# Dataset on the energy performance of atrium type hotel buildings

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## ARTICLE INFO

## ABSTRACT

The data presented in this article are related to the research article entitled "The Influence of Atrium on Energy Performance of Hotel Building" (Vujosevic and Krstic-Furundzic, 2017) [1], which describes the annual energy performance of atrium type hotel building in Belgrade climate conditions, with the objective to present the impact of the atrium on the hotel building's energy demands for space heating and cooling. This dataset is made publicly available to show energy performance of selected hotel design alternatives, in order to enable extended analyzes of these data for other researchers.

## Specifications Table

| | |
|---|---|
| Subject area | Architecture, Energy Efficiency |
| More specific subject area | Heating and cooling demands of atrium type hotel buildings |
| Type of data | Tables, figures, text file |
| How data was acquired | Building energy modeling in OpenStudio software Computer simulation using EnergyPlus software |

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| Data format | *Raw* |
| --- | --- |
| Experimental factors | *The four hypothetical model alternatives of atrium type hotel building, and four orientations of one model alternative, were examined and compared in order to find the most energy efficient solution* |
| Experimental features | *The optimal hotel design alternative were determined* |
| Data source location | *Belgrade, Serbia, 44.7866°N, 20.4489°E* |
| Data accessibility | *Data are available with this article* |
| Related research article | *M. Vujosevic, A. Krstic-Furundzic, The influence of atrium on energy performance of hotel building, Energy Build. (156), 2017, 140–150 (Elsevier)* |

**Value of the data**

- The detailed thermal loading data provided for design alternatives of atrium type hotel buildings in Belgrade would give designers a better understanding of hotel energy demands.
- The building energy modeling and simulation is performed using EnergyPlus simulation software, and could be compared to other studies that used different simulation techniques.
- The data presented in this article could be used for analyzing the facilities located in the climatic conditions similar to Belgrade climate.
- Atrium design alternatives could be used as a basis for further research and development of hotel building envelopes.

## 1. Data

The data in this article present input data and schedules for the building energy simulation of design alternatives of atrium type hotel building (presented in Table 1), and detailed overview of all simulation results for each alternative and each thermal zone (presented in Tables 2–8).

## 2. Experimental design, materials and methods

The created hypothetical model is "U" shaped building, with rooms surrounding a central courtyard from three sides. Following alternatives are subject to the numerical simulations, which give an insight of their energy performances: the building with an open inner courtyard - without the atrium, the building with glazed atrium – the basic atrium type building, the building with glazed atrium and enhanced natural ventilation in atrium during summer, and the building with atrium equipped with shading devices. All alternatives were simulated with southwest oriented atrium. The basic atrium type building is also simulated in three other orientations (southeast, northwest and northeast atrium orientation).

The research method includes the creation of a hypothetical model for the analysis, design of alternatives, application of numerical simulations using computer software, and comparative analyses of the selected results. The building energy simulation is carried out by OpenStudio SketchUp PlugIn – an interface that integrates with EnergyPlus simulation engine. Certain parameters in the particular model are changed (for example building orientation, enhanced infiltration, shading system) so that the observation of how the changes influence energy performance of the building could be conducted.

**Table 1**
Large hotel hourly operation schedules (work day – WD, Saturday – Sat, Sunday – Sun).Source: [2] Deru et al. (2011). Commercial Reference Building Models of the National Building Stock.

| Schedule | | Day | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Always on | | All | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Hotel Building | Equipment | WD | 0.3 | 0.25 | 0.2 | 0.2 | 0.2 | 0.3 | 0.5 | 0.6 | 0.2 | 0. | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.7 | 0.9 | 0.95 | 0.9 | 0.7 | 0.4 |
| | | Sat | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.4 | 0.4 | 0.5 | 0.5 | 0.4 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.7 | 0.8 | 0.8 | 0.8 | 0.7 | 0.4 |
| | | Sun | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.6 | 0.8 | 0.9 | 0.7 | 0.6 | 0.4 |
| | Lighting | WD | 0.2 | 0.15 | 0.1 | 0.1 | 0.1 | 0.2 | 0.4 | 0.5 | 0.4 | 0.4 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.6 | 0.8 | 0.9 | 0.8 | 0.6 | 0.3 |
| | | Sat | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 | 0.3 | 0.4 | 0.4 | 0.3 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.6 | 0.7 | 0.7 | 0.7 | 0.6 | 0.3 | 0.2 |
| | | Sun | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.5 | 0.7 | 0.8 | 0.6 | 0.5 | 0.3 | 0.3 |
| | Occupancy | WD | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.7 | 0.4 | 0.4 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.5 | 0.5 | 0.5 | 0.7 | 0.7 | 0.8 | 0.9 | 0.9 |
| | | Sat | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.7 | 0.5 | 0.5 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.5 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 |
| | | Sun | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.5 | 0.5 | 0.5 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.6 | 0.6 | 0.8 | 0.8 | 0.8 |
| Guest Room | Equipment | WD | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.62 | 0.9 | 0.43 | 0.43 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 | 0.51 | 0.51 | 0.49 | 0.66 | 0.7 | 0.35 | 0.2 |
| | | Sat. Sun | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.62 | 0.9 | 0.62 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 | 0.43 | 0.51 | 0.49 | 0.66 | 0.7 | 0.35 | 0.2 |
| | Lighting | WD | 0.22 | 0.17 | 0.11 | 0.11 | 0.11 | 0.22 | 0.44 | 0.56 | 0.44 | 0.44 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 | 0.67 | 0.89 | 1 | 0.89 | 0.67 | 0.33 |
| | | Sat. Sun | 0.26 | 0.26 | 0.11 | 0.11 | 0.11 | 0.11 | 0.41 | 0.41 | 0.56 | 0.56 | 0.41 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.85 | 1 | 1 | 1 | 0.85 | 0.41 |
| | Occupancy | WD | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.5 | 0.28 | 0.28 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.2 | 0.35 | 0.35 | 0.35 | 0.5 | 0.5 | 0.58 | 0.65 | 0.65 |
| | | Sat. Sun | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.65 | 0.5 | 0.34 | 0.34 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.34 | 0.35 | 0.65 | 0.65 | 0.5 | 0.5 | 0.5 |  |
| Loby | Occupancy | WD | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 | 0.7 | 0.7 | 0.7 | 0.7 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.4 | 0.4 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 |
| | | Sat. Sun | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 | 0.7 | 0.7 | 0.7 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 |
| Commercial area | Equipment | WD | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.9 | 0.9 | 0.9 | 0.9 | 0.8 | 0.9 | 0.9 | 0.9 | 0.9 | 0.8 | 0.6 | 0.6 | 0.5 | 0.5 | 0.4 | 0.4 |
| | | Sat | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.35 | 0.35 | 0.35 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| | | Sun | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lighting | WD | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.1 | 0.1 | 0.3 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.7 | 0.5 | 0.5 | 0.3 | 0.3 | 0.1 | 0.05 |
| | Sat | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.1 | 0.1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.15 | 0.15 | 0.15 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| | Sun | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Occupancy | WD | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.2 | 0.95 | 0.95 | 0.95 | 0.95 | 0.5 | 0.95 | 0.95 | 0.95 | 0.95 | 0.7 | 0.4 | 0.4 | 0.1 | 0.1 | 0.05 | 0.05 |
| | Sat | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.1 | 0.1 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Sun | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 2**
Detailed overview of energy performance parameters – Alternative 1.

Alternative 1: the building with an open inner courtyard - without the atrium

| Thermal zone | Area [m²] | Volume [m³] | HVAC Input Sensible Air Heating [GJ] | HVAC Input Sensible Air Cooling [GJ] | People Sensible Heat Addition [GJ] | Lights Sensible Heat Addition [GJ] | Equipment Sensible Heat Addition [GJ] | Window Heat Addition [GJ] | Infiltration Heat Addition [GJ] | Opaque Surface Conduction and Other Heat Addition [GJ] | Window Heat Removal [GJ] | Infiltration Heat Removal [GJ] | Opaque Surface Conduction and Other Heat Removal [GJ] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atrium | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Corridor story 1 | 115.52 | 589.15 | 17.715 | 0 | 0.940 | 6.162 | 0 | 6.249 | 0.386 | 2.907 | −6.788 | −27.572 | −0.001 |
| Corridor story 2 | 274.72 | 1401.07 | 48.499 | −1.691 | 2.127 | 14.655 | 0 | 61.375 | 0.161 | 0.002 | −49.356 | −71.701 | −4.069 |
| Corridor story 3 | 305.12 | 1141.15 | 31.506 | −2.171 | 2.302 | 16.277 | 0 | 48.642 | 0.119 | 0.057 | −35.5 | −61.232 | 0 |
| Corridor story 4 | 305.12 | 1141.15 | 30.516 | −3.277 | 2.27 | 16.277 | 0 | 55.124 | 0.113 | 0.005 | −36.044 | −62.715 | −2.264 |
| Corridor story 5 | 305.12 | 1141.15 | 29.371 | −4.544 | 2.242 | 16.277 | 0 | 61.763 | 0.107 | 0.002 | −36.586 | −64.096 | −4.534 |
| Corridor story 6 | 305.12 | 1141.15 | 27.847 | −6.258 | 2.211 | 16.277 | 0 | 70.916 | 0.103 | 0.001 | −37.031 | −65.589 | −8.476 |
| Corridor story 7 | 305.12 | 1141.15 | 32.033 | −8.722 | 2.199 | 16.277 | 0 | 83.551 | 0.102 | 0.001 | −36.769 | −66.032 | −22.638 |
| Commercial story 1 | 635.36 | 3240.34 | 49.815 | −111.950 | 147.180 | 93.052 | 33.897 | 145.174 | 2.741 | 0.005 | −78.031 | −200.900 | −80.978 |
| Office story 2 | 635.36 | 3240.34 | 88.175 | −89.275 | 24.055 | 71.465 | 62.973 | 116.572 | 2.705 | 0.005 | −56.561 | −191.832 | −28.277 |
| Room story 3 | 604.96 | 2262.55 | 61.288 | −73.252 | 21.466 | 70.997 | 51.636 | 70.468 | 1.873 | 0 | −33.952 | −142.096 | −28.428 |
| Room story 4 | 604.96 | 2262.55 | 59.546 | −74.558 | 21.431 | 70.997 | 51.636 | 70.955 | 1.854 | 0 | −34.108 | −142.706 | −25.047 |
| Room story 5 | 604.96 | 2262.55 | 59.190 | −75.889 | 21.408 | 70.997 | 51.636 | 71.250 | 1.836 | 0 | −34.219 | −143.206 | −23.002 |
| Room story 6 | 604.96 | 2262.55 | 59.429 | −77.111 | 21.398 | 70.997 | 51.636 | 71.474 | 1.818 | 0 | −34.289 | −143.57 | −21.782 |
| Room story 7 | 604.96 | 2262.55 | 75.395 | −76.623 | 21.523 | 70.997 | 51.636 | 71.954 | 1.804 | 0 | −33.749 | −142.601 | −40.338 |
| **Total Facility** | **6211.36** | **25489.39** | **670.325** | **−605.320** | **292.753** | **621.704** | **355.050** | **1005.466** | **15.723** | **2.985** | **−542.983** | **−1525.848** | **−289.834** |

**Table 3**

Detailed overview of energy performance parameters – Alternative 2.

Alternative 2: the building with glazed atrium – the basic atrium type building – southwest orientation 33

| Thermal zone | Area [m²] | Volume [m³] | HVAC Input Sensible Air Heating [GJ] | HVAC Input Sensible Air Cooling [GJ] | People Sensible Heat Addition [GJ] | Lights Sensible Heat Addition [GJ] | Equipment Sensible Heat Addition [GJ] | Window Heat Addition [GJ] | Infiltration Heat Addition [GJ] | Opaque Surface Conduction and Other Heat Addition [GJ] | Window Heat Removal [GJ] | Infiltration Heat Removal [GJ] | Opaque Surface Conduction and Other Heat Removal [GJ] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atrium | 693.12 | 16,242.21 | 602.187 | −350.912 | 157.727 | 81.378 | 40.044 | 1029.683 | 13.364 | 0.003 | −269.961 | −916.353 | −387.158 |
| Corridor story 1 | 115.52 | 589.15 | 9.790 | −0.008 | 0.907 | 6.165 | 0 | 0 | 0.204 | 12.552 | 0 | −29.610 | 0 |
| Corridor story 2 | 274.72 | 1401.07 | 11.398 | −5.511 | 2.003 | 14.661 | 0 | 0 | 0.130 | 58.074 | 0 | −80.756 | 0 |
| Corridor story 3 | 305.12 | 1141.15 | 7.542 | −4.603 | 2.201 | 16.284 | 0 | 6.131 | 0.104 | 42.090 | −2.699 | −67.048 | 0 |
| Corridor story 4 | 305.12 | 1141.15 | 7.566 | −5.037 | 2.195 | 16.284 | 0 | 6.164 | 0.102 | 42.850 | −2.706 | −67.417 | 0 |
| Corridor story 5 | 305.12 | 1141.15 | 7.594 | −5.439 | 2.190 | 16.284 | 0 | 6.182 | 0.101 | 43.575 | −2.713 | −67.771 | 0 |
| Corridor story 6 | 305.12 | 1141.15 | 7.687 | −5.765 | 2.186 | 16.284 | 0 | 6.193 | 0.099 | 44.060 | −2.717 | −68.027 | 0 |
| Corridor story 7 | 305.12 | 1141.15 | 10.558 | −5.269 | 2.204 | 16.284 | 0 | 6.233 | 0.098 | 39.720 | −2.673 | −67.155 | 0 |
| Commercial story 1 | 635.36 | 3240.34 | 37.238 | −113.076 | 145.808 | 93.092 | 33.897 | 115.598 | 2.741 | 0.003 | −59.318 | −203.750 | −52.228 |
| Office story 2 | 635.36 | 3240.34 | 82.538 | −92.006 | 23.939 | 71.465 | 62.973 | 116.067 | 2.705 | 0.005 | −57.234 | −193.410 | −17.037 |
| Room story 3 | 604.96 | 2262.55 | 56.340 | −74.786 | 21.368 | 71.028 | 51.636 | 70.257 | 1.870 | 0 | −34.277 | −143.061 | −20.376 |
| Room story 4 | 604.96 | 2262.55 | 54.962 | −74.806 | 21.351 | 71.028 | 51.636 | 70.789 | 1.852 | 0 | −34.380 | −143.517 | −18.913 |
| Room story 5 | 604.96 | 2262.55 | 55.016 | −75.036 | 21.349 | 71.028 | 51.636 | 71.130 | 1.834 | 0 | −34.427 | −143.817 | −18.713 |
| Room story 6 | 604.96 | 2262.55 | 55.832 | −74.971 | 21.365 | 71.028 | 51.636 | 71.413 | 1.817 | 0 | −34.418 | −143.940 | −19.762 |
| Room story 7 | 604.96 | 2262.55 | 72.243 | −73.285 | 21.518 | 71.028 | 51.636 | 71.953 | 1.803 | 0 | −33.791 | −142.708 | −40.398 |
| **Total Facility** | **6904.48** | **41,731.60** | **1078.492** | **−960.507** | **448.310** | **703.316** | **395.094** | **1647.792** | **28.824** | **282.932** | **−571.316** | **−2478.340** | **−574.585** |

**Table 4**
Detailed overview of energy performance parameters – Alternative 3.

| Alternative 3: the building with glazed atrium and enhanced natural ventilation in atrium during summer | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Thermal zone | Area [m²] | Volume [m³] | HVAC Input Sensible Air Heating [GJ] | HVAC Input Sensible Air Cooling [GJ] | People Sensible Heat Addition [GJ] | Lights Sensible Heat Addition [GJ] | Equipment Sensible Heat Addition [GJ] | Window Heat Addition [GJ] | Infiltration Heat Addition [GJ] | Opaque Surface Conduction and Other Heat Addition [GJ] | Window Heat Removal [GJ] | Infiltration Heat Removal [GJ] | Opaque Surface Conduction and Other Heat Removal [GJ] |
| Atrium | 693.12 | 16,242.21 | 630.526 | −296.785 | 162.664 | 81.378 | 40.044 | 1035.780 | 33.016 | 0.003 | −262.611 | −1074.802 | −349.211 |
| Corridor story 1 | 115.52 | 589.15 | 9.790 | −0.004 | 0.913 | 6.165 | 0 | 0 | 0.238 | 12.199 | 0 | −29.300 | 0 |
| Corridor story 2 | 274.72 | 1401.07 | 11.398 | −4.134 | 2.041 | 14.661 | 0 | 0 | 0.130 | 54.694 | 0 | −78.790 | 0 |
| Corridor story 3 | 305.12 | 1141.15 | 7.542 | −3.428 | 2.240 | 16.284 | 0 | 6.180 | 0.104 | 39.288 | −2.653 | −65.557 | 0 |
| Corridor story 4 | 305.12 | 1141.15 | 7.566 | −3.777 | 2.234 | 16.284 | 0 | 6.213 | 0.102 | 39.974 | −2.660 | −65.935 | 0 |
| Corridor story 5 | 305.12 | 1141.15 | 7.594 | −4.104 | 2.229 | 16.284 | 0 | 6.230 | 0.101 | 40.633 | −2.667 | −66.299 | 0 |
| Corridor story 6 | 305.12 | 1141.15 | 7.687 | −4.371 | 2.225 | 16.284 | 0 | 6.241 | 0.099 | 41.069 | −2.671 | −66.563 | 0 |
| Corridor story 7 | 305.12 | 1141.15 | 10.558 | −4.010 | 2.242 | 16.284 | 0 | 6.281 | 0.098 | 36.884 | −2.627 | −65.709 | 0 |
| Commercial story 1 | 635.36 | 3240.34 | 37.238 | −110.737 | 145.896 | 93.092 | 33.897 | 115.694 | 2.741 | 0.003 | −59.223 | −203.573 | −55.024 |
| Office story 2 | 635.36 | 3240.34 | 82.54 | −90.120 | 23.947 | 71.465 | 62.973 | 116.164 | 2.705 | 0.005 | −57.126 | −193.141 | −19.407 |
| Room story 3 | 604.96 | 2262.55 | 56.34 | −72.703 | 21.384 | 71.028 | 51.636 | 70.304 | 1.870 | 0 | −34.229 | −142.944 | −22.686 |
| Room story 4 | 604.96 | 2262.55 | 54.962 | −72.742 | 21.366 | 71.028 | 51.636 | 70.834 | 1.852 | 0 | −34.333 | −143.405 | −21.198 |
| Room story 5 | 604.96 | 2262.55 | 55.016 | −72.979 | 21.364 | 71.028 | 51.636 | 71.175 | 1.834 | 0 | −34.381 | −143.706 | −20.988 |
| Room story 6 | 604.96 | 2262.55 | 55.832 | −72.924 | 21.381 | 71.028 | 51.636 | 71.458 | 1.817 | 0 | −34.371 | −143.827 | −22.030 |
| Room story 7 | 604.96 | 2262.55 | 72.243 | −71.375 | 21.536 | 71.028 | 51.636 | 72.000 | 1.803 | 0 | −33.743 | −142.579 | −42.548 |
| **Total Facility** | **6904.48** | **41,731.60** | **1106.833** | **−884.193** | **453.662** | **703.316** | **395.094** | **1654.553** | **48.510** | **264.753** | **−563.296** | **−2626.129** | **−553.091** |

**Table 5**
Detailed overview of energy performance parameters – Alternative 4.

| Thermal zone | Area [m²] | Volume [m³] | HVAC Input Sensible Air Heating [GJ] | HVAC Input Sensible Air Cooling [GJ] | People Sensible Heat Addition [GJ] | Lights Sensible Heat Addition [GJ] | Equipment Sensible Heat Addition [GJ] | Window Heat Addition [GJ] | Infiltration Heat Addition [GJ] | Opaque Surface Conduction and Other Heat Addition [GJ] | Window Heat Removal [GJ] | Infiltration Heat Removal [GJ] | Opaque Surface Conduction and Other Heat Removal [GJ] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atrium | 693.12 | 16,242.21 | 702.054 | −149.618 | 161.620 | 81.378 | 40.044 | 450.428 | 13.398 | 0.008 | −243.626 | −874.651 | −181.028 |
| Corridor story 1 | 115.52 | 589.15 | 11.302 | 0 | 0.936 | 6.165 | 0 | 0 | 0.414 | 9.144 | 0 | −27.961 | 0 |
| Corridor story 2 | 274.72 | 1401.07 | 15.166 | −0.255 | 2.139 | 14.661 | 0 | 0 | 0.208 | 39.965 | 0 | −71.885 | 0 |
| Corridor story 3 | 305.12 | 1141.15 | 9.898 | −0.248 | 2.347 | 16.284 | 0 | 6.089 | 0.154 | 28.071 | −2.488 | −60.106 | 0 |
| Corridor story 4 | 305.12 | 1141.15 | 9.922 | −0.295 | 2.342 | 16.284 | 0 | 6.123 | 0.145 | 28.405 | −2.494 | −60.433 | 0 |
| Corridor story 5 | 305.12 | 1141.15 | 9.958 | −0.335 | 2.338 | 16.284 | 0 | 6.147 | 0.138 | 28.701 | −2.499 | −60.731 | 0 |
| Corridor story 6 | 305.12 | 1141.15 | 10.108 | −0.371 | 2.335 | 16.284 | 0 | 6.155 | 0.132 | 28.801 | −2.503 | −60.941 | 0 |
| Corridor story 7 | 305.12 | 1141.15 | 13.774 | −0.406 | 2.346 | 16.284 | 0 | 6.209 | 0.133 | 24.534 | −2.469 | −60.405 | 0 |
| Commercial story 1 | 635.36 | 3240.34 | 38.842 | −104.283 | 146.746 | 93.092 | 33.897 | 116.214 | 2.741 | 0.002 | −58.499 | −201.770 | −66.980 |
| Office story 2 | 635.36 | 3240.34 | 85.065 | −86.744 | 24.039 | 71.465 | 62.973 | 116.435 | 2.705 | 0.004 | −56.595 | −191.774 | −27.568 |
| Room story 3 | 604.96 | 2262.55 | 58.777 | −69.355 | 21.487 | 71.028 | 51.636 | 70.513 | 1.872 | 0 | −33.926 | −141.970 | −30.062 |
| Room story 4 | 604.96 | 2262.55 | 57.394 | −69.379 | 21.472 | 71.028 | 51.636 | 71.048 | 1.855 | 0 | −34.021 | −142.397 | −28.635 |
| Room story 5 | 604.96 | 2262.55 | 57.485 | −69.588 | 21.471 | 71.028 | 51.636 | 71.393 | 1.837 | 0 | −34.064 | −142.685 | −28.513 |
| Room story 6 | 604.96 | 2262.55 | 58.337 | −69.533 | 21.486 | 71.028 | 51.636 | 71.675 | 1.819 | 0 | −34.057 | −142.818 | −29.574 |
| Room story 7 | 604.96 | 2262.55 | 74.966 | −68.341 | 21.625 | 71.028 | 51.636 | 72.193 | 1.806 | 0 | −33.474 | −141.727 | −49.712 |
| **Total Facility** | **6904.48** | **41,731.60** | **1213.048** | **−688.750** | **454.729** | **703.316** | **395.094** | **1070.623** | **29.358** | **187.634** | **−540.713** | **−2382.254** | **−442.072** |

**Table 6**
Detailed overview of energy performance parameters – Alternative 2 southeast orientation.

**Alternative 2: the building with glazed atrium – the basic atrium type building – southeast orientation 303**

| Thermal zone | Area [m²] | Volume [m³] | HVAC Input Sensible Air Heating [GJ] | HVAC Input Sensible Air Cooling [GJ] | People Sensible Heat Addition [GJ] | Lights Sensible Heat Addition [GJ] | Equipment Sensible Heat Addition [GJ] | Window Heat Addition [GJ] | Infiltration Heat Addition [GJ] | Opaque Surface Conduction and Other Heat Addition [GJ] | Window Heat Removal [GJ] | Infiltration Heat Removal [GJ] | Opaque Surface Conduction and Other Heat Removal [GJ] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atrium | 693.12 | 16,242.21 | 615.661 | −365.852 | 157.544 | 81.378 | 40.044 | 1019.596 | 13.364 | 0.002 | −264.898 | −913.801 | −383.038 |
| Corridor story 1 | 115.52 | 589.15 | 10.047 | −0.014 | 0.906 | 6.165 | 0 | 0 | 0.197 | 12.297 | 0 | −29.598 | 0 |
| Corridor story 2 | 274.72 | 1401.07 | 12.033 | −6.180 | 1.996 | 14.661 | 0 | 0 | 0.133 | 57.831 | 0 | −80.474 | 0 |
| Corridor story 3 | 305.12 | 1141.15 | 7.974 | −5.147 | 2.194 | 16.284 | 0 | 6.587 | 0.106 | 41.474 | −2.645 | −66.827 | 0 |
| Corridor story 4 | 305.12 | 1141.15 | 7.984 | −5.436 | 2.190 | 16.284 | 0 | 6.623 | 0.104 | 42.085 | −2.653 | −67.180 | 0 |
| Corridor story 5 | 305.12 | 1141.15 | 7.964 | −5.689 | 2.186 | 16.284 | 0 | 6.641 | 0.102 | 42.705 | −2.661 | −67.531 | 0 |
| Corridor story 6 | 305.12 | 1141.15 | 7.993 | −5.907 | 2.184 | 16.284 | 0 | 6.655 | 0.100 | 43.128 | −2.666 | −67.772 | 0 |
| Corridor story 7 | 305.12 | 1141.15 | 10.939 | −5.366 | 2.202 | 16.284 | 0 | 6.697 | 0.099 | 38.680 | −2.623 | −66.911 | 0 |
| Commercial story 1 | 635.36 | 3240.34 | 38.199 | −117.415 | 145.955 | 93.092 | 33.897 | 118.093 | 2.741 | 0.003 | −59.251 | −203.425 | −51.886 |
| Office story 2 | 635.36 | 3240.34 | 82.332 | −96.315 | 23.934 | 71.465 | 62.973 | 122.729 | 2.705 | 0.005 | −57.463 | −193.764 | −18.595 |
| Room story 3 | 604.96 | 2262.55 | 54.862 | −71.665 | 21.335 | 71.028 | 51.636 | 69.486 | 1.868 | 0 | −34.782 | −143.313 | −20.455 |
| Room story 4 | 604.96 | 2262.55 | 53.363 | −71.270 | 21.317 | 71.028 | 51.636 | 70.003 | 1.850 | 0 | −34.889 | −143.783 | −19.255 |
| Room story 5 | 604.96 | 2262.55 | 53.364 | −71.392 | 21.315 | 71.028 | 51.636 | 70.335 | 1.833 | 0 | −34.937 | −144.087 | −19.093 |
| Room story 6 | 604.96 | 2262.55 | 54.157 | −71.257 | 21.332 | 71.028 | 51.636 | 70.601 | 1.815 | 0 | −34.925 | −144.199 | −20.188 |
| Room story 7 | 604.96 | 2262.55 | 70.482 | −69.681 | 21.493 | 71.028 | 51.636 | 71.141 | 1.800 | 0 | −34.266 | −142.895 | −40.736 |
| **Total Facility** | **6904.48** | **41,731.60** | **1087.353** | **−968.586** | **448.084** | **703.316** | **395.094** | **1645.188** | **28.817** | **278.209** | **−568.659** | **−2475.560** | **−573.247** |

**Table 7**
Detailed overview of energy performance parameters – Alternative 2 northwest orientation.

**Alternative 2: the building with glazed atrium – the basic atrium type building – northwest orientation 123**

| Thermal zone | Area [m²] | Volume [m³] | HVAC Input Sensible Air Heating [GJ] | HVAC Input Sensible Air Cooling [GJ] | People Sensible Heat Addition [GJ] | Lights Sensible Heat Addition [GJ] | Equipment Sensible Heat Addition [GJ] | Window Heat Addition [GJ] | Infiltration Heat Addition [GJ] | Opaque Surface Conduction and Other Heat Addition [GJ] | Window Heat Removal [GJ] | Infiltration Heat Removal [GJ] | Opaque Surface Conduction and Other Heat Removal [GJ] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atrium | 693.12 | 16,242.21 | 669.881 | −299.010 | 159.194 | 81.378 | 40.044 | 830.627 | 13.366 | 0.004 | −264.664 | −899.723 | −331.092 |
| Corridor story 1 | 115.52 | 589.15 | 10.442 | −0.007 | 0.911 | 6.165 | 0 | 0 | 0.231 | 11.538 | 0 | −29.281 | 0 |
| Corridor story 2 | 274.72 | 1401.07 | 13.930 | −4.169 | 2.047 | 14.661 | 0 | 0 | 0.145 | 50.782 | 0 | −77.395 | 0 |
| Corridor story 3 | 305.12 | 1141.15 | 9.110 | −3.423 | 2.246 | 16.284 | 0 | 6.679 | 0.114 | 36.031 | −2.592 | −64.450 | 0 |
| Corridor story 4 | 305.12 | 1141.15 | 9.111 | −3.631 | 2.242 | 16.284 | 0 | 6.715 | 0.111 | 36.580 | −2.600 | −64.811 | 0 |
| Corridor story 5 | 305.12 | 1141.15 | 9.018 | −3.809 | 2.238 | 16.284 | 0 | 6.732 | 0.106 | 37.234 | −2.608 | −65.193 | 0 |
| Corridor story 6 | 305.12 | 1141.15 | 8.947 | −3.971 | 2.235 | 16.284 | 0 | 6.744 | 0.103 | 37.746 | −2.614 | −65.473 | 0 |
| Corridor story 7 | 305.12 | 1141.15 | 12.165 | −3.688 | 2.250 | 16.284 | 0 | 6.782 | 0.103 | 33.422 | −2.575 | −64.743 | 0 |
| Commercial story 1 | 635.36 | 3240.34 | 35.032 | −127.837 | 144.857 | 93.092 | 33.897 | 145.872 | 2.741 | 0.003 | −59.731 | −205.769 | −62.154 |
| Office story 2 | 635.36 | 3240.34 | 76.473 | −107.127 | 23.678 | 71.465 | 62.973 | 148.877 | 2.705 | 0.005 | −57.705 | −195.852 | −25.487 |
| Room story 3 | 604.96 | 2262.55 | 51.521 | −76.445 | 21.263 | 71.028 | 51.636 | 82.405 | 1.868 | 0 | −34.498 | −144.210 | −24.568 |
| Room story 4 | 604.96 | 2262.55 | 50.304 | −75.839 | 21.25 | 71.028 | 51.636 | 82.844 | 1.85 | 0 | −34.586 | −144.625 | −23.859 |
| Room story 5 | 604.96 | 2262.55 | 50.321 | −75.926 | 21.248 | 71.028 | 51.636 | 83.107 | 1.832 | 0 | −34.634 | −144.923 | −23.689 |
| Room story 6 | 604.96 | 2262.55 | 51.106 | −75.755 | 21.267 | 71.028 | 51.636 | 83.328 | 1.815 | 0 | −34.620 | −145.025 | −24.779 |
| Room story 7 | 604.96 | 2262.55 | 67.065 | −73.887 | 21.439 | 71.028 | 51.636 | 83.864 | 1.798 | 0 | −33.945 | −143.585 | −45.413 |
| **Total Facility** | **6904.48** | **41,731.60** | **1124.426** | **−934.524** | **448.365** | **703.316** | **395.094** | **1574.574** | **28.889** | **243.344** | **−567.373** | **−2455.06** | **−561.042** |

**Table 8**
Detailed overview of energy performance parameters – Alternative 2 northeast orientation.

**Alternative 2: the building with glazed atrium – the basic atrium type building – northeast orientation 213**

| Thermal zone | Area [m²] | Volume [m³] | HVAC Input Sensible Air Heating [GJ] | HVAC Input Sensible Air Cooling [GJ] | People Sensible Heat Addition [GJ] | Lights Sensible Heat Addition [GJ] | Equipment Sensible Heat Addition [GJ] | Window Heat Addition [GJ] | Infiltration Heat Addition [GJ] | Opaque Surface Conduction and Other Heat Addition [GJ] | Window Heat Removal [GJ] | Infiltration Heat Removal [GJ] | Opaque Surface Conduction and Other Heat Removal [GJ] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atrium | 693.12 | 16,242.21 | 675.363 | −276.051 | 159.187 | 81.378 | 40.044 | 779.342 | 13.368 | 0.004 | −262.693 | −897.279 | −312.660 |
| Corridor story 1 | 115.52 | 589.15 | 10.474 | −0.003 | 0.914 | 6.165 | 0 | 0 | 0.248 | 11.342 | 0 | −29.139 | 0 |
| Corridor story 2 | 274.72 | 1401.07 | 13.973 | −2.825 | 2.054 | 14.661 | 0 | 0 | 0.148 | 48.792 | 0 | −76.803 | 0 |
| Corridor story 3 | 305.12 | 1141.15 | 9.140 | −2.412 | 2.255 | 16.284 | 0 | 6.214 | 0.116 | 35.002 | −2.597 | −64.002 | 0 |
| Corridor story 4 | 305.12 | 1141.15 | 9.153 | −2.713 | 2.249 | 16.284 | 0 | 6.247 | 0.112 | 35.654 | −2.604 | −64.382 | 0 |
| Corridor story 5 | 305.12 | 1141.15 | 9.103 | −2.984 | 2.243 | 16.284 | 0 | 6.263 | 0.109 | 36.375 | −2.612 | −64.781 | 0 |
| Corridor story 6 | 305.12 | 1141.15 | 9.100 | −3.200 | 2.239 | 16.284 | 0 | 6.273 | 0.107 | 36.901 | −2.617 | −65.086 | 0 |
| Corridor story 7 | 305.12 | 1141.15 | 12.387 | −3.011 | 2.253 | 16.284 | 0 | 6.309 | 0.107 | 32.653 | −2.579 | −64.403 | 0 |
| Commercial story 1 | 635.36 | 3240.34 | 34.380 | −121.307 | 144.730 | 93.092 | 33.897 | 141.322 | 2.741 | 0.003 | −60.331 | −206.218 | −62.306 |
| Office story 2 | 635.36 | 3240.34 | 74.561 | −104.252 | 23.670 | 71.465 | 62.973 | 150.157 | 2.705 | 0.005 | −58.247 | −196.372 | −26.660 |
| Room story 3 | 604.96 | 2262.55 | 51.632 | −80.307 | 21.255 | 71.028 | 51.636 | 87.294 | 1.868 | 0 | −34.484 | −144.279 | −25.643 |
| Room story 4 | 604.96 | 2262.55 | 50.637 | −80.041 | 21.245 | 71.028 | 51.636 | 87.716 | 1.850 | 0 | −34.562 | −144.660 | −24.849 |
| Room story 5 | 604.96 | 2262.55 | 50.710 | −80.221 | 21.245 | 71.028 | 51.636 | 87.967 | 1.832 | 0 | −34.607 | −144.947 | −24.644 |
| Room story 6 | 604.96 | 2262.55 | 51.522 | −80.104 | 21.263 | 71.028 | 51.636 | 88.183 | 1.815 | 0 | −34.594 | −145.050 | −25.698 |
| Room story 7 | 604.96 | 2262.55 | 67.464 | −78.087 | 21.433 | 71.028 | 51.636 | 88.705 | 1.799 | 0 | −33.930 | −143.632 | −46.416 |
| **Total Facility** | **6904.48** | **41,731.60** | **1129.601** | **−917.516** | **448.234** | **703.316** | **395.094** | **1541.990** | **28.925** | **236.732** | **−566.456** | **−2451.030** | **−548.876** |

## Acknowledgements

## Transparency document. Supporting information

Transparency data associated with this article can be found in the online version at https://doi.org/10.1016/j.dib.2018.01.040.

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