.g. asphalt/bitumen) with a layer of vegetation. Typical summer air temperatures can increase the surface temperature of a gravel roof to 140-175 degrees F. The temperature of an equivalent green roof will not exceed 77 degrees F, resulting in cooling energy cost savings. In reducing diurnal and annual temperature swings, degradation of the roof structure is slowed, potentially doubling the life of the membrane. Maintenance and replacement costs are also reduced.

Heat absorbed by the vegetation is used in the process of photosynthesis, reducing maximum summer air temperatures within the microclimate of the building. In addition, the vegetation filters air moving across the surface of the roof. Three sq.m of green roof can remove approximately 0.4 lb of airborne particulates from the air every year. Other benefits:

- Reduces radiant heat gain by shading heat-absorbing ground surfaces.
- Reduces solar heat gain in buildings by shading the envelope.
- Mitigates maximum air temperatures through evapotranspiration.
- Absorbs water, mitigating need for drainage.
- Extends life of roof membrane.
- Slows the growth of atmospheric CO2 levels by sequestering carbon through photosynthesis.
- Reduces airborne agricultural dust through use of landscape features like hedgerows.
- Absorbs noise transmission at ground level



ROOFING ALTERNATIVES

Convention

- Composite roofing systems are typically installed in the UK for logistics buildings. Membrane roofs are more common in other parts of Europe.
- Syphonic drainage is the typical solution for large roofed buildings.

Goals

- Investigate roofing systems and determine which alternative may be more cost-effective than the composite roof.
- Determine which roofing system is most conducive for the installation of photovoltaic panels and green roofs.
- Determine which roofing system best allows a cost-effective incorporation of roof lights.
- Consider the cost-effectiveness and ease of application across Europe.
- Minimise the number of penetrations required in the roof system, therefore reducing the risk of potential leaks.

Composite Roof Systems

- Factory manufactured, pre- engineered cladding system which combines weather, structure, thermal, fire performance, long life cycle of up to 40 years, durability and fast-track buildability on site, potentially cutting site installation by up to 50% compared to other systems, is CFC and HCFC free and non-deleterious. Composite roof systems are easily incorporated on site and include a good level of ancillary component packages.
- This roofing system has been used extensively on Gazeley schemes to date, principally due to its ease of fixing, and its compliance with Part L of the UK Building Regulations. However there have also been disadvantages with these panels which include the number of fixings required, which then creates potential weak areas for water penetration. Another disadvantage is the cost of the panels.

Membrane Roof

- The membrane roof offers an alternative system combining a number of layers to meet each building's specific requirements. This roofing system provides a very cost effective solution, depending on the amount of penetrations and additional systems required to be incorporated, however it extends the construction time, therefore affecting sequencing and making the building watertight.
- The cost effectiveness of this roofing system is reliant on the number of penetrations required, and the specific detailing.
- The membrane system is also more cost effective in mainland Europe.

Built up / Standing seam

- The standing seam roof system provides weather-tightness, thermal, air tightness, fire resistance, structural and durability performance. The standing seam concept allows it to be used with pitches as low as 1.5%, and curved roofs over 150 metres radius with no fasteners penetrating the external facing, therefore maximising weather reliability performance. The systems also include standard fixings that will easily accommodate additional systems such as photovoltaics, roof lights, other penetration solutions, and flashings.
- Although the above system has many advantages, it is relatively expensive compared to the composite panel and does extend the build time, affecting the period to make the building watertight, and affecting sequencing.
- This roofing system can be transformed into a green roof by the addition of a drainage mat controlling the integral water management substrate acting as a vegetation layer for an extensive sedum roof.

Conclusions

The most cost effective systems are the built-up and composite trapezoidal systems which need a 4° slope. Below 4° a membrane system would be required or a standing seam built up system or low pitch composite that adds cost. In addition, this should be considered in line with maximising the clear headroom, whilst reducing the maximum roof height below 13.4 metres, and therefore not requiring in-rack sprinklers.

Considerations for the Revolutionised Scheme

- Lightweight and heavyweight structures and the roofing solutions associated with them are to be studied. The following will be considered, as discussed within the structural reports:
  - Tensile, tent, fabric and net structures
  - Pneumatic structures
- Most of the materials currently in use as roof fabrics (such as ETFE – ethylene tetra flouro ethylene - and PTFE - flurorethylenepropylene) are either made from, or involve manufacturing processes that include toxins and compounds that are disruptive to the human body and natural systems.

ROOF LIGHTS

Convention

- In the UK, it is common for10% of the roof area to be covered with roof lights.
- Institutional funds typically require between 5-10% roof lights. In mainland Europe the common practice is 5% roof lights.

Goals

- Provide sufficient roof lights to achieve a 2% daylight factor.

Conclusions

- A well-designed glazing system can offer ample natural light, allow for significant energy savings and provide a sense of connection to the outdoors.
- Although roof lighting will reduce the need for artificial lighting during the day, full complements of lamps will be required after dark.
- While roof lights are beneficial to working conditions within the building, in order to maintain a "dark sky" at night in less populated land areas, the number and size as well as the possibility of shading skylights should be considered.
- It is beneficial if the number of roof light penetrations are balanced against capital and operational costs.

WAREHOUSE STRUCTURAL FRAME

Convention

- Steelwork designed to optimise span, building height and tonnage used and suited for building height.
- Clear height typically between 12 – 15 m.
- Column centres co-ordinated with racking and loading door centres.
- Bracing members required to resist wind loading etc, must be located to avoid operational clashes.

Goals

- Lower the height of the building to eliminate the need for in-rack fire sprinklers.
- Simplify the roof form to a single gable and a minimal slope to facilitate external roof drainage.
- Consider solutions that place the green roof over the major structural elements of the building.
- Consider lightweight solutions that reduce the amount of material to enclose the building and thus reduce embodied energy and carbon emissions.

Marsh Leys solution

- Steel portal frame over the majority of the warehouse with a grid in the range 27 to 35m by 6 to 8m bay width (internal columns at 12 to 16 metres, centre to centre).
- Steel frame to the marshalling area on 8 by 8m grid (adjusted to suit warehouse) with concrete on holorib decking to provide support to the green roof if required.

Optimised solution

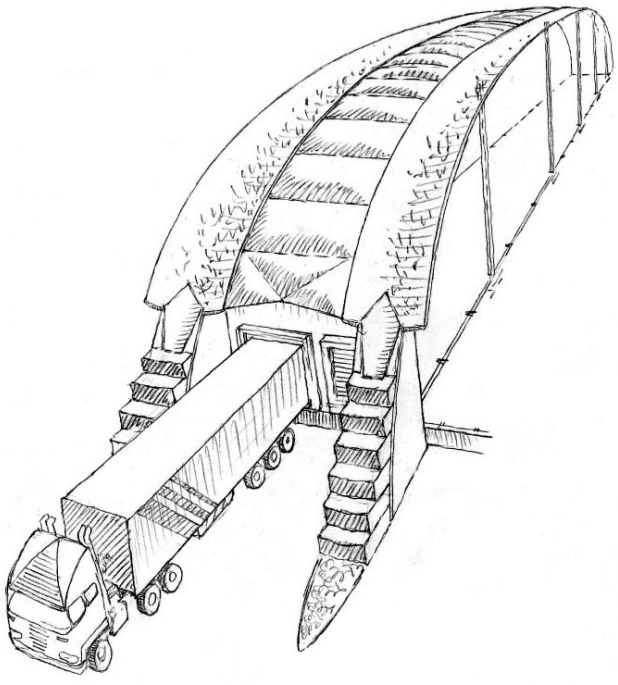
- Flat Portal frame (materials to be reviewed: steel, concrete, timber) over the majority of the warehouse with a grid in the range 27 to 35m by 6 to 8m bay width (internal columns at 12 to 16 metres, centre to centre).
- Frame (materials to be reviewed steel concrete, timber) to marshalling area on 8 by 8m (adjusted to suit warehouse grid) to provide support to the green roof if required.
- If green roof not required portal frame solution to be extended over the marshalling area

Revolutionised Solution with a Heavyweight Structure

- Half Portal Frame (materials to be reviewed steel, concrete, timber) over marshalling area on a 16 by 16m grid.
- Fibre reinforced plastic timber beam and purlin system at warehouse on precast concrete columns on a 16 by 30m grid.

REVOLUTIONISED SOLUTION WITH A LIGHTWEIGHT STRUCTURE

- Fabric covered tent-like structure for uninsulated envelope.
- Fabric infilled cable net structure for insulated envelope.
- Longer spans
- Fire engineered approach to provision of sprinklers
- Green-ten solution. This solution is based on a green roof set on a tensile roof covering. The benefits would be:
    - Low embodied energy
    - Primary roof members constructed by using (renewable) timber and steel in combination. Each material is used to its best advantage.
    - Weight of the green roof means wind uplift is not an issue.
    - The green roof is aesthetically pleasing and acts as a carbon sink.
    - The green roof slows rainwater run off.
    - The green roof acts as an insulating layer (when unsaturated).



SLAB CONSTRUCTION OPTIONS

Convention

- Onerous flatness requirement to suit equipment movements.
- Joints to be co-ordinated with racking geometry and vehicle wheel paths.
- Slab design to accommodate both laden forklift loading and racking point loads.
- Slab required to meet large point loads from the racking.

Goals

- Determine if the slab construction can be improved to increase flatness, avoid construction-sequencing issues.
- Assess the potential for removing the slab entirely and using internal rails for goods sorting.
- Determine a common slab thickness for all European locations.

Marsh Leys solution

- Use of fibre reinforced slab
- Steel fibre construction offers the opportunity to significantly reduce the number of joints in a floor but it does not eliminate joints entirely.
- Pfa (pulverised fuel ash) cement replacement is environmentally sound practice because it uses waste material, is highly beneficial and allows low water/cement ratios to be used minimising shrinkage.

Optimised solution

- Post-tensioned floors are thinner than traditional slabs and use less steel. Pfa (Pulverised fly ash) is nearly always used in PT slabs where shrinkage needs to be kept below 650 micro-strain. It should be noted however, that concrete using pfa cement replacement takes longer to cure.
- If slabs are required in the future for operational reasons, PT is probably the way forward. Performance will be improved, maintenance costs and disruption will be reduced and quantities of materials per unit area of slab will be reduced. PT slabs are highly efficient.

Revolutionised solution

- By the time the revolutionised scheme is built, a slab may be redundant, due to MHE automated equipment in use.

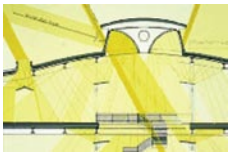
OFFICES

Convention

- Typically constructed within envelope of warehouse, sharing structural steel.
- Ground floor principally warehouse lockers, toilets, etc.
- First floor principally office accommodations with raised access floor.
- Kitchens additional fitments included if client specific.
- Minimum provision includes reception area; staircases, toilets, lift and open plan offices.
- Offices typically rely on air conditioning and a predominance of artificial lighting.

Goals

- Remove offices from the critical path build program.
- Use more prefabrication technologies for the office component.
- Maximise opportunities for natural lighting, ventilation and an improved working environment.
- Improve the speed of construction on the site.
- Strive for zero defects.



OFFICE DAYLIGHTING

Convention

- Because the office building is usually located within the warehouse or attached to it, one side of the building does have access to natural daylight.

Goals

- Remove the office building from the warehouse.
- Provide ample daylight to enhance the workplace and improve worker productivity.
- Reduce reliance on electrical lighting, which requires use of fuel.

Conclusions

- Lighting accounts for 20% to 25% of all electricity consumed in Northern Europe. An average household dedicates 5% to 10% of its energy budget to lighting, while commercial establishments consume 20% to 30% of their total energy just for lighting.
- A well-designed glazing system can offer ample natural light, allow for significant energy savings and provide a sense of connection to the outdoors.
- High-performance glazing systems maximise the amount of sunlight entering a building, while limiting the transmittance of ultraviolet and infrared energy.
- Optimising the energy efficiencies offered by glazing involves integration of the building's mechanical and lighting design with the glazing system. Designing for abundant natural light reduces the need for artificial lighting and so lowers the building's power load.
- Studies have shown heat gain from daylight to be significantly less than heat gain from electric lighting sources (including T8 fluorescent fixtures). Thus, reducing the use of electric lighting can reduce the building's cooling load, providing additional energy savings.

MATERIAL CHOICES

Convention

- Materials are typically chosen for low cost, durability and aesthetics.

Goals

- Select materials that are ecologically intelligent.

Conclusions

The following list serves as a guide to this process for the selection and vetting of construction materials:

Low environmental impact

- Extraction and refining of metals such as aluminium and copper is harmful to the environment and extremely energy intensive. Likewise, the processing of coal to make coke for steel making is highly polluting. Many of these processes occur in developing countries where the environmental impact is not recognised by Westerners. Because these materials are fully integrated within our culture, however, the best solution may be to take advantage of the embodied energy by providing for continuous loop recycling. Where possible, current procedures can be modified to reduce the ecological footprint. It is recommended that fly ash and magnesium cement be substituted in concrete to reduce the CO2 impact. Up to 20% of fill or concrete aggregate can be replaced with recycled materials.

Continuous loop recycling

- Successful recyclability is contingent on the purity of the material and can be hindered when dissimilar ingredients are combined; particularly when the product includes ingredients of both organic and synthetic origin. True cradle-to-cradle recycling is attained when a material can be re-formed repeatedly without losing its essential characteristics.

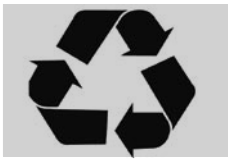
Design for dis-assembly

- There is a great advantage to reusing materials in their existing state without requiring the addition of energy needed for further processing. Materials such as masonry, steel and wood may often be reused in this manner. Building components such as siding panels may be designed to be attached and detached from the building by screws or other reversible means. In contrast, nails and rivets are often permanent and cannot be undone without destroying the panel.

Leasing

- Although rare, certain companies have established product-leasing programmes that allow the manufacturer to retain ownership of a product. This provides the manufacturer with a greater measure of control, ensuring that products are recycled at the end of their useful lives. The Interface Corporation runs a carpet leasing programme of this nature in the United States.

Support Information



Recycled content

- Certain materials can be obtained which already contain a high recycled content either from post-industrial or post-consumer origins. It is common for structural steel to include recycled content. Synthetic gypsum for gypsum wall board is often obtained from industrial smokestack scrubbers (pollution control devices).

Rapidly renewable content

- Rapidly renewable materials are organic materials that can be readily grown at little cost in resource consumption. Common building materials are bamboo and wheat straw products. Bamboo is sliced into strips and laminated together for use as flooring and tabletops. Wheat straw can be used in loosely packed building modules, as a component in pre-formed interior partitions, and in compressed finish panels. Care must be taken to avoid the use of formaldehyde in the binders and adhesives often employed in the manufacture of these products. Formaldehyde can be an irritant to building occupants.

Certified wood

- Sustainably certified wood is grown in well-managed forests and tracked through a chain of custody to its final destination to ensure its provenance. Key requirements of certification include: fair labour practices, the avoidance of forest depletion and timber replacement programmes to ensure continued forest health.

Regionally sourced materials

- Locally and regionally based materials are preferable due to lower transportation costs and the associated reduction in CO2 generation. There may also be advantages in supporting local labour forces.

Halogenated materials

- Use of synthetic plastics containing the halogenated compounds of chlorine, bromine and fluorine is to be discouraged. These chemicals are toxic to the environment and stringent controls are required to contain them in the manufacturing process and prevent harm to employees. These compounds are also dangerous during combustion as they are toxic to building occupants and fire fighters and leave behind a dioxin residue. Chlorine is a component of polyvinyl chloride (PVC) a common building material used for single-ply roof membranes, vinyl composition tile flooring, vinyl siding, and plumbing pipe. Fluorine is a component in most factory-applied exterior paint finishes (known as PVDF). Bromine is used as a fire retardant in some thermoplastic olefin roof membranes.

Offgassing

- Composite wood products, paints and adhesives often contain formaldehyde binders, solvents or other ingredients that may be irritating or harmful to the nervous system. Paints should be low in volatile organic compound (VOC) content, biocides, fungicides and other additives. In order to avoid preservatives, paints may be purchased from the factory within a designated shelf-life. Glu-lam beams, oriented strand board, plywood, and particleboard may consist of adhesives and binders containing formaldehyde. Formaldehyde-free binders should be specified.

MECHANICAL & ELECTRICAL

Office Lighting Convention

- Recessed parabolic fluorescent fixtures in suspended ceiling grid.
- Office lighting suited to PC use.

Office Heating and Ventilation Convention

- Comfort cooling to offices provided as enhancement to base specification.
- First floor typically has raised access floor.

Warehouse Heating and Ventilation Convention

- Gas fired hot air system used to maintain warehouse temperature.
- Standby generation provided to suit tenant requirement.

Goals

- Incorporate pendant lighting fixtures in offices to create a task/ ambient lighting scheme that reduces glare.
- Provide natural ventilation to the offices, eliminating the need for cooling except for specific uses.
- Move toward the elimination of space heating in the warehouse.

ENERGY SOURCES

Convention

- Lighting and equipment is powered by electricity or natural gas provided from a local utility that is derived from fossil fuels.

Goals

- Consider the use of photovoltaics and wind turbines as alternative energy sources to reduce the burden on fossil fuel resources and the associated emissions.
- Purchase power from the utility that has been obtained from alternative resources.

Photovoltaics

- Photovoltaics (PVs) convert sunlight into electricity. Next to wind power, they represent the fastest growing source of renewable energy today. PVs are comprised of two or more layers of semiconductors that have different electrical properties so that an electric field forms at the boundary between these layers. When a PV cell is exposed to sunlight, electrons from one of the layers are released and directed by the electric field into the wires of a circuit, producing direct electric current. The direct current can be used in DC appliances or converted into alternating current (AC) by an inverter.
- Only requires daylight to produce electricity.
- No noise, no pollution, no waste, just clean electricity.
- Electricity generated at point of use with no transmission wastage.
- Mono Crystalline-Most efficient 15%, Higher cost to produce.
- Multi Crystalline -Slightly less efficient 12%, Cheap to produce.

- Thin film (amorphous silicon), Rigid and flexible, Efficiency 6%, Cheaper to produce.
- Future, Cadmium telluride (CdTe) 16% efficiency.

Thermal Solar

- The sun heats tubes carrying water. The water is circulated into the building where it can be used. This is the most efficient method of capturing solar gain.

Wind Turbines

One 660 kW wind turbine on site would generate 1.5 gigawatt of electricity annually for a cost of £400K. In comparison, a thin film solar installation on the entire roof would generate two gigawatt of electricity annually for a cost of £10M. (These are installed costs exclusive of incentives or subsidies). It has been suggested that the decreasing costs of solar will never catch up with the decreasing costs of wind generation and that wind will remain the more cost effective option. The payback for wind is approximately 4.5 years as compared with 20+ years for solar.

Solar options should nonetheless be considered as wind will not always be an acceptable solution: wind turbines are large, can be noisy, are not suitable for urban environments, and are sometimes found objectionable by local planning departments.

- Clean, green electricity
- No waste products or emissions
- Primary source of fuel will never run out
- UK has largest potential wind energy resource in Europe
- World's fastest growing renewable
- Trees and buildings break the force of the wind
- Open hilltop sites or coastal locations with unobstructed views better for siting of turbine.
- Visual impact of tall turbines can be an obstacle.
- Turbines must be sized for the required energy load.
- Approx 30% of the energy in the wind is converted to electricity.

Distributed or Ground Source Heat Pumps

By using renewable heat sources (such as geothermal), heat pumps offer the most energy-efficient heating and cooling strategy for many applications. Although there is limited application of large-scale municipal heat pump installations, the technologies are straightforward and proven.

- There are four main types of heat pump systems:
  - Space and/or water heating-only heat pumps.
  - Space heating and cooling heat pumps, the most common type being the reversible air-to-heat pump.
  - Integrated heat pump systems, providing space heating, cooling, water heating and sometimes exhaust air heat recovery.
  - Water heating-only heat pumps.

- Optimum efficiency is achieved if heat sources are in close proximity to the heat load. This results in reduced transmission and distribution costs.
- Good input to output ratios: a heat pump needs only 100 kWh to turn 200 kWh of environmental/waste heat into 300 kWh useful heat.
- Reduced energy requirements and corresponding CO2 emissions can provide both heating and cooling.
- Heat pump performance is highly dependent on the nature of the heat source: for heating, ideal sources have high stable temperature during the heating season, are abundantly available, and not corrosive or polluted. If heat source is unstable, a heating backup system is required.
- Can be costly, depending on the capacity of the distribution network, extent of street work required and phasing.

WATER USE

Convention

- Traditional plumbing fixture design does not consider the future scarcity of water.

Goals

- Use low or no-flow WC fixtures and urinals.
- Use sensors to limit the operation time for water faucets.
- Collect and filter roof water for use in flushing toilets.

Low-flow Fixtures

- Low-flow fixtures have become commonplace throughout Europe and should be utilized for all schemes.
- Waterless urinals in men's rooms are a proven and reliable technology, and should be utilized wherever possible in all schemes. Given average use, a single waterless urinal can spare 900 hl to 1800 hl of drinking water per year.
- Waterless toilets connected to sludge separating tanks and submerged bed wetlands are a proven, though as yet, less accepted technology. Maintenance is required of this type of toilet in cleaning out separating tanks and caring for its associated wetland, but water spared in average commercial use can be in the 50,000 to100,000 gallon per year range.

Roof Water Collection

- Intensive green or brown roofs capture some 70% of the rainwater that falls in ordinary storm events, and more than half of that water transpires to the air before it can reach the ground.
- Capture of roof-collected rainwater that does make it to ground level can easily in cisterns, either above or belowground for use as toilet flushing water or landscape watering.
- In tandem with cisterns, stormwater pond storage areas that may remain dry for most of the year can meet the entire parcel's need for keeping storm water onsite, offsetting costs associated with piping water off site for municipal cleansing.

FIRE PROTECTION

Convention

- Sprinkler provision at roof level and in rack if required by nature of product.
- Hydrant ring main provided to perimeter of site.

Goals

- Explore methods to reduce the extent and expense of building a fully charged sprinkler system.

Conclusions

- Ordinarily, sprinklers are an end-user fit-out item and are based primarily on the floor to underside of structure dimension. 12.2m, 13.4m and 15m are three cutoff dimensions that determine the extent of piping required by code.
- Density of warehouse racking is another factor in determining requirements.
- Types of sprinklers for warehouse application vary from wet pipe to pre-charged to pre-activation type, though the latter also may require compartmentalisation of the building.
- In the case of the Revolutionised scheme where exterior walls may be omitted, either heat tracing or dry-pipe systems become necessary, increasing system costs approximately 50 to 100 per cent.

Appendix

European Future Environmental Regulations

With the growing realisation of the effects of construction on the environment, new regulations and incentives are being introduced to encourage a more favourable environmental impact.

Although many proposed regulations have yet to be instated, implementation is anticipated in the short term. Companies will soon be held liable and subjected to severe penalties if found to be non-compliant. Creative concepts, such as emissions trading, may offer additional benefits to companies that exceed minimum levels of attainment. Incentives offer a more positive method of encouragement as they reward those who participate rather than penalise those who do not.

Gazeley intends to be proactive and anticipate these regulations before they take effect. The Euro build model recognises this goal.

Key future regulations

- Action and the Environment; 'Environment 2010: Our future, our choice'.

  This programme focuses on four major areas for action as indicated below. It was derived from the major report by the European Environment Agency on the State of the Environment. Priority areas include:
  - *Climate Change:* 8% emission reductions targeted for 2008-2012 under the Kyoto Protocol. The commission calls for global emission cuts in the order of 20-40% by 2020. In the longer term, a 70% reduction in global greenhouse gas emissions(compared to 1990) will be needed.
  - *Nature and Bio-Diversity*
  - *The Environment and Health*
  - *Sustainable use of Natural resources and waste*

- Kyoto Protocol: Strives for achievement of international agreement on the Kyoto

- Greenhouse gas 'trading' scheme: Establishes a plan for 'trading' greenhouse gas emissions within the European union by 2005.

  This initiative will require businesses to take additional and sustained action to reduce the CO2 emissions impact of their activities on the environment over time. It is predicted to create new sources of income for companies acting proactively to manage their CO2 emissions.
  The EU trading scheme will require companies to either reduce their emissions or purchase emission allowances from other trading participants. If companies are unable to meet their emissions reduction commitments through these two options, they will be required to pay financial penalties. These penalties will be 40 Euros per tonne of CO2 from 2005, rising to 100 Euros per tonne of CO2 from 2008.

- Widespread support of renewable energy sources, such as wind and solar power.

- Promotion of markets for recycled materials

- Encouragement for consumers to select products and services that create less waste.

- Start of Environmental Award Schemes for Businesses

- Waste Electrical and Electronic Equipment Directive (WEEE Directive).

  Since the late 1980's and the advent of strict EU packaging regulations, there has been a growing amount of legislation aimed at increasing awareness and responsibility for waste throughout Europe. The issue of waste creation and its impact on the environment has been high on the agenda of the European Government for a number of years. To tackle this problem, a raft of statutes referred to as 'End-of-Life' legislation has, and

will be passed, to place increased responsibility on the manufacturer to take back and recover their goods. Producers will have to organise and finance the treatment, recovery & disposal of waste.

Recent progress has been made in this area with regard to 'End-of-Life' Vehicles (ELVs) and their ability/ responsibility to be recycled. For example, some 60% of BMW car bumpers are in fact made from 'End-of-Life' BMW car bumpers.

With specific regard to electrical and electronic appliances, the 'End-of-Life' issue is on a far greater scale to that of abandoned cars. The UK currently produces over 1,000,000 tonnes of electrical and electronic waste each year. This figure equates to a staggering 200,000,000 items per annum! The scale of this problem is equally reflected throughout Europe.

In 2001, the European Parliament voted in the Waste Electrical and Electronic Equipment Directive (WEEE Directive). Its principal aims were to:

- Minimise waste from end-of-life electrical & electronic equipment
- Set measures for re-use, recycling and other forms of recovery of brown, grey and white goods.
- Minimise the risks and impact associated with using hazardous substances in the production, treatment and disposal of equipment.

It is proposed that a recycling and recovery target of up to 80%, dependant on the product, is adopted. The European Parliament is supporting a per capita collection target of 6 kilograms per person per year.

Incentive Programs for new technologies

In addition to items listed above, there are growing opportunities for Governmental funding for the implementation of environmental technologies. These will assist in the capital cost of introducing the technologies in the future; examples of these for green roofs are listed below, illustrating their improved future viability;

- Green Roof Incentives in Germany*
  - Thirteen cities allow a reduction of 50% - 80% of the stormwater discharge utility fee when a green roof is used.
  - Twenty-nine cities provide grants to developers ranging from 0.42€ /sq ft. to 5.06€ /sq ft. up to 10,000€.
  - Munich has a program to provide 2.56€ per square foot for up to 50% of the capital cost to install a green roof.
  - The province of Hessen requires a green roof on any industrial building over 600 m².
  - Some local ordinances allow developers to replace open space with green roof (necessary for a building permit). Green roof can be substituted for 50% - 70% of land area required by open space regulations.

  *Euro figures converted from DMs (to be verified in current Euro denominations).

- Solar Incentives and Policy in the UK
  DTI Major PV Demonstration Programme (£20 million in 1st phase) has two types of grants available:
  - Stream 1 grants for 0.5kWp to 5kWp PV installations by SMEs (Small/Medium Enterprises with <250 employees and <£25 million annual turnover). Grant cap for bolt-on installations is the lesser of £3000/ kWp or 50% of total eligible costs; Cap for integrated installations is the lesser of £4250/kWp or 50% of total eligible costs.
  - Stream two grants for 5kWp to 100kWp PV installations. Grants are up to 50% of eligible costs for SMEs, up to 40% for large-scale organizations, and are paid in two stages (up to 70% at approval (with proof of purchase), and 30% paid on

completion and after satisfactory site inspection). Applications to the programme are made on a quarterly competitive call basis.
- VAT rate reduced from 7.5% to 5% for solar-based systems.
- Solar qualifies for Enhanced Capital Allowances equivalent to around 5% saving for tax paying companies.
- Limited local authorities have given small grants (5% to 10%) for systems or arranged group discounts.

• Solar Incentives in France

France is considering a regulation that will pay 0.15€/ kWh for electricity purchased from photovoltaic sources.

• Solar Incentives in Germany

The Renewable Energy Law (Erneubare Energien Gesetz) provides compensation for solar energy. Use has increased, depending on the type of PV system:
- Roofs with sound barrier 30 – 100kW receive 57,4 €cent/kWh.
- Roofs with sound barrier >100kW receive 54 €cent/kWh.
- Building facades <30 kWp receive 62,4 €cent/kWh.
- Building facades >30 kWp receive 60 €cent/kWh.
- Free field systems of any size receive 45,7 €cent/kWh.
- The buy-back rates listed above decrease by 5% per year over a 20-year duration for newly installed systems.
- Caps on PV installations are set at 100kW freeland, 1GW in total.

• Solar Incentives in Italy
- Italy will provide a subsidy for up to 70% of the capital cost for PVs
- Tax incentives of 40% provided over 10 years.
- Green certificates for systems greater than 50 kWp and net metering for systems less than 20 kWp.
- Accelerated depreciation of 5 years instead of 10 years.
- In the 4th quarter of 2004, a feed-in tariff system will be implemented that guarantees the payback of the investment and maintenance cost (proposed at 0,95 €/kWh over 10 years).

• Solar Incentives in Spain
- There is a feed-in tariff of €0,4/ kWh for systems < 5 kWp and €0.2/kWh for systems > 5 kWp.
- Solar installations qualify for a 10% tax deduction.
- Some regional governments provide subsidies of 30-40% of installation costs.
- Low interest loans offered for 89% of PV system cost, plus a 19% capital subsidy from IDEA.
- Output credits are highest for wind and solar plants: 11.48 Ptas/kWh over a 5-year period.
- New regulations in some municipalities require the use of solar thermal in new buildings; Barcelona requires new buildings to use solar thermal if their daily hot water consumption exceeds 2.500 liters at 45ºC. Pamplona, Madrid, Seville, and Valencia have announced they will follow Barcelona's example.

6.2 European Future Environmental Regulations

7.1 Background Reports

Benchmarking
Gazeley Current Warehouse Performances
(Based on an approximate unit of 40,000sqm)

Main Element	Sub -Element	Clients requirements (excluding climate data)	Classic Solutions in Europe (cost project shown before)					Eco Template Marsh Leys - Proposals	Eco Template Optimised Proposals
			France	Germany	Italy	Spain	Previous UK Bedford proposal		
General	Climate	Rainfall	Site specific	Site specific	Site specific	-	37-57 mm p/m	37-57 mm p/m	37-57 mm p/m
		Monthly average days rain	Site specific	Site specific	Site specific	6-7 days p/m	7-11 days p/m	7-11 days p/m	7-11 days p/m
		Monthly average days frost	Site specific	Site specific	Site specific	-	0-12 days p/m	0-12 days p/m	0-12 days p/m
		Temperature	Site specific	Site specific	Site specific	9-31 degree C	1-22 degreeC	1-22 degreeC	1-22 degreeC
		Sunshine	Site specific	Site specific	Site specific	180-360 hours p/m	50–200 hours p/m	50–200 hours p/m	50–200 hours p/m
		Frequency distribution of wind speed	Site specific	Site specific	Site specific	-	1 at 12m/s to 17 at 4m/s	1 at 12m/s to 17 at 4m/s	1 at 12m/s to 17 at 4m/s

	Site Density	Maximise the density of the land. Minimise land costs. Flexibility and easy access.	Site density approx 45%	Site density approx 45%	Site density approx 45%	Site density up to 60%	Site density between 30 -45%	Site density currently approx 45%	Site density approx 45%
	Site Costs	Variable across Europe	18 - 23 € /m Paris region varies	-	-	-	North £120 - £150K per acre South East - £700 -£900 per acre	-	-
	Parking Requirements	Parking for Goods Vehicles	1 per door	0.7 per door	-	-	1 per 4000sqft	1 per 4000sqft	1 per 4000sqft
		Parking for staff /visitors	1 per person	1 per person + 5 visitors			Building sqft / 1600sqft	Building sqft / 1600sqft	Parking reduced by 5 spaces
Envelop	**Strucure**	Maximum Clear span	Steel and concrete frame 35m/ 24m	Steel frame 30 m	Concrete frame 24 m	Steel and concrete frame 35m/ 24m	Steel Frame 28.75	Multi ridged Steel Portal Frame 28.75m	Flat portal frame with single ridge
		Clear Height	10 m	10 m	10 m	11 m	10-15m	15m	13.4m (eliminating the need for in-rack sprinklers)
		Budget cost (Exc foundations) Steel Frame	**37.1 € /m²**	**48.2 € /m²**	**NA**	**37.1 € /m²**	**53 € /m²**	**53 € /m²**	**49.3 € /m²**
		Budget cost (Exc foundations) Concrete	54 € /m²	NA	49 € /m²	35 € /m²	NA	NA	NA

	Roof	Roof covering and insulation. Roof to facilitate smoke vents, and rooflight requirements. Buildability and Cost are Key parameters	Profiled metallic roof + insulation (generally rock-wool) + membrane. Thickness of insulation : 100 mm in France, 100 mm in Germany, 100 mm in Spain, 65 mm in Italy.				Composite panels with 80mm polyurethane insulation.	Non PVC Polyisobutylene Membrane roof. insulation or similar	Non PVC APAO Modified Bitumen Membrane roof (Membrane allows for the Green roof)
		Rooflights	Roof lights vary between 5% and 10% depending on user requirements.				10% As funding requirements	15% rooflights, maximising natural daylighting, reducing energy costs	15% rooflights, maximising natural daylighting, reducing energy costs
		Drainage	Gravity drainage is most commonly used In limited cases symphonic drainage is used.				Syphonic Drainage	Gravity Drainage	Gravity Drainage
		Budget cost (excluding lightning protection fittings, security elements, airproofing tests and smoke vents)	30 € /m²	32.4 € /m²	28 € /m²	28,5 € /m²	49 € /m²	61,2 € /m²	See Section 4.3
	Cladding	An envelope to protect the internal items. External envelope -	Double skin cladding with 100 mm of insulation	Double skin cladding with 80 mm of insulation	Concrete panels	Double skin cladding with 100 mm of insulation	Profiled composite wall panels with polyurethane insulation, 70 mm	Profiled composite wall panels with mineral fibre insulation	Profiled composite wall panels with mineral fibre insulation
		Current Costs by Geographic region	39 € /m²	50 € /m²	72 € /m²	37 € /m²	53 € /m²	-	-

	SLAB	Slab to provide necessary strength. Flatness necessary to facilitate the racking solutions **Current Practice** **&** **Euro Build Proposals**	Concrete slab, fibre reinforced with joints. Thickness between 15 and 18 cm. Designed to "recommendations pour les dallages industriels"	Concrete slab, fibre reinforced with joints. Thickness between 15 and 18 cm. Designed to DIN 15185 ,DIN 18202 for flatness	Concrete slab, fibre reinforced with joints. Thickness between 15 and 18 cm.	Concrete slab, fibre reinforced with joints. Thickness between 15 and 18 cm.	Concrete slab, fibre reinforced Thickness 20cm No joints. Designed to Gazeley standards, as The 2003 Third Edition of TR34 FM (Special)	Concrete slab, fibre reinforced Thickness 20 cm No joints. Designed to Gazeley standards, as The 2003 Third Edition of TR34 FM (Special)	Concrete post tension slab,
		Budget cost (for the slab without considering the platform) **Current Cost**	25 € /m²	31 € /m²	27 € /m²	21 € /m²	50,3 € /m²	50,3 € /m²	-
Internal Networks	**Fire Protection**	Sprinkler Systems to protect people and products	Sprinkler with FM insurance for Gazeley, head elements type ESFR K14	Sprinkler with FM insurance for Gazeley, head elements type ESFR K14	Sprinkler with FM insurance for Gazeley, head elements type ESFR K14	Sprinkler head elements type ESFR K25	Sprinkler system compliant with FM insurance requirements Standard head sprinkler system + in rack sprinkler	Sprinkler system compliant with FM insurance requirements Standard head sprinkler system + in rack sprinkler	Sprinkler system compliant with FM insurance requirement. Standard head elements (Height below 13.4m)
		Budget cost (for sprinkler networks inside the warehouse without tanks)	18 € /m²	21.7 € /m²	17.8 € /m²	18.3 € /m²	18,5 € /m²	18,5 € /m²	-
	Mechanic	**A** Gas per sqft (£)	-	-	-	-	0.08	Assume 0.08	
		Electricity per sqft (£)	-	-	-	-	0.45	Assume 0.45	

			Water per sqft (£)	-	-	-	-	0.0005	Assume 0.0005	
			Maintenance per sqft (£)	-	-	-	-	0.26	Assume 0.26	
			Cost per sq ft (less maintenance) (£)	-	-	-	-	0.53	Assume 0.53	
			Total cost per sqft (£)	-	-	-	-	0.80	Assume 0.80	
		Systems	Heating	Unit heater Distributed across the building	Unit heater Distributed across the building	Unit heater Distributed across the building	Unit heater Distributed across the building	Nozzle jet air system (mainly due to Fast-track requirements)	Nozzle jet air system (mainly due to Fast-track requirements)	Nozzle jet air system (mainly due to Fast-track requirements)
			Lighting	Discharge lighting systems Standard switch start in offices	Discharge lighting systems. Standard switch start in offices	Discharge lighting systems Standard switch start in offices	Discharge lighting systems Standard switch start in offices	Fluorescent lighting systems. High frequency fittings throughout offices	Fluorescent lighting systems. High frequency fittings throughout offices	
			Ventilation	Make up air for toilets extracted through adjacent spaces. Supply air and extract into General offices	Can only reduce the ambient temperature by 6 degrees C.			Dedicated supply and extract system from the toilets. Supply air and extract into General offices No restrictions on reduction of ambient temperature. Office 6ac/hr Toilets 8ac/hr Kitchen 15ac/hr Smoking15ac/h	Dedicated supply and extract system from the toilets. Supply air and extract into General offices No restrictions on reduction of ambient temperature. Office 6ac/hr Toilets 8ac/hr Kitchen 15ac/hr Smoking15ac/h	

		Air leakage performance					Less than 10m3/m2/hr at 50Pa	Less than 10m3/m2/hr at 50Pa	Less than 10m3/m2/hr at 50Pa
Offices	**General**	Varied requirements for the differing operations within the buildings. Common areas are found within each building.	Offices on two levels Ratio approx 4%	Offices on two levels Ratio approx 4%	Offices on two levels	Offices on two levels	Offices on two levels Ratio between 5 -10%	Offices on three levels Ratio 5% Marsh leys currently attached to main warehouse	Offices on three levels Ratio 5% Totally separated Pre-fabricated unit, linked to main warehouse
		<u>Floor loadings</u> Suspended floor Partitions Computer flooring					4.0kn/m2 1.0kn/m2 0.5kn/m2	4.0kn/m2 1.0kn/m2 0.5kn/m2	
		Specification notes	Steel & Concrete Frame Concrete slab & Raised floor	Steel Frame Concrete floors Raised floor	Concrete Frame Concrete floors Raised floor	Steel & Concrete Frame Concrete slab & Raised floor	Steel Frame Concrete slab Raised floor	Steel Frame Pre-cast Concrete floors Raised floor	Steel Frame Pre-cast Concrete floors Raised floor
		Lifts	Disabled access	Disabled access	Disabled access	Disabled access	Disabled access	Disabled access	Disabled access
Externals	**Docks**	Efficient and quick loading and un-loading for the vehicles. To suit varying vehicle sizes and heights.	Single sided dock arrangement is common	Single sided dock arrangement is common	Single sided dock arrangement is common	Single sided dock arrangement is common	Single & Double sided depending on the end users requirements	Single sided dock arrangement.	Provision for Cross docking facility. One side to provide rail connection

		Type		Dock levellers with concrete cast in situ				Dock levellers + Pre–cast elements	Dock levellers + Pre–cast elements	Dock Levellers. Tilt up walls to docks. Precast dock elements
		Material		Bitumen Macadam	Bitumen Macadam	Concrete	Bitumen Macadam	Concrete /Bitumen Macadam	Concrete & areas of Bitumen Macadam	Concrete and areas of Pervous paving
		Costs	- Lorry Yard	€26.4/m2	€36/m2	€24/m2	€17/m2	€43.8/m2	€43.8/m2	€43.8/m2
			- Car Parking	€21.6/m2	€27/m2	€27/m2	€12.5/m2	€45.2/m2	€45.2/m2	€65 /m2
		Number of docks		1 per 1,000m2	1 per 1,000m2			1 per 4,000m2	1 per 4,000m2	1 per 4,000m2
	Landscaping	As design guide and Planning requirements. Minimal maintenance with good working conditions for employees.		As Gazeley Magna Park Design Guide & local authority planning regs Grass. 1x small tree / 200m2. 1x tree/ 500m2	As Gazeley Magna Park Design Guide & local authority planning regs Grass. 1x small tree / 200m2. 1x tree/ 500m2	As Gazeley Magna Park Design Guide & local authority planning regs Grass. 1x small tree / 200m2. 1x tree/ 500m2	As Gazeley Magna Park Design Guide & local authority planning regs Grass. 1x small tree / 200m2. 1x tree/ 500m2	As Gazeley Magna Park Design Guide & local authority planning regs.	Low maintenance generally below 1m height. As Gazeley Magna Park Design Guide & local authority planning regs. Detail layout agreed within 106 Agreement	Green roof to offices and above dock areas. Extended landscaping and feature Landscaping including water features and pervious paving.
		Ratio		Ratio : 20% of the site	Ratio : 20% of the site	Ratio : 20% of the site	Ratio : 20% of the site	Ratio : 20% of the site	Ratio : 20% of the site	Ratio : 20% of the site
		Cost		2.0 € /m²	1.7 € /m²	3.6 € /m²	1.8 € /m²	6.41€ /m2	6.41€ /m2	
Main	**See full Eco –**	External Wall						B		
		Roof Construction						A		

		Upper Floor Construction					B		
		Internal walls & partitions					A		
		Windows					C		
		Wall insulation					C		
		Roof insulation					B		
		Floor surfacing					-		
		Floor finishes and coverings					A		
		Doors					A		
		Paint Systems					A-B		
		Suspended ceilings / ceiling finishes					A-C		
Life Cycle Costing	**Eco -Tools**	Life Cycle Assessment Tools	EQUER & TEAM for Buildings	Ecopro			BREEAM	BREEAM	BREEAM
		Energy Calculations	COMFIE & Th-C and DEL 2 Methods	-			Esicheck	Esicheck	Esicheck

SUPPLEMENTARY INFORMATION

Standard Performance Critieria for Gazeley Projects

MECHANICAL

TEMPERATURES AND VENTILATION RATES

AREA	TEMP. Winter	TEMP. Summer	INFILTRATION A/C RATE Natural	Mech.
Warehouse	10/16^{0}C	N/A	0.50	10/100%
Toilet Areas	18^{0}C	N/A	-	10
Stairwells	18^{0}C	N/A	0.5	N/A
Offices (H & V only).	21^{0}C	N/A	0.5	4
Offices(Comfort Cooled).	21^{0}C	22^{0}C	0.5	Occupancy
Corridors/Lobbies	18^{0}C	N/A	0.5	-
Smoking Rooms	21^{0}C	N/A	0.5	20
Meeting Rooms	21^{0}C	22^{0}C	0.5	Occupancy
Ambient	-4^{0}C	28^{0}C	-	-

The Communications room are maintained at 21^{0}C ($\pm$1.5^{0}C) with external ambient temperatures of -4^{0}C (Winter) and 28^{0}C (Summer) and a relative humidity of 55% ($\pm$5%). Comfort Cooling plant is be provided at 133% of total requirements, with 66% duty/standby compressors etc.

Humidity control is excluded in all other office areas.

Occupancy levels in offices are assessed at 10 l/s of make up air per person and 1 person per $9m^2$ and in meeting rooms 1 person per $6m^2$.

Heat gain from people/equipment as CIBSE

Warehouse areas are heated/ventilated to achieve a maximum stratification level of 0.3^0C per metre of building height.

All internal temperatures given above for design purposes are to be $\pm$ 1.5^0C measured at the point of control and based on the 'U' values contained within the current edition of the L2 building regulations

Smoke Ventilation

Smoke ventilation systems are only installed where required as part of an Engineered Solution to increased travel distances for means of escape.

The Smoke Ventilation systems are based on SVA guidelines throughout and make due allowance for the design fire size appropriate to the Product being stored.

Sprinkler Systems

Sprinkler systems are installed either where required by the End User's Insurer or as part of an Engineered Solution to Increased Travel Distances for Means of Escape (or both).

The Sprinkler systems are based on either LPC Rules, FM Guidelines or other appropriate certifying authority throughout and make due allowance for the design appropriate to the Product being stored.

Electrical

Warehouse Lighting

a) Security Lighting 1 in 10 luminaries

b) 50% lighting

c) 100% lighting

d) Emergency lighting

Illumination between 150 – 300 lux on the floor

Within racking minimum 150 lux on the horizontal face

Minimum uniformity 65%

Consideration required as to the method of picking with due regard to limiting glare.

Office Lighting

Dimmable lighting interconnected to presence detection and where appropriate daylight interface.

Illumination levels to be consistent with CIBSE recommendations with the exception of toilets where 300 Lux is considered more appropriate.

Emergency lighting provided with either integral batteries or via a central battery system.

to provide 3 hour standby

Given the size of the developments consideration is normally given to an automated test facility.

External Lighting

Lighting shall be designed to give the following average maintained levels, generally to the CIBSE Guide standards: -

Roadway	20	Floor level
Lorry/Car Park	25	Floor level
Main Entrance	50	Floor level
Site Perimeter	10	Floor level

Lighting Control

The external lighting shall be controlled primarily by photo-electric cell and zoned time control, with a manual override facility.

Consideration must be given to the dark sky policy and luminaries to be selected accordingly.

Mains Distribution

Almost without exception the supplies are taken at MV.

Also given the critical nature of these type of developments full standby generation is also required.

Small Power

This would normally be provided to institutional standards to the office with 1No twin socket per 9 M^2

Elsewhere sockets would be provided for either maintenance purposes or for specific end user requirements.

Fire Alarm

Would be provided to BS in consultation with building control and giving due consideration to the engineered solution for increased escape distances

Background Reports

7.2. Pan-European Solar Grants & Incentives

Pan-European Solar Grants and Incentives

(with policy information for other renewables)

1 Current Picture – Energy Production and Sources

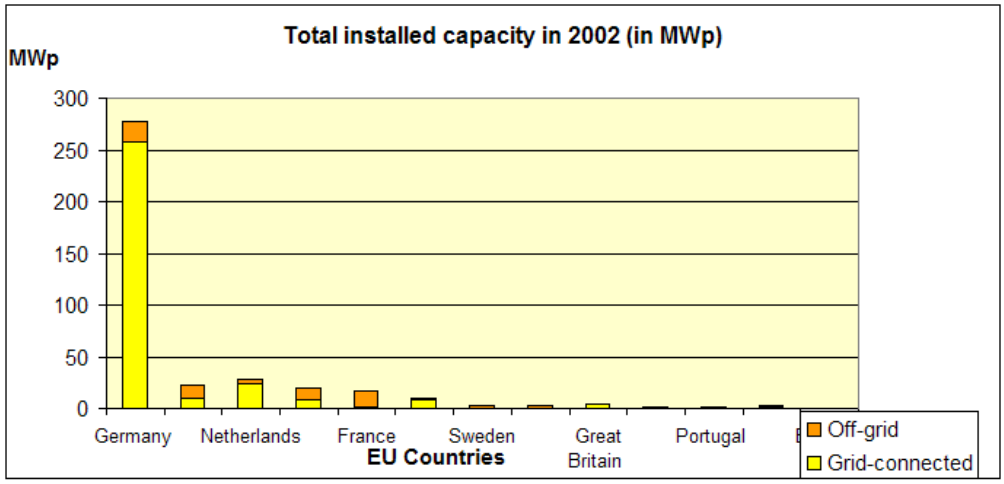
European Union

General Energy Consumption and Contribution of Renewable Sources

- Share of renewable energy: 6% (1999)
- Green energy customers: 1.4 million (October 2002, est.)
- The European renewable energy industry represents one of Europe's fastest growing sectors with a current annual turnover of more than €10 billion.

Solar

- Europe: third manufacturer of solar cells in the world in 2000 with 59MWp, after Japan (110 MWp, a 46% increase over the previous year), and the US (80MWp). In 2000, the main producers, based in France, Germany, Spain, and the Netherlands, achieved a similar growth rate to the Japanese market.
- Both BP Solar and the German company ASE have major plant expansion plans. BP solar is building a 60 MWp production facility in Spain and ASE a similar sized factory in Germany. When completed, the two outlets will increase present production capacity in Europe by 150%.
  [Acrobat file Part 2 from: http://www.epia.org/03publications/publications.htm]
- EU's installed PV capacity grew by 37.7% to reach 392 MWp in 2002 (worldwide: +33.3%)
- Installed capacity of solar thermal collectors is 12.8 million m², (represents 34 m² per 1,000 Europeans).
  [Acrobat file Second quarter 2003 from: http://www.eufores.org/summary.htm]



Scientific and Technological References Energy Technology indicators – European Commission, DG Research
[http://www.epia.org/02photovoltaic/pv_europe.htm]

Capacity installed in Europe: 2000, 2001 and 2002

Country	Total installed capacity in 2000 (in MWp)			Total installed capacity in 2001 (in MWp)			Total installed capacity in 2002 (in MWp)		
	On-grid	Off-grid	Total	On-grid	Off-grid	Total	On-grid	Off-grid	Total
Germany'	100	13,8	113,8	175	14	189	258	20	278
Italy	9	13	22	9,1	15	24,1	10,35	12,4	22,75
Netherlands	8,7	4,1	12,8	16,2	4,3	20,5	23,68	4,63	28,31
Spain	2,9	9,2	12,1	5,3	10,3	15,6	7,91	11,39	19,3
France	0,6	10,7	11,3	1	12,7	13,7	1,47	15,18	16,66
Austria	3,2	1,7	4,9	4,7	2	6,7	7,88	2,16	10,04
Sweden	0,1	2,7	2,8	0,1	2,9	3	0,18	3,1	3,28
Finland	0,1	2,5	2,6	0,2	2,6	2,8	0,14	2,89	3,03
Great Britain	1,5	0,4	1,9	2,2	0,5	2,7	3,63	0,62	4,25
Denmark	1,3	0,2	1,5	1,3	0,2	1,5	1,44	0,23	1,66
Portugal	0,3	0,7	1	0,5	0,9	1,4	0,27	1,19	1,46
Greece	0,2	0,7	0,9	0,3	0,8	1,1	1,04	1,33	2,37
Belgium	0,1	0,1	0,2	0,1	0,1	0,2	0,53	0	0,53
Total UE	128	59,8	187,8	216	66,3	282,3	316,52	75,12	391,64
Source : Eurobserv'ER									

1a United Kingdom

General Energy Consumption and Contribution of Renewable Sources

- Total energy consumption in 2000: 9.9 quadrillion Btu, 2.6 % of world total energy consumption. UK energy intensity decreased to 7.6 thousand Btu per $1995 in 2000, a 2.6% decline.
  [http://www.eia.doe.gov/emeu/cabs/ukenv.html]
- Over the past two decades, energy consumption in the UK industrial sector has increased slightly, consumption in the residential and commercial sectors has remained steady, and transportation sector consumption has risen fairly quickly. The industrial sector was the primary consumer of energy in 1998, accounting for 37% of total primary energy consumption.
  [http://www.eia.doe.gov/emeu/cabs/ukenv.html]
- green energy customers: 45.150 (December 2001)
- domestic green energy consumption: 149 mln kWh (December 2001)
- green energy consumption business customers: 591 mln kWh (November 2001)
- Currently, renewable energy supplies around 3% of the electric and 1% of the total energy.
  [*Acrobat file Sun in Action II – A Solar Thermal Strategy for Europe, Volume 2 from:* http://www.estif.org]
- Government assessment of the “accessible resource” for electricity production from renewable energy (defined as technologies capable of producing electricity for less than 10p/kWh) are at 1,100 TWh per year, or over three times the UK’s total electricity generation in 1993. This estimate will increase with decreasing costs of renewable electricity, but has not yet been updated.

[www.iea.org/pubs/studies/files/renenp2/ren/35-ren.htm]

- The total energy consumption is expected to reach 12.2 quadrillion Btu in 2020, an average annual increase of 1%, equal to Western European average. However, renewable energy consumption in the UK is expected to grow 0.4 quadrillion Btu, compared to the 1999 level of 0.1. [http://www.eia.doe.gov/emeu/cabs/ukenv.html]

Solar

- The British solar thermal industry is largely underdeveloped and underfinanced by the government. UK remains a small player in the global market with an annual market size of £6-10 million, depending on off grid inclusion.
- Housing Associations lead the way in installing solar systems into new houses.
- Large-scale examples of PV systems (>10 kWpeak) are rare, but include the recently completed 106 kWp amorphous PV installation at the Alexander Stadium in Birmingham, installed by Solar Century, at just under £4/Wp. Smaller systems which are typically <5kWp and are often installed on single dwellings, are likely to cost more at typically £10-20/Wp.

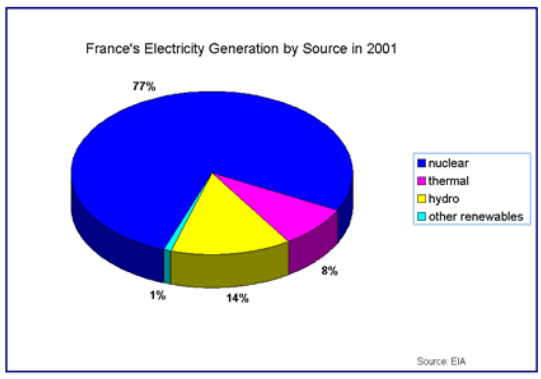
Wind

- The UK's largest accessible renewable energy source is wind power: the accessible resource has been estimated at 340TWh/y onshore and 380TWh/y offshore. [http://www.eia.org/pubs/studies/files/renenp2/ren/35-ren.htm]

1b France

General Energy Consumption and Contribution of Renewable Sources

- France has the second largest consumer electricity market in Europe, behind Germany.
- France is the largest exporter of electricity in Europe, and generating roughly 77% of its electricity from power plants. Total energy consumption in 2001 was 10.5 quadrillion Btu (quads), 2.6% of the world's total energy consumption.
- Geothermal, solar, and wind power consumption make up less than 1% of France's total energy consumption (natural gas: 14%, hydroelectricity: 7%, coal: 4%).



Solar

- (No data available)

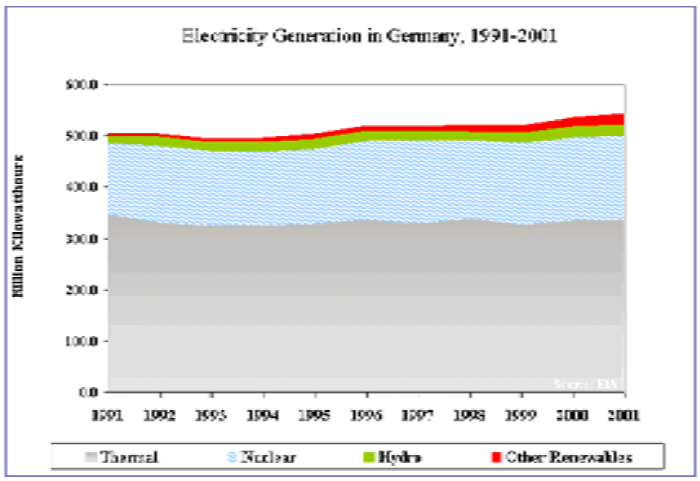
Wind

- France has only about 80 MW of installed wind power (compared to about 3,000MW in Germany). [http://www.eia.doe.gov/cabs/franenv.html]

1c Germany

General Energy Production and Contribution of Renewable Sources

- Total energy consumption in 2001: 14.35 quadrillion Btu, 3.6% of world total energy consumption, energy intensity: 7.5 thousand Btu per $1995 in PPP (purchasing power parity) reflects 13.3% decrease in energy consumption (from 1991 levels), annual growth rate estimated at 0.6% through 2025. [http://www.eia.doe.gov/emeu/cabs/germany.html]
- Germany has Europe's largest electricity market. In 2001, it generated 544.8 billion kWh of electricity. Although Germany produces more electricity than it consumes, the country is a small net importer, because of transmission losses and its proximity to foreign sources of generation.
- Recent German estimates predict 14% growth in electricity consumption between 1999 and 2020.



- Renewable energy production: 36,3 TWh (2002)
- Green energy customers: 324.000 (June 2002, calculation)
- Green energy sales: 800Mio kWh (June 2002, estimate)
- Germany's consumption of renewable energy (including geothermal, solar, wind, wood and waste electric power) has increased dramatically since 1991. The consumption of renewable electricity, particularly wind power, has more than quadrupled since 1991, to 22.6 billion kWh in 2001, representing approximately 4% of the country's total electricity consumption.

Renewables' Contribution to Gross Electricity Consumption

	1998	1999	2000	2001	2002	2010
Gross Electricity Consumption (Bkwh)	556.7	557.3	576.4	580.5	581.7	580
Electricity from Renewables (Bkwh)	25	29	36	38	46	70
Percentage	4.6%	5.3%	6.3%	6.7%	8.0%	12.5%

Solar

- Average capacity of domestic systems for BIPV (Building Integrated Systems) approaches 3kWp.
- Current installed capacity of 113MWp is a result of the high growth rate of Germany's building-integrated market, from small units through the megawatt rooftop systems. More than 44MWp was installed in 2000 alone, and estimates foresee that the country could achieve a figure of 439MWp by 2004.
  [Acrobat file Part 3 from: http://www.epia.org/03publications/publications.html]
- Germany contributes 79.5% of the supplementary solar capacity in the EU, including 42 MWp linked to the power grid. The German law on renewable energies provides for a purchase price of €0.5/kWh for the first 350 MWp on installed on the electrical power grid.
  [http://www.europa.eu.int/comm./energy/res/sectors/photovoltaic_en.html]
- According to the German Solar Energy Association, there are plans to increase German's industrial capacity to almost 160 MW of silicon solar cells, more than 150 MW of crystalline silicon modules, and more than 9 MW of thin film modules, which could turn the country in a net exporter in a few years.
  [Acrobat file Part 2 from: http://www.epia.org/03publications/publications.html]
- PV market grew by 184% between 1999 and 2000
  http://www.epia.org/03publications/publications.htm]

Table 2.1: PV cell/module manufacture - leading producers by region
This table includes most manufacturers with production capacity over 4 MWp in Europe, US and Japan, over 2 MWp in ROW.
Source: PV News, 2001

	Total shipments in 2000 (MWp)	Growth from 1999 (%)	Leading producers	Shipments in 2000 (MWp)
• **Europe**	58.5	46	Photowatt-France (France) ASE (Germany) Isofoton (Spain) BP Solar (Spain) Shell (Germany/ Netherlands) Solar-Fabrik Freiburg (Germany)	14 10 9.5 7 6.5 4.6
• **United States**	78.5	29	Siemens Solar Solarex Astropower ASE Americas	28 20 18 6
• **Japan**	116.6	46	Sharp Kyocera Sanyo	50.4 42 17
• **Rest of the World**	24.2	18	BP Solar (Australia) BP Solar (India) Sinonar (Taiwan) China	6 5 3 2.5

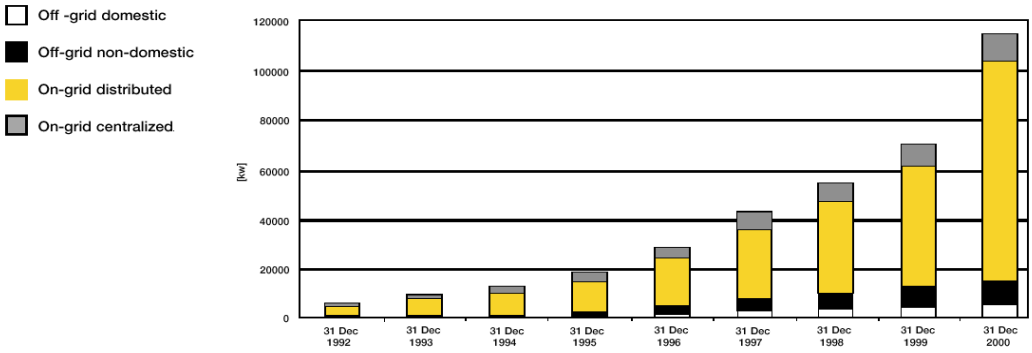
Germany

PV CAPACITY END 2000: 114 MWp

SUPPORT SYSTEM: 100,000 ROOFS PROGRAMME AND PREMIUM PRICE PER KWH

Figure 3.1: Installed PV in Germany by sub-market

Source:IEA



SOLARGENERATION

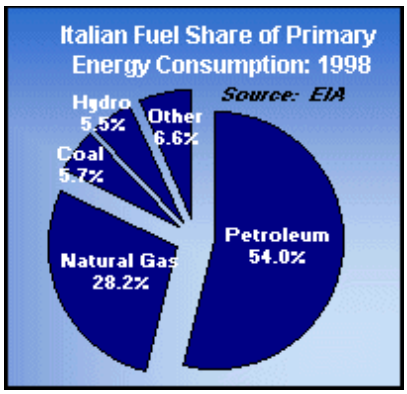
Wind

- Germany has become the world's leader in wind energy, having an estimated 39% of the world's installed capacity, 12,828 MW, 14,283 wind turbines. [http://www.eia.doe.gov/emeu/cabs/germe.html]
- Suitable sites for additional wind farms are becoming scarce. As a result, the government has permitted the building of wind parks offshore. By 2006, the German government hopes to increase offshore installed capacity to 500 MW; by 2010 to 2,000-3,000 MW, and by 2030 to 20,000-25,000 MW. If this plan is realized, wind energy on both land and sea could meet 25% of German's electricity demand in 2030, according to the government. [http://www.eia.doe.gov/emeu/cabs/germe.html]

1d Italy

General Energy Consumption and Contribution of Renewable Sources

- Total energy consumption in 1998: 8 quadrillion Btu (quads), 2% of the world total energy consumption, fourth highest energy consumption in Europe.
- Total energy consumption per person in 1998: 139 Million Btu.
- Electric generation capacity: 69 million kWh.
- Electric generation in 2001: 203.4 billion kWh.
- Electric consumption in 2001: 289.1 billion kWh. [http://www.www.eia.doe.gov/emeu/cabs/itenv.html]



- Non-hydro renewable electricity generation (mostly solar and geothermal) almost doubled in the 1990's. Over 2% of Italian electricity is now produced from renewable sources.
- Italy is one of the largest producers of geothermal energy in the world, behind the United States, the Philippines, Mexico, and Japan. In 1997, Italy had an installed geothermal capacity of 550 MW.
- Italy is studying the potential of biomass. The focus of the National Program on Renewable Energy from biomass is to examine genetic varieties of plants that will maximize the energy obtained from combustion.
  [http://www.www.eia.doe.gov/emeu/cabs/itenv.html]

Solar

- According to a European Union study, Italy funds one quarter of all photovoltaic research occurring tin the EU. The Italian government has implemented the "10,000 Photovoltaic Roofs" program.
  [http://www.www.eia.doe.gov/emeu/cabs/itenv.html]
- The Rooftop Program aims to stimulate the market through the installation of an initial 50 MW of PV roofs.
  [Acrobat file Part 3 from: http://www.epia.org/03publications/publications.html]
- Around €40m in subventions has been granted for the realization of public, commercial and residential projects. Financing is limited to €7.7 per peak watt and the amount cannotexceed 75% of total project cost.
  [http://www.europa.eu.int/comm./energy/res/sectors/photovoltaic_en.html]

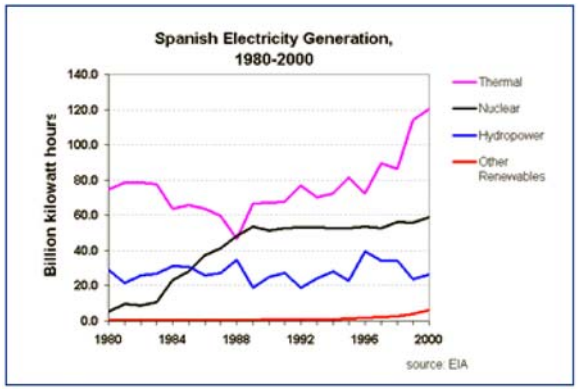
Wind

- Funding for research in harvesting wind energy is small compared with programs examining solar and biomass.

1e Spain

General Energy Consumption and Contribution of Renewable Sources

- Total energy consumption in 2001: 5.7 quadrillion Btu, 1.4% of world total energy consumption.
  [http://www.eia.doe.gov/emeu/cabs/spain.html]
- Electric capacity (geothermal and other) in 2001: 1.894 million kW
- Electricity generation (geothermal and other) in 2001: 9.177billion kW
  [http://www.eia.doe.gov/emeu/world/country/entry_SP.html]
- Electricity demand for 2001 was estimated to be 210.4 billion kWh. It is estimated that Spain's electricity demand will increase 30% by 2010.
  [http://www.eia.doe.gov/emeu/cabs/spain.html]



Solar

- Spanish Solar Industry Association (ASENSA)
- Institute for diversification and Energy Saving (IDEA)
  [*Acrobat file Sun in Action II – A Solar Thermal Strategy for Europe, Volume 2 from:* http://www.estif.org]
- **ISOFOTON, ATERSA, BP-SOLAREX**: manufacture photovoltaic cells and modules, and develop news technologies (mainly thin-film cells, concentration cells, photovoltaic modules to integrate on roof) to improve efficiency and costs.

Table 1. Modules manufacturers in Spain

Company	Cell production [MW]	Production capacity [MW]
Atersa/Astrasolar	2	3,8
BP Solar Espana	7	10,0
Isofoton	6	10,0

- In 2000 and 2001, the installation of more than 30.000 m² of solar collectors was subsidized at 30-35% of total installation cost.
- The domestic hot water system with flat plate collector is the most common solar product. The share of vacuum collectors is estimated at 2-3%, and is roughly the same for unglazed collectors, which are used for swimming pool heating.
  - Domestic hot water production market share: over 90-95%, of which large collective systems have 28-30%.
  - Space heating: 6-7% of the market (usually used in combination with domestic hot water)
  - Swimming pool heating market share: 5-10%
  - The market for district heating, air conditioning and industrial process heat is marginal but growing
- Newly installed area of solar thermal collectors has risen from 40 m² in 2002 to more than 51 m² in 2001. To reach the 2010 goal, an average or more than 400 m² needs to be newly installed each year between 2001 and 2010.
- Thirteen companies are involved in solar thermal collector production, with a production capacity greater than 200.000m² per year, and a capacity utilization less than 50%.
  [*Acrobat file Sun in Action II – A Solar Thermal Strategy for Europe, Volume 2 from:* http://www.estif.org]
- Solar goals have been exceeded and photovoltaic power has increased by 5 MW since the start of the Programme.

2 Kyoto Protocol and Carbon Emissions

2a United Kingdom

Goals for Kyoto Compliance

- **Climate Change Levy**
  [http://www.agores.org/POLICY/NAT_STRATEGY/MEMBERS/UK/default.htm]
- The UK agreed to a 12.5% reduction below 1990 levels of greenhouse gases emissions by 2008-2012. The government suggested a domestic goal of 20% below 1990 levels by 2010. Energy related carbon emissions in the UK have fallen from 167.4 million metric tons of carbon in 1990 to 147.8 million metric tons in 2000, almost 12% reduction. [http://www.eia.doe.gov/emeu/cabs/ukenv.html]

2b France

Goals for Kyoto Compliance

- To ensure that France meets its commitment under the Kyoto Protocol, the French government and MIES introduced new measures under “Climate Plan 2003”. [http://www.eia.doe.gov/cabs/franenv.html]
- French government Inter-Ministerial Greenhouse Effect Mission (MIES) during the 2000-2010 period, plans to limit carbon emissions, including an initial carbon tax of $23 to $30 per metric ton of carbon emitted, rising about $75 by 2010. The tax is applied to the general Tax on Polluting Activities and will be gradually extended to energy consumption by businesses and by electricity producers.

2c Germany

Goals for Kyoto Compliance

- The German government’s climate protection program sets goals of reducing carbon emissions by 25% from 1990 levels by 2005. The six greenhouse gases cited in the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, hydrofluoro-carbons, perfluorocarbons, and sulphur hexafluoride) should be reduced by 21% between 2008 and 2012, within the context of the EU burden-sharing program. [Acrobat file Part 3 from: http://www.epia.org/03publications/publications.htm]

2d Italy

Goals for Kyoto Compliance

- The Italian Government is hoping that a carbon tax enacted in January 1999 will help to reduce carbon emissions, as consumers switch to less carbon-intensive fuels. Revenues accrued from the tax will be used to finance energy efficiency and renewable energy initiatives, among other ecological projects. [http://www.www.eia.doe.gov/emeu/cabs/itenv.html]

2e Spain

Goals for Kyoto Compliance

- (No data available)

3 Targets and Policies related to Solar Conversion

European Union

- Renewable energy objectives for year 2010:
  - 12% share for renewable energy in gross inland energy consumption
  - 22% share for green electricity
  - 5.75% share for biofuels.
    [http://www.erec.renewables.org/Berlin2004html]
- 8% reduction below 1990 levels for a "basket" of greenhouse gases by the 2008-2012 commitment period. [http://www.eia.doe.gov/emeu/cabs/ukenv.html]

3a United Kingdom

- A target has been set to increase energy generation through **Combined Heat and Power (CHP)** by at least 10,000 MW by 2010. Government is investing $364 million+ over the next three years into renewable energy sources including solar, biomass and wind. [http://www.eia.doe.gov/emeu/cabs/ukenv.html]
- **The Renewables Obligation** proposes that suppliers provide 5% of UK electricity requirements with renewable sources of energy by the end of the year 2003, increasing to 10% by 2010 (a 10% target for renewable electricity would be equivalent to an additional 2.6 to 3 million tones of carbon saving for the UK climate change commitment). The period of the obligation is expected to last at least until 2025, and the purchase price to be set initially at a minimum level of about 2 pence for every kWh. A new hydroelectric plan includes a 10-20 MW increase in output and is expected to result from the refurbishment of 30 hydroelectric power stations.
- The UK is considering a **70,000 roofs programme**.
  [*Acrobat file Part 3 from:* http://www.epia.org/03publications/publications.html]
- UK policy affects the PV sector primarily through the supply of funds to **DTI** and **EPSRC** to run the PV specific R&D and capital grants programmes respectively.
- Information and advice on passive solar design of buildings is available on a regional basis. The aims of the UK passive solar design programme are to encourage the uptake of passive solar design, develop internationally competitive industries for the domestic and export markets, and to quantify the environmental improvements and benefits associated with passive solar design.
- The **Clear Skies** national grant for community and household renewables provides the solar thermal industry an opportunity to increase the market in the domestic sector, raise standards, and increase the number of professional installers.
  [*Acrobat file Sun in Action II – A Solar Thermal Strategy for Europe, Volume 2 from:* http://www.estif.org]

3b France

- The government plan to meet Kyoto commitments includes several long-term structural measures encouraging use of renewable energy resources. However, renewable energy use will not rise appreciably until government sponsored market barriers (such as subsidies for other energy sources) are removed.
- By extending the public service policy tax to households, France is trying to promote wind power in the country. The French regulator (CRE) says that prices will have to rise in order to meet the government's target of providing 21% of power consumption by renewable means by 2010.

3c Germany

- Renewable energy sources are expected to increase at an average annual rate of 2.9%. The Eco-Tax (Ökologische Steuerreform) was introduced with the goal of encouraging conservation, energy efficiency, and the use of renewable energies.
- The Renewable Energy Act (Erneubare Energien Gesetz) is intended to double the amount of electricity generated from renewable sources by 2010 (Current predictions are for solar rooftop installations alone to grow to 30% by end of 2004). The mid-term goal was set to increase electricity generated from renewables to 20% by 2020 with 50% provided by year 2050. This program replaces the 100,000 solar roof tops programme which expired this year. [http://www.eeg-aktuell.de]
- The combined Heat and Power Law (Kraft-Wärme-Kopplungsgesetz) provides €4.5 billions of funding for the refurbishment of existing power plants and installation of new smaller plants to reduce greenhouse gas emissions by 23 million metric tons (mmt) per year by 2010.

3d Italy

- The Government's goal is to double the country's production of energy from renewable resources by 2012.
- The Italian government is undertaking numerous measures to moderate growing air pollution problems. In 1999, an electric car-sharing program was launched, where selected cities (Rome, Milan, Turin, Modena, Brescia, Udine, Florence, Bologna, and Venice) are provided with 500-600 electric cars, which are shared by participant citizens. Customers pay a membership fee of $80-$300 (according to the distance traveled) and are provided with a magnetic card, allowing them the use of an electric car from several parking areas throughout the city.
- Italy is highly reliant on energy imports from North Africa, and has focused on development of energy efficiency technologies as one mean to protect national security. Higher energy prices compared to other countries also provide a strong stimulus for companies to invest in energy efficiency research and development.

3e Spain

- **Renewable Energy Plan 2000-2010**: consolidates Spanish policy on renewable energy, offers economic and regulatory measures to favor photovoltaic solar energy, and is in line with the content of the European Union White Paper. Goal is 12% contribution of renewables to the national energy balance. [http://www.oja-services.nl/iea-pvps/ar01/esp.html]
- The Spanish government has mandated that all utilities must charge the same amount per unit, rendering true competition almost nonexistent. Furthermore, the government has mandated that between 2003-2010 prices can rise by a maximum of 2% per year. The actual percentage will be adjusted according to demand, percentage rates, the treatment of renewable energy and gas prices. [http://www.eia.doe.gov/emeu/cabs/spain.html]
- The new Plan deals with public subsidies to R&D projects; objectives are the improvement of PV technologies, production, commercialization and installation processes; public subsidies to the installation of PV systems, both off-grid and grid-connected systems; establishment of a new regulation for the connection of PV systems to the grid; and tax benefits for PV installations.
- **IDEA** is responsible for the distribution of €6million of direct investment subsidies for solar thermal. Detailed regulations covering technical and economic quality are mandatory for installers.

4 Solar Incentives

4a United Kingdom

General Energy Reduction

- (No data available)

Solar

- DTI Major **PV Demonstration Programme** (£20 million in 1st phase) has 2 types of grants available:
  - Stream 1 grants for 0.5kWp to 5kWp PV installations by SMEs (Small/Medium Enterprises with <250 employees and <£25 million annual turnover). The grant cap for bolt-on installations is the lesser of £3000/kWp or 50% of total eligible costs, while the cap for integrated installations is the lesser of £4250/kWp or 50% of total eligible costs.
  - Stream 2 grants for 5kWp to 100kWp PV installations. The grants are up to 50% of eligible costs for SMEs, up to 40% for large scale organizations, and are paid in 2 stages (up to 70% at approval (with proof of purchase), and 30% paid on completion and after satisfactory site inspection). Applications to the programme are made on a quarterly competitive call basis. [http://www2.dti.org.uk/energy/renewables/renewables_uk/publications.shtml]
- **VAT** rate reduced from 7.5% to 5% for solar systems.
- Solar qualifies for **Enhanced Capital Allowances** equivalent to around 5% saving for tax paying companies.
- Limited local authorities have given small grants (5% to 10%) for systems or arranged group discounts.

4b France

General Energy Reduction

- (No data available)

Solar

- The government is considering a regulation that will pay €0.15/kWh in continental metropolitan France and €0.3/kWh in Corsica and the French overseas departments for a 20 year period for electricity purchased from solar sources. [http://www.europa.eu.int/comm./energy/res/sectors/photovoltaic_en.html]

4c Germany

General Energy Reduction

- The Energy Saving Ordinance (Energieeinsparverordnung) requires new buildings to reduce energy consumption by 30% in comparison to current standards.

Solar

- The Renewable Energy Law (Erneubare Energien Gesetz) replaces the 100,000 solar rooftops programme [http://www.eeg-aktuell.de]. Compensation for solar energy use has increased, depending on type of PV system:
  - Roofs with sound barrier 30 – 100kW receive 57,4 €cent/kWh
  - Roofs with sound barrier >100kW receive 54 €cent/kWh
  - Building facades <30 kWp receive 62,4 €cent/kWh
  - Building facades >30 kWp receive 60 €cent/kWh
  - Free field systems of any size receive 45,7 €cent/kWh

- The buy-back rates listed decrease by 5% per year over a 20 year duration for newly installed systems.
- Caps on PV installations are set at 100kW freeland, 1GW in total.

4d Italy

General Energy Reduction

- (No data available)

Solar

- Capital subsidy up to 70% are available at the regional level.
- Tax incentive of 40% provided over 10 years.
- Green certificates for systems >50kWp (~ 0,07 € to 0.084/kWh during 8 years)
- Net metering for systems <20kWp. Cost of electricity goes up to 0,20 €.
- Accelerated depreciation over 5 years.
- In the 4th quarter of 2004, a feed in tariff system will be implemented that guarantees the payback of the investment and the maintenance cost. The proposal of the Italian PV association is 0,95 €/kWh over 10 years.

4e Spain

General Energy Reduction

- The government strategy to promote increased use of renewables rests on two main approaches: favorable buy-back rates for electricity produced from facilities under 100 MW, and financial support via capital subsidies and loans for third party financing under the **PAEE** plan.

Solar

- There is a feed-in tariff of €0,4/kWh for systems < 5kWP and €0,21/kWh for systems > 5kWP.
- Solar installations qualify for a 10% tax deduction.
- Capital subsidies of 40-80% of installation costs are available at a regional level.
- Low interest loan for 89% of PV system cost, plus a 19% capital subsidy from **IDEA (Institute for Energy Diversification and Conservation)** is available at a national level.
- Output credits highest for wind, solar plants: 11.48 Ptas/kWh over a 5-year period.
- New regulations in some municipalities require the use of solar thermal in new buildings; Barcelona requires new buildings to use solar thermal if their daily hot water consumption exceeds 2.500 litres at 45ºC. Pamplona, Madrid, Seville, and Valencia have announced they will follow Barcelona's example.