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| **Energy Modelling Form**  **(Finalisation of Building Design)** | | |
| Green Mark Department  Building & Construction Authority  52 Jurong Gateway Road #11-01  Singapore 608550 | INSTRUCTIONS:   1. Please refer to the Explanatory Notes attached before completing the form. 2. Use a separate set of forms for each building. 3. \*Delete accordingly | |
| Project Ref. No.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |  |  |  |  | - |  |  |  |  |  | - |  |  |  |  | - | B | P |  |  |   Description of Building / Building Works:   |  | | --- | |  |  |  |  |  |  | | --- | --- | --- | --- | | \*Lot / Plot |  | \*TS / MK |  |   Address / Road:   |  | | --- | |  | | | |
| (1) As the Qualified Persons responsible for the design of M&E services for the above-mentioned project, we declare that:   1. the energy modelling conducted for the project is in accordance with the requirements of BCA’s Framework for Energy Modelling and 2. based on the results of the energy modelling, the Proposed Model is expected to achieve a saving of \_\_\_\_% in annual energy consumption compared to the Reference Model. | | |
| (2) We attach the following documentations to support the above declaration:   1. Summary of Space and ETTV of the Building Envelope 2. Comparison of Reference Model versus Proposed Model 3. Summary of Energy by End Use including Efficiency Indicators for both models 4. Summary printouts of energy modelling software | | |
| (1) Name, Signature & Membership Number of Green Mark Advanced Accredited Professional (GM AAP) | | (2) Name & Signature of Qualified Person (Mechanical PE) |
| Name, Address, Email and Tel of Energy Modelling Firm for the project | | (3) Name & Signature of Qualified Person (Electrical PE) |

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| **(A) Space Summary** | | | |
| **Building Use** | **Air-Conditioned Area (m2)** | **Non-Air-Conditioned Area (m2)** | **Total Area (m2)** |
| Office |  |  |  |
| Retail |  |  |  |
| F&B areas |  |  |  |
| M&E Areas |  |  |  |
| Storage |  |  |  |
| Carpark |  |  |  |
| Atrium |  |  |  |
| Corridors |  |  |  |
| Lobbies |  |  |  |
| Staircases |  |  |  |
| Toilets |  |  |  |
| Others |  |  |  |
| Total |  |  |  |
| Note: The building use floor areas for both the Reference and Proposed Models must be the same. | | | |

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| **(B) Building Envelope Summary – ETTV** | | | |
| **Orientation of Façade** | **Gross Area of External Walls and Windows (m2)** | **Reference Model**  **ETTV (W/m2)** | **Proposed Model**  **ETTV (W/m2)** |
| North |  |  |  |
| East |  |  |  |
| South |  |  |  |
| West |  |  |  |
| Average ETTV (W/m2) |  | 45 W/m2 |  |

| **(C) Comparison of Reference Model versus Proposed Model** | | |
| --- | --- | --- |
| **Building Element** | **Reference Model** | **Proposed Model** |
| **Building Envelope** | | |
| Wall Construction |  |  |
| Opaque Doors |  |  |
| Windows |  |  |
| Floor |  |  |
| Roof |  |  |
| Skylight |  |  |
| Window to Wall Ratio (WWR) |  |  |
| Others |  |  |
| **Electrical Systems** | | |
| Lighting Power Density (W/m2) |  |  |
| Lighting Occupant Sensor Controls |  |  |
| Lighting Daylighting Controls |  |  |
| Receptacle Power (W/m2) |  |  |
| Lifts & Escalators |  |  |
| Others |  |  |
| *Note: The Receptacle Loads for both the Reference and Proposed Models must be the same.* | | |
| **Renewable Energy Systems** | | |
| Photovoltaics (On-site) (kWp) |  |  |
| Renewable Energy Certificate (REC) (MWh/year) |  |  |
| *Note: To include a description of renewable energy systems used to reduce Proposed Model energy consumption.* | | |
| **Schedules** | | |
| Occupancy, Lighting & Equipment |  |  |
| ACMV |  |  |
| *Note: The occupancy rates and operating schedules for both the Reference and Proposed Models must be the same.* | | |
| **Mechanical & Plumbing Systems** | | |
| **ACMV System Type** |  |  |
| AHU Fan Properties |  |  |
| PAU Fan Properties |  |  |
| FCU Fan Properties |  |  |
| Boiler Efficiency |  |  |
| Central Plant Efficiency (kW/ton) |  |  |
| Air Distribution Efficiency (kW/ton) |  |  |
| *Note: Central plant efficiencies and capacities for chillers and cooling towers should be listed whenever the central plant is included as part of the energy model.* | | |
| ACMV Circulation Loop Properties |  |  |
| Domestic Water System |  |  |
| Mechanical Ventilation Fans |  |  |
| **Others** | | |
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Description of differences between the Reference Model and Proposed Model not documented on other forms:

Not Applicable Attached

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| **(D1) Summary of Energy by End Use - General** | | | |
| **End Use** | **Reference Model**  **Energy Consumption**  **(MWh)** | **Proposed Model**  **Energy Consumption**  **(MWh)** | **Energy Consumption Savings (D1)**  **(%)** |
| Lighting – (Air-Conditioned Space) |  |  |  |
| Lighting – (Non-Air-Conditioned Space) |  |  |  |
| External Landscape and Façade Lighting |  |  |  |
| Chillers |  |  |  |
| Chilled Water and Condenser Water Pumps |  |  |  |
| Cooling Towers |  |  |  |
| Airside System (Air- Conditioning Fans) |  |  |  |
| Mechanical Ventilation Fans |  |  |  |
| Lifts |  |  |  |
| Escalators |  |  |  |
| Receptacle Loads |  |  |  |
| Domestic Water Systems |  |  |  |
| Car Park (Lighting) |  |  |  |
| Car Park (Air System Fan) |  |  |  |
| Others |  |  |  |
| **Sum of Building Energy Consumption** |  |  |  |

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| **(D2) Renewable Energy Sources (RE) and Passive Design Enhancement (PDE)** | |
| **Feature** | **Energy Reduction (D2)**  **(MWh/year)** |
| Passive Design Enhancement |  |
| Photovoltaics (On-site) |  |
| Other Renewable Energy Sources |  |
| **Total (RE/PV (on-site) + PDE)** |  |

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| **(D3): (D1) - (D2)** | | | | |
| **End Use** | **Reference Model**  **Energy Consumption**  **(MWh)** | **Proposed Model**  **Energy Consumption**  **(MWh)** | | **Energy Consumption Savings (D3)**  **(%)** |
| **Total Building Energy Consumption (include (D2)** |  |  | |  |
| **(E) Efficiency Indicators** | **Result (kWh/m2/yr)** | | | |
| **Reference Model** | | **Proposed Model** | |
| Energy Use Intensity, EUI (D1) (kWh/m2/yr) |  | |  | |
| Energy Use Intensity, EUI (D3) (kWh/m2/yr) |  | |  | |
| Internal Lighting (W/m2) |  | |  | |
| External Lighting (W/m2) |  | |  | |
| Air-Conditioning Plant Efficiency (kW/RT) |  | |  | |
| Airside System Efficiency (kW/RT) |  | |  | |
| Air-Conditioning System Total System Efficiency (AC TSE) (kW/RT) |  | |  | |

This form will be accompanied by energy modeling report which includes the following:

1. Project Brief
2. Images of the model (if applicable)
3. Energy saving results
4. Performance of A/C systems (Cooling load vs time, A/C efficiency vs time)
5. Assumptions
6. Limitation of modeling and rectifications
7. Print screen from the modeling
8. Summary of energy modeling results
9. Recommendations (if any)

**Checklist of the energy modelling simulation inputs and results (by Energy Modeller)**

This checklist allows the Energy Modeller to gather information on the results from the energy simulations, ensure consistency, evaluate energy efficiency features and energy improvement targets.

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| **Description** | | **Checks done on Reference and Proposed Model (Yes/No)** |
| 1. Overview | 1. Verify the key performance indicators (KPI)    1. EUI (kWh/m2/yr)    2. Cooling load intensity (W/m2)    3. AC TSE (kW/RT) | Yes  No |
| 1. Input Checks (for both proposed and reference model) | 1. General Setting    1. Weather (Singapore)    2. Elevation    3. Orientation    4. Area summary (discrepancies within 5%) 2. Façade    1. Select at least 3 areas to verify façade selection    2. Construction    3. SC value of glass and U-Value of walls and windows (with reference to BCA ETTV guideline) 3. Thermal Zoning (oversizing is not appliable to reference model) 4. ACMV design    1. Typical space W/m2 and whole building W/m2    2. Cooling load and profile  * Oversizing is not appliable to reference model. * Total reference equipment cooling load size = peak cooling load. * Reference model to include smaller chiller(s) to cater for lower load operation where necessary.   1. Cooling system  1. Compressor (e.g. chiller if applicable) 2. Condenser (e.g. cooling tower if applicable) 3. Pumps (if applicable) 4. Overall and individual efficiency (kW/RT)    1. Air distribution (fan coil – oversizing factor of 15% is applicable to reference model. Fan power - oversizing is not appliable to reference model)    2. Individual W/CMH    3. Typical CMH/m3 and whole building CMH/m3    4. Overall air distribution kW/RT    5. Overall – Provide unmet hours (shall not exceed 300 unmet hours) 5. Lighting 6. Receptacle load 7. MV fans 8. Schedule and diversity (including non-A/C areas like car park) 9. Energy saving items, e.g heat recovery 10. Non-modelled items by alternative calculation | Yes  No |
| 1. Output checks | 1. Indoor thermal parameters for three typical indoor spaces 2. Daily, weekly, and monthly building cooling load 3. Energy breakdown proportion | Yes  No |
| 1. Consistency checks | 1. Proposed model and reference model consistency 2. Input data and output data consistency 3. Assumption verification 4. Exception calculation method | Yes  No |

**EXPLANATORY NOTES – SUBMISSION FORM FOR ENERGY MODELLING**

The QP and the appropriate practitioners shall ensure the following documents and records are available as evidence to demonstrate compliance with the energy modelling framework and validation of the potential energy savings during final assessment. The energy modelling submission shall be accompanied by the following:

1. Certification showing that the simulation software is tested and meet the criteria in accordance with the ANSI/ASHRAE Standard 140.
2. Detailed drawings and other necessary information of proposed design.
3. Detailed system design calculation.
4. Summary of Space and Envelope Thermal Transfer Value (ETTV) of the Building Envelope as in Form: Energy Modelling Form (Finalisation of Building Design).
5. List of data such as:

* Space input data for all zones comprising detail information on construction materials and their properties designed for each individual zone. For example, room area, walls, windows, doors, floors, partitions, sensible and latent loads (lightings, occupancy rates, receptacles load, outdoor ventilation rates, misc. loads etc.). Schedules for each individual operating zone (e.g., lighting, occupants, mechanical fans, AHUs, other mechanical and electrical equipment, etc.).
* Executable input data files used in the generation of the energy estimates for the Proposed and Reference Models.
* Output data on the monthly energy consumption by mechanical and electrical system components (e.g. Air-conditioned systems, Lighting Systems, Receptacle Equipment, Lifts, Escalators etc.).
* One year simulated hourly cooling load data in the form of the Frequency vs Cooling Load (RT) plot, Cooling Load vs Time, A/C efficiency vs Time.
* Detailed computation of the ETTV for both Reference and Proposed Models.
* Comparison of Reference Model versus Proposed Model as in Form: Energy Modelling Form (Finalisation of Building Design).
* Summary of Energy of End Use including Efficiency Indicators for both Reference and Proposed Models as in Form: Energy Modelling Form (Finalisation of Building Design).
* Summary printouts of energy modelling software for the Reference and Proposed Models including summary of weather data results Monthly energy consumption of mechanical and electrical system components such as air-conditioned system, lighting systems, receptacle equipment’s, lift and escalator etc.
* Assumptions and limitations in modelling with rectifications

1. Executable file of the EM simulation for both the Proposed and Reference Models
2. Recommendations (if any)