Part L–NZEB & Major Renovations
and
Part F-Ventilation

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Outline

• EPBD Requirements
• Dwellings
  – Part L Dwellings
    • NZEB
    • Major Renovations to cost Optimal
  – Part F
• Buildings other than Dwellings
  • NZEB
  • Major Renovations to cost Optimal
• Next Steps
Energy Performance of Buildings Directive (EPBD) NZEB and Major Renovations

• Article 9
  Member states to ensure that all new buildings are “Nearly Zero Energy Buildings” by 31st Dec 2020

• Article 7
  Major Renovations to be at Cost Optimal Level in Building Codes
‘nearly zero-energy building’ means a building that has a very high energy performance, as determined in accordance with Annex I. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby;

‘major renovation’ means the renovation of a building where more than 25 % of the surface of the building envelope undergoes renovation;
Implementation of NZEB-Dwellings

• SI 4 of 2017 amended Building Regulations to include the definition of NZEB on 17th Jan 2017

• TGD L 2011-Dwellings has been amended to include numerical indicators for NZEB Dwellings on the 22nd Feb 2017. The numerical indicators provide MPEPC of 0.30 and MPCPC of 0.35 for dwellings.

• A full review of Part L for NZEB Dwellings in 1H 2018 to apply from early 2019
Achieving compliance with 2018 Draft L Dwellings

**Overall Compliance**
Sect. 1.1 calculation in DEAP by achieving MPEPC (0.3) and MPCPC(0.35) (equivalent to 70% Reduction on 2005)

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**Minimum Threshold Level Compliance**
TGD L Sections:
- **1.2 Renewable Energy Ratio** =0.20
- **1.3 Building Fabric**
  - U-Values (Backstops)
  - Thermal Bridging ACDs
  - Air Tightness 5m3/hr/m2
- **1.4 Building Services**
  - Boiler Efficiency 90%
  - Space Heating Controls (zoning and time control)
  - Insulation
  - Mechanical Ventilation
  - System Efficiency
- **1.5 Construction Quality and Commissioning**
- **1.6 User Information**

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N.B. Check Overall compliance Prior to Commencement
Overview of key changes to TGD L Dwellings 2018

- Introduction of NZEB, MPEPC=0.30, MPCPC=0.35
- Introduction of Major Renovations to a cost optimal level where technically, economically and functionally feasible.
- Introduction of a Renewable Energy Ratio (RER) of 20% as per ISO EN 52000 (to replace 10kWh/m²/yr).
- Reduction of air tightness backstop from 7m³/hr/m² to 5m³/hr/m²
- Table 1 - Reduction of wall backstop UV from 0.21W/m²K to 0.18 W/m²K
- Table 1 - Reduction of window backstop UV from 1.6 W/m²K to 1.4 W/m²K
- Inclusion of guidance to avoid overheating in dwellings
- Par 1.3.2.5 –removal of variation of U Value with percentage glazing
Overview of key changes to TGD F 2018

• Mechanical Ventilation guidance for AP $\leq 3m^3/hr/m^2$
• Guidance provided for Continuous Mechanical Extract Ventilation
• Introduction of certification of ventilation systems installation
• New examples for apartments
• Installation and Commissioning guide for Ventilation systems
Main changes TGD L Appendix E –Semi Detached Example 2011 vs 2018

• In gas boiler example PV increases from 7.9m$^2$ to 8.63m$^2$
• Double glazing of 1.4 W/m$^2$K changes to Triple Glazing 0.9 W/M2k
• LED lighting accounted for in DEAP
• Efficient hot water use in showers/taps accounted for in DEAP
• Additional examples added for heat pumps and apartments
• Mechanical ventilation included in examples
<table>
<thead>
<tr>
<th></th>
<th>TGD L 2011 Dwelling heated by mains gas</th>
<th>TGD L 2018 Dwelling heated by mains gas</th>
<th>TGD L 2018 Dwelling heated by heat pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary energy [kWh/m²/yr]</td>
<td>56</td>
<td>43</td>
<td>42</td>
</tr>
<tr>
<td>CO2 emissions [kg/m²/yr]</td>
<td>10</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>EPC</td>
<td>0.40</td>
<td>0.30</td>
<td>0.28</td>
</tr>
<tr>
<td>CPC</td>
<td>0.37</td>
<td>0.28</td>
<td>0.24</td>
</tr>
<tr>
<td>Renewable Energy Ratio (RER)</td>
<td>0.18</td>
<td>0.24</td>
<td>0.35</td>
</tr>
</tbody>
</table>
TGD L 2018-Dwellings Major Renovations

- Where more than 25% of the surface of the building envelope undergoes renovation the energy performance of the building or the renovated part thereof is upgraded in order to meet minimum energy performance requirements with a view to achieving a cost optimal level in so far as this is technically, functionally and economically feasible.

- The cost optimal performance level to be achieved is 125 kWh/m$^2$/yr when calculated in DEAP.

- Alternatively,

Table 6 Cost Optimal Works activated by Major Renovation

<table>
<thead>
<tr>
<th>Major Renovation &gt; 25% surface area$^{1,2,3}$</th>
<th>Works to bring dwelling to cost optimal level</th>
</tr>
</thead>
<tbody>
<tr>
<td>External wall renovation</td>
<td>a. Insulation at ceiling with U Values less than Table 5,</td>
</tr>
<tr>
<td></td>
<td>b. Oil or gas boiler replacement &amp; Controls Upgrade where the oil or gas boiler is more than 15 years old and efficiency less than 86%</td>
</tr>
<tr>
<td></td>
<td>c. Replacement of electric storage heating systems where more than 15 years and with heat retention not less than 45% measured according to IS EN 60531.</td>
</tr>
</tbody>
</table>

$^1$Where works are planned as a single project.
$^2$ Where major renovations to walls, roofs and ground floors constitute essential repairs e.g. repair or renewal of works due to fire, storm or flood damage or as a result of a material defect e.g. reactive pyrite in sub-floor hardcore, it is not considered economically feasible to bring these renovations to a cost optimal level.
$^3$ Major Renovation of external wall elements should also meet the requirements of Table 5.
Draft Transitional Arrangements

- TGD L Dwellings to apply to new Dwellings commencing construction from 1\(^{st}\) April 2019 subject to transition.

- Transitional arrangements to allow TGD L 2011-Dwellings to be used where planning permission has been applied for prior to the application date of 1\(^{st}\) April 2019 and substantial completion is completed within 1 year ie by 31\(^{st}\) March 2020

“Substantial work has been completed” means that the structure of the external walls has been erected.
Regulatory Impact Assessment - Costs

- Uplift costed across 5 dwelling types using different combinations of fabric, services and renewables

- The average uplift in cost across all dwelling types modelled was 1.9% over current construction costs depending on the dwelling archetype and design specification applied

- The range of uplift was 0.7% to 4.2%.
Overheating risk

• CIBSE TM59 was used to assess the risk of overheating. It is a new methodology specifically developed to assess the risk of overheating in residential buildings. It is based on the use of thermal modelling; IES Virtual Environment software was used for this evaluation.

• An overheating assessment was undertaken on 5 building types

• All dwellings passed with some mitigation required (reduced solar transmittance, appropriate use of blinds).

• New guidance in TGD L to avoid overheating
High Rise apartment blocks

• Multiple storey apartment blocks modelled

• Photovoltaics with gas boiler viable up to 12 floors

• Heat pumps viable for all heights

Passive House Tower – New York - 27 Floors
Training/Skills

• Waterford Wexford Educational Training Board are developing NZEB vocational add on qualifications for existing crafts persons (awareness, blocklayers, carpenters, foremen, plasterers, plumbers, electrician) to be available for delivery nationally by ETBs for 2018.

• Government policy has supported the upskilling of professionals through Springboard funding of DIT Postgraduate Certificate in Digital Analysis and Energy Retrofit course to date.

• CPD delivered by professional bodies (eg. EI, RIAI, SCS, CIBSE, CIF, ACEI, IGBC)

• DEAP updates to be facilitated by SEAI

• Qualibuild has developed a curriculum for crafts and trained 80 trainers

• SOLAS training schemes for air tightness and thermal bridging onsite skills

• Advanced engineering and architectural qualifications available through 3rd Level Institutes.

• NSAI Certification schemes (Thermal Bridging, Air Tightness, Window Energy Performance, EWI, CWI, WEPS)

Public Consultation-Closes Fri. 8th June

Documents

- Draft Part L Amendment Regulations 2018 (95.74 KB)
- Technical Guidance Document L - Dwellings 2018 - for Public Consultation (2.14 MB)
- Draft Part F Amendment Regulations 2018 (91.95 KB)
- Technical Guidance Document F - Ventilation 2018 - for Public Consultation (1.29 MB)
- Installation and Commissioning of Ventilation Systems for Dwellings Achieving Compliance with Part F (697.8 KB)
- Proposed Changes to the Dwelling Energy Assessment Procedure (DEAP) Methodology for Part L 2018 - Public Consultation (589.98 KB)
- Regulatory Impact Analysis (RIA) - Proposed Amendments to Part L and Part F - Public Consultation (672.67 KB)
- Calculations for Part L 2018 - Technical Guidance Document: Dwellings (739.25 KB)

- Template for Submissions - Part L Dwellings 2018 (13.49 KB)
- Template for Submissions - Part F Ventilation 2018 (9.32 KB)
- Template for Submissions - Dwelling Energy Assessment Procedure (DEAP) Methodology for Part L 2018 (9.29 KB)
- Template for Comments - Installation and Commissioning of Ventilation Systems for Dwellings 2018 (13.56 KB)
- Dwelling Energy Assessment Procedure (DEAP) - 4.1 Draft Public Consultation Example A E1.1 (264.31 KB)
- Dwelling Energy Assessment Procedure (DEAP) - 4.1 Draft Public Consultation Example B E1.2 (264.14 KB)
- Dwelling Energy Assessment Procedure (DEAP) - 4.1 Draft Public Consultation Example C E1.3 (264.32 KB)
- Dwelling Energy Assessment Procedure (DEAP) - 4.1 Draft Public Consultation Example D E1.4 (264.16 KB)
- Dwelling Energy Assessment Procedure (DEAP) - 4.1 Draft Public Consultation Example E E1.5 (264.91 KB)
- Dwelling Energy Assessment Procedure (DEAP) - 4.1 Draft Public Consultation Example F E1.6 (264.15 KB)
Next steps-Part L Dwellings

• NZEB and Major Renovation & DEAP for Public Consultation – Closing 8th June 2018

• Publication of Part L and TGD L Dwellings-July 2018

• Publication of DEAP-Sept. 2018

• Proposed Application to new dwellings commencing – 1st April 2019 with 1 year transition arrangements
Part L and TGD L 2017
NZEB-Buildings other than Dwellings

OPW Leeson Lane

Forensic Labs

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Implementation of EPBD-Part L Buildings other than Dwellings

- TGD L Buildings other than Dwellings 2017 has been reviewed to provide detailed NZEB guidance and include Major Renovations performance requirement:
  
  Published - Dec 2017
  Application - 1\textsuperscript{st} Jan 2019 (subject to transition)

- NZEB Interim Specification for Public Buildings issued 23\textsuperscript{rd} Dec 2016 for buildings commencing design in early 2017

- Extensive Consultation with Stakeholders:
  - OPW, DES, HSE, SEAI, Construction Industry Council (RIAi, SCS, EI, ACEI, CIF), CIBSE, IGBC, IBEC
  - Multiple industry workshops to approximately 1500 professionals
Transitional Arrangements-Part L- Buildings other than Dwellings

- TGD L 2017 applies to works, or buildings in which a material alteration or change of use or major renovation takes place, where the work, material alteration or the change of use commences or takes place, as the case may be, on or after 1st Jan 2019.


- TGD L 2008 may continue to be used in the case of buildings:
  - where the work, material alteration or the change of use commences or takes place, as the case may be, on or before 31st December 2018, or
  - where planning approval or permission for buildings has been applied for on or before 31st Dec 2018, and substantial work has been completed by 1st Jan 2020

- “Substantial work has been completed” means that the structure of the external walls has been erected.
Key Components of performance requirement
TGD L Buildings other than Dwellings

• Provides an improvement in performance in the order of 60% over 2008 TGD L

• Improved Fabric Specification

• Advanced Services and Lighting specification

• Renewable Energy Ratio of 20% with flexibility of 10%

• Major Renovations
Achieving compliance with 2017 Part L Buildings other than Dwellings

Overall Compliance
Sect. 1.1 calculation in NEAP by achieving MPEPC (1.0) and MPCPC(1.15) (equivalent to 60% Reduction)

Minimum Threshold Level Compliance
TGD L Sections:
- 1.2 Renewable Energy
  - RER=0.20
- 1.3 Building Fabric
  - U-Values (Backstops)
  - Thermal Bridging ACDs
  - Air Tightness $5m^3/hr/m^2$
  - Limiting Solar gains
- 1.4 Building Services
  - Cooling system efficiency
  - Boiler Efficiency
  - Space Heating & Cooling Controls
  - Lighting
  - Mechanical Ventilation System Efficiency
- 1.5 Construction Quality and Commissioning
- 1.6 User Information

N.B. Check Overall compliance Prior to Commencement

Compliance with Part L Buildings other than Dwellings
Whole Building Compliance in NEAP

Reference building,
Same shape and size as actual.
Advanced fabric, efficient services & 20% Renewables

Actual building,
Same shape and size.
Advanced fabric, efficient services
20% Renewables

Compliance in NEAP
MPEPC = Proposed Primary Energy Use/Reference Prim. Energy Use ≤ 1.0
MPCPC = Proposed Carbon Emissions/Reference Carbon Emissions ≤ 1.15
RER > 0.20

An Roinn Tithíochta,
Pleanála agus Rialtais Áitiúil
Department of Housing,
Planning and Local Government
## Performance requirements for Buildings other than Dwellings

### Specification - Reference Building: Fabric

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Reference values-TGD L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Floor Area and Building Volume</td>
<td>Same as actual building</td>
</tr>
<tr>
<td>Opening Areas</td>
<td>Offices and Shops – windows and pedestrian doors are 40% of the total area of exposed walls</td>
</tr>
<tr>
<td>Walls</td>
<td>$U=0.18 \text{ W/m}^2\text{K}$</td>
</tr>
<tr>
<td>Roofs</td>
<td>$U=0.15 \text{ W/m}^2\text{K}$</td>
</tr>
<tr>
<td>Floor</td>
<td>$U=0.15 \text{ W/m}^2\text{K}$</td>
</tr>
<tr>
<td>Thermal bridging</td>
<td>Actual Length of Key Junctions x Advanced psi value</td>
</tr>
<tr>
<td>Air Permeability</td>
<td>$5\text{m}^3/(\text{hr.m}^2)$ Floor area $\leq 250\text{m}^2$</td>
</tr>
<tr>
<td>Window U Value</td>
<td>$3\text{m}^3/(\text{hr.m}^2)$ Floor area $&gt; 250\text{m}^2$</td>
</tr>
<tr>
<td>Solar energy transmittance</td>
<td>$1.4 \text{ W/(m}^2\text{K)}$</td>
</tr>
<tr>
<td></td>
<td>0.40 hold for $10%$</td>
</tr>
</tbody>
</table>
## Services

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Proposed reference values-TGD L 2017/Public Sector Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating efficiency (heating and hot water) %</td>
<td>91% Gas Boiler</td>
</tr>
<tr>
<td>Cooling Seasonal Energy Efficiency Air conditioned building Ratio (SEER)</td>
<td>SEER=4.5/SSEER=3.6</td>
</tr>
<tr>
<td>Lighting</td>
<td>65 lm/circuit watt</td>
</tr>
<tr>
<td>Occupancy Control</td>
<td>Automated</td>
</tr>
<tr>
<td>Daylight Control</td>
<td>Automated</td>
</tr>
<tr>
<td>Central Ventilation SFP</td>
<td>1.8 (W/(l/s))</td>
</tr>
<tr>
<td>Variable speed control of fans</td>
<td>Yes</td>
</tr>
<tr>
<td>Renewable Energy Ratio using PV</td>
<td>0.2</td>
</tr>
</tbody>
</table>
TGD L Buildings other than Dwellings - Renewable Energy Ratio (RER) from ISO 52000

• Renewables requirement will be included in TGD L Buildings other than Dwellings as the ISO 52000 Standard Renewable Energy Ratio (RER)- 20% with a flexibility of 10%.

\[
RER = \frac{E_{\text{Pren;RER}}}{E_{\text{Ptot}}}
\]

• Renewable Energy Ratio (RER) Flexibility
MPEPC=1, MPCPC=1.15, RER ≥ 0.2
MPEPC=0.9, MPCPC=1.04, RER ≥ 0.1
Minimum Threshold Backstop U-Values Par 1.3.2.5

<table>
<thead>
<tr>
<th>Column 1 Fabric Elements</th>
<th>Column 2 Area – weighted Average Elemental U-Value (Uₘ)</th>
<th>Column 3 Average Elemental U-value Individual element or section of element</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roofs²</td>
<td>0.16</td>
<td>0.3</td>
</tr>
<tr>
<td>Pitched roof</td>
<td>0.16</td>
<td></td>
</tr>
<tr>
<td>- Insulation at ceiling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Insulation on slope</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flat roof</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>Walls²</td>
<td>0.21</td>
<td>0.6</td>
</tr>
<tr>
<td>Ground Floors²</td>
<td>0.21</td>
<td>0.6</td>
</tr>
<tr>
<td>Other exposed floors²</td>
<td>0.21</td>
<td>0.6</td>
</tr>
<tr>
<td>External personnel doors, windows³ and rooflights⁶</td>
<td>1.6³</td>
<td>3.0</td>
</tr>
<tr>
<td>Curtain Walling</td>
<td>1.8</td>
<td>3.0</td>
</tr>
<tr>
<td>Vehicle access and similar large doors</td>
<td>1.5</td>
<td>3.0</td>
</tr>
<tr>
<td>High usage entrance door⁷</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Swimming Pool Basin⁶</td>
<td>0.25</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Notes:
Fabric

• Airtightness backstop $\leq 5\text{m}^3/\text{hr/m}^2$. Alternative approach for large buildings

• Testing by INAB or NSAI certifiers, to ISO EN 9972

• Solar gain reference case in NEAP is an east-facing façade with full width glazing to a height of 1.0m. having a framing factor of 10 per cent and a normal solar energy transmittance (g-value) of 0.68

• Overheating check in NEAP Software, detailed checks to use CIBSE TM52
Section 2: Existing Buildings

• Separate Sections
  – Extensions
  – Material Alterations
  – Material Change of Use
  – Major Renovations
Par 2.1.2.4
Material Change of use

- Separate U Value table created for change of use of buildings other than dwellings.

<table>
<thead>
<tr>
<th>Column 1 Fabric Elements</th>
<th>Column 2 Area-weighted Threshold Elemental U-Value ($U_i$)</th>
<th>Column 3 Area-weighted Average Elemental U-Value ($U_m$)</th>
<th>Column 4 Average Elemental U-value – individual element or section of element</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roofs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pitched roof</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Insulation at ceiling</td>
<td>0.16</td>
<td>0.16</td>
<td>0.35</td>
</tr>
<tr>
<td>- Insulation on slope</td>
<td>0.35</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>Flat roof</td>
<td>0.35</td>
<td>0.35</td>
<td></td>
</tr>
<tr>
<td>Walls</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CavityWall 50mm³</td>
<td>0.55</td>
<td>0.55</td>
<td>0.60</td>
</tr>
<tr>
<td>Other Walls</td>
<td>0.55</td>
<td>0.35</td>
<td></td>
</tr>
<tr>
<td>Curtain Walls (frame and centre panels)</td>
<td>3.0</td>
<td>1.8</td>
<td>3.0</td>
</tr>
<tr>
<td>Ground Floors</td>
<td>0.45</td>
<td>0.45&lt;sup&gt;4,5&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Other Exposed Floors</td>
<td>0.6</td>
<td>0.35</td>
<td>0.60</td>
</tr>
<tr>
<td>External doors, windows and rooflights</td>
<td>3.3</td>
<td>1.6&lt;sup&gt;2&lt;/sup&gt;</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Notes:
1. The U-value includes the effect of unheated voids or other spaces.
2. For material change of use, windows, doors and rooflights should have a maximum U-value of 1.6 W/m<sup>2</sup>K.
3. This only applies in the case of a wall suitable for the installation of cavity insulation. Where this is not the case it should be treated as for "other walls".
4. This U value only applies where floors are being replaced.
TGD L-Buildings other than Dwellings Major Renovations

• Where more than 25% of the surface area of the building envelope undergoes renovation the energy performance of the whole building should be improved to Cost Optimal level in so far as this is technically, functionally and economically feasible.

• Works to the surface area of the building include the following:
  - Cladding the external surface of the element
  - Drylining the internal surface of an element
  - Replacing windows
  - Stripping down the element to expose the basic structural components (brickwork/blockwork, timberframe steelframe, joists, rafters, purlins etc.) and then rebuilding to achieve all the necessary performance requirements
Major Renovations

• Upgrading oil, gas or biomass heating systems more than 15 years old and with an efficiency of less than that shown in Table 2;

• Upgrading controls for direct electric space heating systems to achieve the level of controls described in Table 5;

• Upgrading cooling and ventilation systems more than 15 years old and a cooling unit Seasonal Energy Efficiency Ratio less than that in the Eco-design Regulations referenced in par 1.4.3.11 and/or Specific Fan Power greater than that in Table 12 and by the provision of new plant; and

• Upgrading general lighting systems that are more than 15 years old or have an average lamp efficacy of less than 40 lamp-lumens per circuit-watt as defined in NEAP and that serves greater than 100m² to the guidance in section 2.2.7.
## Major Renovations-alternative

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Major Renovation Cost Optimal Performance kWh/m²/yr primary energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail Air Conditioned</td>
<td>338</td>
</tr>
<tr>
<td>Office Natural Ventilated offices and other Buildings</td>
<td>124</td>
</tr>
<tr>
<td>Office Air Conditioned</td>
<td>180</td>
</tr>
<tr>
<td>Hotel Air Conditioned</td>
<td>342</td>
</tr>
<tr>
<td>Schools</td>
<td>60</td>
</tr>
<tr>
<td>Other Air Conditioned Buildings</td>
<td>338</td>
</tr>
<tr>
<td>Other Naturally Ventilated Buildings</td>
<td>124</td>
</tr>
</tbody>
</table>
Regulatory Impact Assessment Uplift in costs-New Buildings other than Dwellings

- Offices: 2.0% to 2.4%
- AC Hotels: 4.6% to 5.4%
- AC Retail: 2.4% to 3%
- NV Mixed Use: 1.3% to 1.5%
### % Roof area for PV

#### Table 15b Summary of PV system required to meet a 10% renewable energy ratio

<table>
<thead>
<tr>
<th>Building type</th>
<th>Renewable Energy Ratio</th>
<th>PV panel capacity</th>
<th>PV panel area</th>
<th>Roof space required for PV</th>
<th>EPC and CPC Improvement to qualify for RER 10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office NV 2F, LMF - Ref</td>
<td>10%</td>
<td>5.8</td>
<td>41</td>
<td>11% 81</td>
<td>0.900</td>
</tr>
<tr>
<td>Office NV 2F, LMF - Opt1</td>
<td>10%</td>
<td>6.0</td>
<td>42</td>
<td>12% 84</td>
<td>0.317</td>
</tr>
<tr>
<td>Office NV 2F, LMF - Opt2</td>
<td>10%</td>
<td>9.3</td>
<td>65</td>
<td>18% 130</td>
<td>0.329</td>
</tr>
<tr>
<td>Office AC 2F, LMF - Ref</td>
<td>10%</td>
<td>9.5</td>
<td>66</td>
<td>18% 133</td>
<td>0.610</td>
</tr>
<tr>
<td>Office AC 2F, LMF - Opt1</td>
<td>10%</td>
<td>11.1</td>
<td>77</td>
<td>22% 155</td>
<td>0.281</td>
</tr>
<tr>
<td>Office AC 2F, LMF - Opt2</td>
<td>10%</td>
<td>11.3</td>
<td>79</td>
<td>22% 158</td>
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<td>Office NV 4F, MC - Opt1</td>
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<td>9% 119</td>
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<td>School - Primary NV, MC - Opt1</td>
<td>10%</td>
<td>8.6</td>
<td>60</td>
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<td>0.314</td>
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<tr>
<td>School - Secondary NV, MC - Ref</td>
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<tr>
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<td>10%</td>
<td>56.9</td>
<td>398</td>
<td>110% 796</td>
<td>0.314</td>
</tr>
<tr>
<td>Hotel AC, LMF - Ref</td>
<td>10%</td>
<td>56.4</td>
<td>395</td>
<td>109% 790</td>
<td>0.311</td>
</tr>
<tr>
<td>Hotel AC, LMF - Opt1</td>
<td>10%</td>
<td>56.9</td>
<td>398</td>
<td>110% 796</td>
<td>0.314</td>
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<tr>
<td>Retail AC, LMF - Ref</td>
<td>10%</td>
<td>14.2</td>
<td>100</td>
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<td>0.313</td>
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<tr>
<td>Retail AC, LMF - Opt1</td>
<td>10%</td>
<td>14.4</td>
<td>101</td>
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</tr>
<tr>
<td>Mixed-use NV, LMF - Ref</td>
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<td>65</td>
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<tr>
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<td>9.3</td>
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#### Diagram

- Light plant room
- Laundry
- Performance area
- Laboratory
- Light plant room
- Small Shop Unit
- Post Mortem Facility
- Physiotherapy Studio
- Laboratory
- Laboratory
- Food preparation
- Food preparation
- Fitness suite/gym
- Performance area
- Performance area
- Heavy Plant Room
- Dept Store Sales
- Retail Warehouse
Next steps-NEAP

- NEAP Publication

- Cap placed on HVAC process loads for RER calculation

- New schedule for treatment rooms in healthcare

- New schedules for schools

- Primary Energy Factor is 1.94 and for CO2 emissions is 0.323.