

**Article:**

**Techno-economic and environmental evaluation of a solar energy system on a Ro-Ro vessel for sustainability**

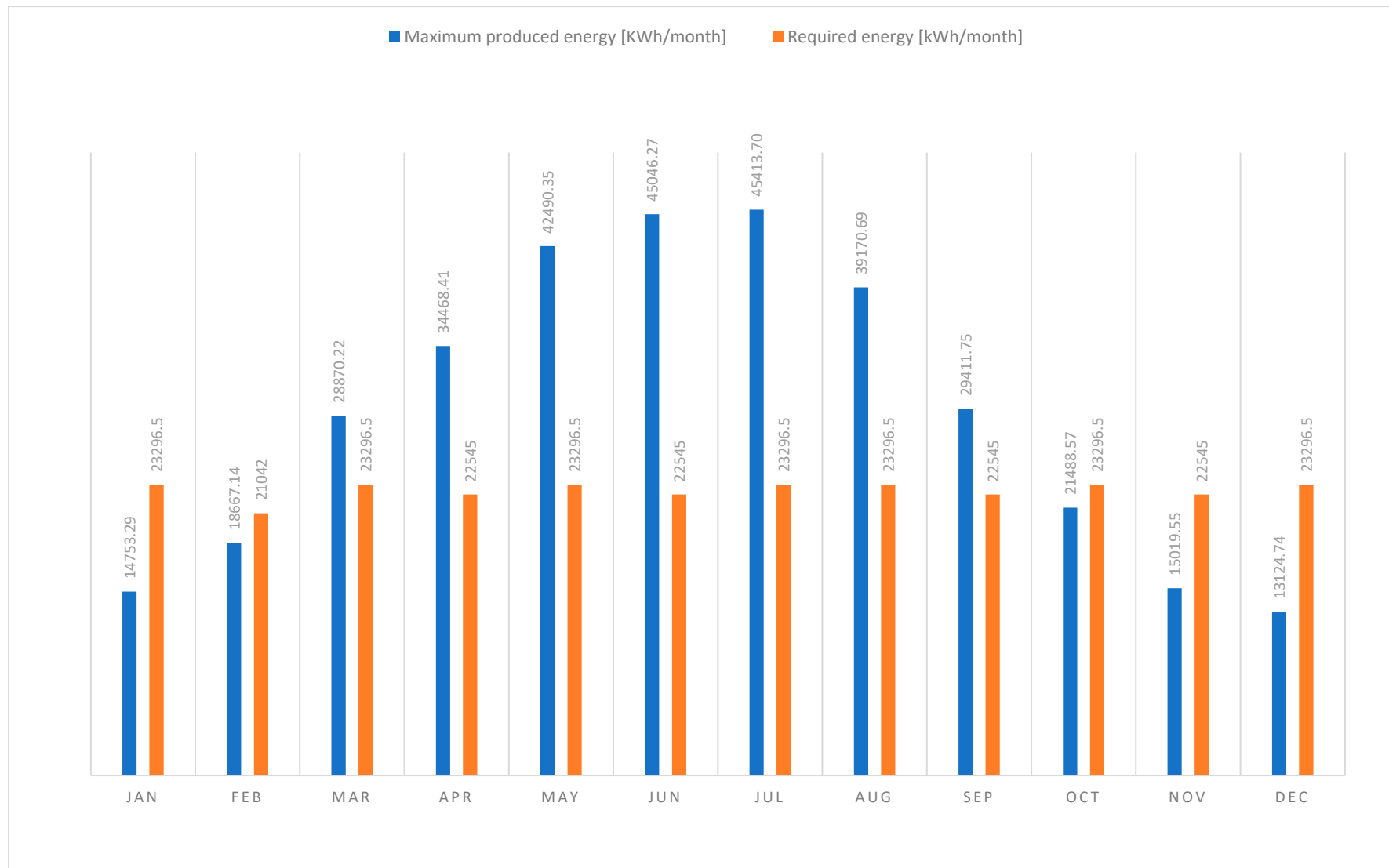
Calculations of lighting loads:

| CONSUMERS                | POWER (W) | VOLT (V) | HOURS (H) | ENERGY/DAY (Wh) |
|--------------------------|-----------|----------|-----------|-----------------|
| Machinery Space Lighting | 20000     | 230      | 5         | 100000          |
| Accommodation Lighting   | 12000     | 230      | 5         | 60000           |
| Deck Lighting            | 15000     | 230      | 5         | 75000           |
| Cargo Hold Lighting      | 120000    | 230      | 5         | 600000          |

|                    |            |  |  |            |     |
|--------------------|------------|--|--|------------|-----|
| TOTAL POWER        | 167,000.00 |  |  | 835,000.00 | Wh  |
| 90% OF TOTAL POWER |            |  |  | 751.50     | kWh |

Calculations of required energy for lighting and maximum energy produced by the PV system:

| Days | Months | Ta Avg.<br>Temperature | E_HA Per Day   | E_HA Per Month        | $\sigma_{\theta}$ | E_ΜΠ Per Day                                      | E_ΜΠ Per Month | E_lighting Per Day | E_lighting Per Month |
|------|--------|------------------------|--|-----------------------|-------------------|---|----------------|--------------------|----------------------|
|      |        |                        | Ενέργεια προσπίπτουσας<br>ακτινοβολίας - Solar radiation |                       |                   | Μέγιστη αποδιδόμενη ενέργεια<br>Maximum PV energy |                |                    |                      |
| [-]  | [-]    | °C                     | [kWh/m <sup>2</sup> ]                                    | [kWh/m <sup>2</sup> ] | [-]               | [kWh]   | [kWh]          | [kWh]              | [kWh]                |
| 31   | Jan    | 7.9                    | 2.20   | 68.12                 | 0.948             | 475.91  | 14753.29       | 751.5              | 23296.5              |
| 28   | Feb    | 8.5                    | 3.09   | 86.41                 | 0.946             | 666.68  | 18667.14       | 751.5              | 21042                |
| 31   | Mar    | 10.9                   | 4.36   | 135.01                | 0.936             | 931.30  | 28870.22       | 751.5              | 23296.5              |
| 30   | Apr    | 13.5                   | 5.43   | 163                   | 0.926             | 1148.95   | 34468.41       | 751.5              | 22545                |
| 31   | May    | 17                     | 6.58   | 204.02                | 0.912             | 1370.66   | 42490.35       | 751.5              | 23296.5              |
| 30   | Jun    | 21.3                   | 7.35   | 220.45                | 0.895             | 1501.54   | 45046.27       | 751.5              | 22545                |
| 31   | Jul    | 23.8                   | 7.25   | 224.76                | 0.885             | 1464.96   | 45413.70       | 751.5              | 23296.5              |
| 31   | Aug    | 23.9                   | 6.26   | 193.95                | 0.884             | 1263.57   | 39170.69       | 751.5              | 23296.5              |
| 30   | Sep    | 20.9                   | 4.79   | 143.68                | 0.896             | 980.39  | 29411.75       | 751.5              | 22545                |
| 31   | Oct    | 17.4                   | 3.33   | 103.36                | 0.910             | 693.18  | 21488.57       | 751.5              | 23296.5              |
| 30   | Nov    | 12.1                   | 2.35   | 70.6                  | 0.932             | 500.65  | 15019.55       | 751.5              | 22545                |
| 31   | Dec    | 8.6                    | 1.96   | 60.78                 | 0.946             | 423.38  | 13124.74       | 751.5              | 23296.5              |
| -    | Avg    | -                      | -  | -                     | -                 | 951.76  | 28993.72       | -                  | 22858.13             |



$$E_{\max\_PVsystem} = B_n \cdot A_{PV} \cdot n_{STC} \cdot AF \cdot SF \cdot DF \cdot T_{coef} \cdot N$$

|                                   |       |       |             |
|-----------------------------------|-------|-------|-------------|
| PV panel surface area             | Apv   | [m^2] | 2.830116    |
| Number of PV panels               | N     | [ - ] | 450         |
| PV panel efficiency rating in STC | n_STC | [ - ] | 0.214       |
| PV panel aging factor             | AF    | [ - ] | 0.98        |
| PV panel shading factor           | SF    | [ - ] | 0.9         |
| Diode loss factor                 | DF    | [ - ] | 0.99        |
| Average monthly temperature       | Tavg  | [°C]  | 14.76666667 |
| Temperature coefficient           | Tcoef | [-]   | 0.839266667 |

Fuel savings calculations:

| Months | Days | Average of DG SFOC [g/kWh] | E_lighting daily for 5 hours [kWh] | Energy required per month [kWh] | Required fuel per month [tons] = Days x SFOC x E_lighting | Energy produced by PV system [kWh] | Energy covered by PV system [kWh] | Days covered by PV system | Days covered by PV system | Fuel savings per month [tons] = Energy provided by PV system x SFOC |
|--------|------|----------------------------|------------------------------------|---------------------------------|---|------------------------------------|-----------------------------------|---------------------------|---------------------------|---|
| Jan    | 31   | 300                        | 751.5                              | 23296.5                         | 6.99  | 14753.29                           | 14753.29                          | 19.63                     | 19.6                      | 4.43  |
| Feb    | 28   | 317                        | 751.5                              | 21042.0                         | 6.67  | 18667.14                           | 18667.14                          | 24.84                     | 24.8                      | 5.92  |
| Mar    | 31   | 268                        | 751.5                              | 23296.5                         | 6.24  | 28870.22                           | 23296.5                           | 38.42                     | 31                        | 6.24  |
| Apr    | 30   | 289                        | 751.5                              | 22545.0                         | 6.52  | 34468.41                           | 22545.0                           | 45.87                     | 30                        | 6.52  |
| May    | 31   | 254                        | 751.5                              | 23296.5                         | 5.92  | 42490.35                           | 23296.5                           | 56.54                     | 31                        | 5.92  |
| Jun    | 30   | 259                        | 751.5                              | 22545.0                         | 5.84  | 45046.27                           | 22545.0                           | 59.94                     | 30                        | 5.84  |
| Jul    | 31   | 241                        | 751.5                              | 23296.5                         | 5.61  | 45413.70                           | 23296.5                           | 60.43                     | 31                        | 5.61  |
| Aug    | 31   | 214                        | 751.5                              | 23296.5                         | 4.99  | 39170.69                           | 23296.5                           | 52.12                     | 31                        | 4.99  |
| Sep    | 30   | 217                        | 751.5                              | 22545.0                         | 4.89  | 29411.75                           | 22545.0                           | 39.14                     | 30                        | 4.89  |
| Oct    | 31   | 244                        | 751.5                              | 23296.5                         | 5.68  | 21488.57                           | 21488.57                          | 28.59                     | 28.5                      | 5.24  |
| Nov    | 30   | 272                        | 751.5                              | 22545.0                         | 6.13  | 15019.55                           | 15019.55                          | 19.99                     | 19.9                      | 4.09  |
| Dec    | 31   | 286                        | 751.5                              | 23296.5                         | 6.66  | 13124.74                           | 13124.74                          | 17.46                     | 17.4                      | 3.75  |
| SUM    |      |                            |                                    | 274297.5                        | 72.15   | 347924.68                          | 243874.30                         |                           |                           | 63.43   |

Emissions calculations (base case):

| Month | Energy covered by PV system (kWh) | CO2 (Kg) |           | SOx (Kg) |        | PM (kg) |       | NOx (Kg) |
|-------|-----------------------------------|----------|-----------|----------|--------|---------|-------|----------|
|       |                                   | MGO      | HFO       | MGO      | HFO    | MGO     | HFO   |          |
| Jan   | 14753.29                          | 5675.89  | 8269.51   | 3.46     | 25.96  | 0.97    | 3.76  | 170.32   |
| Feb   | 18667.14                          | 7588.58  | 11056.23  | 4.63     | 34.71  | 1.20    | 4.17  | 215.50   |
| Mar   | 23296.50                          | 8006.62  | 11665.28  | 4.88     | 36.62  | 1.59    | 7.32  | 268.94   |
| Apr   | 22545.00                          | 8355.48  | 12173.57  | 5.10     | 38.21  | 1.50    | 6.21  | 260.26   |
| May   | 23296.50                          | 7588.36  | 11055.90  | 4.63     | 34.71  | 1.62    | 7.92  | 268.94   |
| Jun   | 22545.00                          | 7488.13  | 10909.88  | 4.57     | 34.25  | 1.56    | 7.46  | 260.26   |
| Jul   | 23296.50                          | 7199.98  | 10490.05  | 4.39     | 32.93  | 1.65    | 8.48  | 268.94   |
| Aug   | 23296.50                          | 6393.34  | 9314.82   | 3.90     | 29.24  | 1.70    | 9.65  | 268.94   |
| Sep   | 22545.00                          | 6273.84  | 9140.71   | 3.83     | 28.69  | 1.64    | 9.21  | 260.26   |
| Oct   | 21488.57                          | 6723.89  | 9796.41   | 4.10     | 30.75  | 1.52    | 7.71  | 248.07   |
| Nov   | 15019.55                          | 5239.01  | 7633.01   | 3.19     | 23.96  | 1.02    | 4.61  | 173.39   |
| Dec   | 13124.74                          | 4813.72  | 7013.37   | 2.94     | 22.02  | 0.88    | 3.69  | 151.51   |
| Sum   |                                   | 81346.84 | 118518.74 | 49.61    | 372.05 | 16.85   | 80.20 | 2815.33  |

| Month | SFOC<br>[g/kWh] | EF_CO2 (g/kWh) |        | EF_SOx<br>(g/kWh) |      | EF_PM<br>(g/kWh) |      |
|-------|-----------------|----------------|--------|-------------------|------|------------------|------|
|       |                 | MGO            | HFO    | MGO               | HFO  | MGO              | HFO  |
| Jan   | 300             | 961.80         | 934.20 | 0.59              | 2.93 | 0.16             | 0.43 |
| Feb   | 317             | 1016.30        | 987.14 | 0.62              | 3.10 | 0.16             | 0.37 |
| Mar   | 268             | 859.21         | 834.55 | 0.52              | 2.62 | 0.17             | 0.52 |
| Apr   | 289             | 926.53         | 899.95 | 0.57              | 2.83 | 0.17             | 0.46 |
| May   | 254             | 814.32         | 790.96 | 0.50              | 2.48 | 0.17             | 0.57 |
| Jun   | 259             | 830.35         | 806.53 | 0.51              | 2.53 | 0.17             | 0.55 |
| Jul   | 241             | 772.65         | 750.47 | 0.47              | 2.36 | 0.18             | 0.61 |
| Aug   | 214             | 686.08         | 666.40 | 0.42              | 2.09 | 0.18             | 0.69 |
| Sep   | 217             | 695.70         | 675.74 | 0.42              | 2.12 | 0.18             | 0.68 |
| Oct   | 244             | 782.26         | 759.82 | 0.48              | 2.39 | 0.18             | 0.60 |
| Nov   | 272             | 872.03         | 847.01 | 0.53              | 2.66 | 0.17             | 0.51 |
| Dec   | 286             | 916.92         | 890.60 | 0.56              | 2.80 | 0.17             | 0.47 |

| EF_NOx<br>(g/kWh) |
|-------------------|
| 11.544            |

| CO2 (Kg)         | SOx (Kg)      | PM (kg)      | NOx (Kg)       |
|------------------|---------------|--------------|----------------|
| 13945.40         | 29.42         | 4.73         | 170.32         |
| 18644.81         | 39.33         | 5.37         | 215.50         |
| 19671.90         | 41.50         | 8.91         | 268.94         |
| 20529.05         | 43.31         | 7.71         | 260.26         |
| 18644.26         | 39.33         | 9.55         | 268.94         |
| 18398.01         | 38.81         | 9.02         | 260.26         |
| 17690.03         | 37.32         | 10.13        | 268.94         |
| 15708.16         | 33.14         | 11.35        | 268.94         |
| 15414.55         | 32.52         | 10.86        | 260.26         |
| 16520.31         | 34.85         | 9.22         | 248.07         |
| 12872.02         | 27.16         | 5.63         | 173.39         |
| 11827.09         | 24.95         | 4.56         | 151.51         |
| <b>199865.58</b> | <b>421.65</b> | <b>97.05</b> | <b>2815.33</b> |



Fuel savings and emissions calculations (scenario 1):

| Month | SFOC<br>[g/kWh] | Energy<br>required<br>[kWh] | Fuel<br>required<br>[tons] | Energy<br>produced<br>by PV<br>system<br>[kWh] | 10%<br>decrease | Energy<br>provided<br>by PV<br>system<br>[kWh] | Fuel<br>savings<br>[tons] |
|-------|-----------------|-----------------------------|----------------------------|--|-----------------|--|---------------------------|
| Jan   | 300             | 23296.5                     | 6.99                       | 14753.29                                       | 13277.96        | 13277.96                                       | 3.98                      |
| Feb   | 317             | 21042.0                     | 6.67                       | 18667.14                                       | 16800.43        | 16800.43                                       | 5.33                      |
| Mar   | 268             | 23296.5                     | 6.24                       | 28870.22                                       | 25983.20        | 23296.50                                       | 6.24                      |
| Apr   | 289             | 22545.0                     | 6.52                       | 34468.41                                       | 31021.57        | 22545.00                                       | 6.52                      |
| May   | 254             | 23296.5                     | 5.92                       | 42490.35                                       | 38241.31        | 23296.50                                       | 5.92                      |
| Jun   | 259             | 22545.0                     | 5.84                       | 45046.27                                       | 40541.64        | 22545.00                                       | 5.84                      |
| Jul   | 241             | 23296.5                     | 5.61                       | 45413.70                                       | 40872.33        | 23296.50                                       | 5.61                      |
| Aug   | 214             | 23296.5                     | 4.99                       | 39170.69                                       | 35253.62        | 23296.50                                       | 4.99                      |
| Sep   | 217             | 22545.0                     | 4.89                       | 29411.75                                       | 26470.58        | 22545.00                                       | 4.89                      |
| Oct   | 244             | 23296.5                     | 5.68                       | 21488.57                                       | 19339.71        | 19339.71                                       | 4.72                      |
| Nov   | 272             | 22545.0                     | 6.13                       | 15019.55                                       | 13517.59        | 13517.59                                       | 3.68                      |
| Dec   | 286             | 23296.5                     | 6.66                       | 13124.74                                       | 11812.27        | 11812.27                                       | 3.38                      |
| SUM   |                 | 274297.5                    | 72.15                      | 347924.68                                      | 313132.21       | 235568.97                                      | 61.09                     |

| Month | Energy covered by PV system (kWh) | CO2 (Kg) |           | SOx (Kg) |        | PM (kg) |       | NOx (Kg) |
|-------|-----------------------------------|----------|-----------|----------|--------|---------|-------|----------|
|       |                                   | MGO      | HFO       | MGO      | HFO    | MGO     | HFO   |          |
| Jan   | 13277.96                          | 5108.30  | 7442.56   | 3.12     | 23.36  | 0.87    | 3.39  | 153.28   |
| Feb   | 16800.43                          | 6829.72  | 9950.60   | 4.16     | 31.24  | 1.08    | 3.76  | 193.95   |
| Mar   | 23296.50                          | 8006.62  | 11665.28  | 4.88     | 36.62  | 1.59    | 7.32  | 268.94   |
| Apr   | 22545.00                          | 8355.48  | 12173.57  | 5.10     | 38.21  | 1.50    | 6.21  | 260.26   |
| May   | 23296.50                          | 7588.36  | 11055.90  | 4.63     | 34.71  | 1.62    | 7.92  | 268.94   |
| Jun   | 22545.00                          | 7488.13  | 10909.88  | 4.57     | 34.25  | 1.56    | 7.46  | 260.26   |
| Jul   | 23296.50                          | 7199.98  | 10490.05  | 4.39     | 32.93  | 1.65    | 8.48  | 268.94   |
| Aug   | 23296.50                          | 6393.34  | 9314.82   | 3.90     | 29.24  | 1.70    | 9.65  | 268.94   |
| Sep   | 22545.00                          | 6273.84  | 9140.71   | 3.83     | 28.69  | 1.64    | 9.21  | 260.26   |
| Oct   | 19339.71                          | 6051.50  | 8816.77   | 3.69     | 27.68  | 1.36    | 6.94  | 223.26   |
| Nov   | 13517.59                          | 4715.11  | 6869.71   | 2.88     | 21.57  | 0.92    | 4.15  | 156.05   |
| Dec   | 11812.27                          | 4332.34  | 6312.03   | 2.64     | 19.81  | 0.79    | 3.32  | 136.36   |
| Sum   | 235568.97                         | 78342.73 | 114141.89 | 47.77    | 358.31 | 16.29   | 77.81 | 2719.46  |

| Month | SFOC<br>[g/kWh] | EF_CO2 (g/kWh) |        | EF_SOx<br>(g/kWh) |      | EF_PM<br>(g/kWh) |      |
|-------|-----------------|----------------|--------|-------------------|------|------------------|------|
|       |                 | MGO            | HFO    | MGO               | HFO  | MGO              | HFO  |
| Jan   | 300             | 961.80         | 934.20 | 0.59              | 2.93 | 0.16             | 0.43 |
| Feb   | 317             | 1016.30        | 987.14 | 0.62              | 3.10 | 0.16             | 0.37 |
| Mar   | 268             | 859.21         | 834.55 | 0.52              | 2.62 | 0.17             | 0.52 |
| Apr   | 289             | 926.53         | 899.95 | 0.57              | 2.83 | 0.17             | 0.46 |
| May   | 254             | 814.32         | 790.96 | 0.50              | 2.48 | 0.17             | 0.57 |
| Jun   | 259             | 830.35         | 806.53 | 0.51              | 2.53 | 0.17             | 0.55 |
| Jul   | 241             | 772.65         | 750.47 | 0.47              | 2.36 | 0.18             | 0.61 |
| Aug   | 214             | 686.08         | 666.40 | 0.42              | 2.09 | 0.18             | 0.69 |
| Sep   | 217             | 695.70         | 675.74 | 0.42              | 2.12 | 0.18             | 0.68 |
| Oct   | 244             | 782.26         | 759.82 | 0.48              | 2.39 | 0.18             | 0.60 |
| Nov   | 272             | 872.03         | 847.01 | 0.53              | 2.66 | 0.17             | 0.51 |
| Dec   | 286             | 916.92         | 890.60 | 0.56              | 2.80 | 0.17             | 0.47 |

| CO2 (Kg)         | SOx (Kg)      | PM (kg)      | NOx (Kg)       |
|------------------|---------------|--------------|----------------|
| 12550.86         | 26.48         | 4.26         | 153.28         |
| 16780.33         | 35.40         | 4.83         | 193.95         |
| 19671.90         | 41.50         | 8.91         | 268.94         |
| 20529.05         | 43.31         | 7.71         | 260.26         |
| 18644.26         | 39.33         | 9.55         | 268.94         |
| 18398.01         | 38.81         | 9.02         | 260.26         |
| 17690.03         | 37.32         | 10.13        | 268.94         |
| 15708.16         | 33.14         | 11.35        | 268.94         |
| 15414.55         | 32.52         | 10.86        | 260.26         |
| 14868.28         | 31.37         | 8.30         | 223.26         |
| 11584.82         | 24.44         | 5.07         | 156.05         |
| 10644.38         | 22.46         | 4.11         | 136.36         |
| <b>192484.62</b> | <b>406.08</b> | <b>94.10</b> | <b>2719.46</b> |

Fuel savings and emissions calculations (scenario 2):

| Month | SFOC<br>[g/kWh] | Energy<br>required<br>[kWh] | Fuel<br>required<br>[tons] | Energy<br>produced<br>by PV<br>system<br>[kWh] | 20%<br>decrease | Energy<br>provided<br>by PV<br>system<br>[kWh] | Fuel<br>savings<br>[tons] |
|-------|-----------------|-----------------------------|----------------------------|--|-----------------|--|---------------------------|
| Jan   | 300             | 23296.5                     | 6.99                       | 14753.29                                       | 11802.63        | 11802.63                                       | 3.54                      |
| Feb   | 317             | 21042.0                     | 6.67                       | 18667.14                                       | 14933.71        | 14933.71                                       | 4.73                      |
| Mar   | 268             | 23296.5                     | 6.24                       | 28870.22                                       | 23096.17        | 23096.17                                       | 6.19                      |
| Apr   | 289             | 22545.0                     | 6.52                       | 34468.41                                       | 27574.73        | 22545.00                                       | 6.52                      |
| May   | 254             | 23296.5                     | 5.92                       | 42490.35                                       | 33992.28        | 23296.50                                       | 5.92                      |
| Jun   | 259             | 22545.0                     | 5.84                       | 45046.27                                       | 36037.01        | 22545.00                                       | 5.84                      |
| Jul   | 241             | 23296.5                     | 5.61                       | 45413.70                                       | 36330.96        | 23296.50                                       | 5.61                      |
| Aug   | 214             | 23296.5                     | 4.99                       | 39170.69                                       | 31336.55        | 23296.50                                       | 4.99                      |
| Sep   | 217             | 22545.0                     | 4.89                       | 29411.75                                       | 23529.40        | 22545.00                                       | 4.89                      |
| Oct   | 244             | 23296.5                     | 5.68                       | 21488.57                                       | 17190.85        | 17190.85                                       | 4.19                      |
| Nov   | 272             | 22545.0                     | 6.13                       | 15019.55                                       | 12015.64        | 12015.64                                       | 3.27                      |
| Dec   | 286             | 23296.5                     | 6.66                       | 13124.74                                       | 10499.80        | 10499.80                                       | 3.00                      |
| SUM   |                 | 274297.5                    | 72.15                      | 347924.68                                      | 278339.74       | 227063.31                                      | 58.69                     |

| Month | Energy covered by PV system (kWh) | CO2 (Kg) |           | SOx (Kg) |        | PM (kg) |       | NOx (Kg) |
|-------|-----------------------------------|----------|-----------|----------|--------|---------|-------|----------|
|       |                                   | MGO      | HFO       | MGO      | HFO    | MGO     | HFO   |          |
| Jan   | 11802.63                          | 4540.71  | 6615.61   | 2.77     | 20.77  | 0.77    | 3.01  | 136.25   |
| Feb   | 14933.71                          | 6070.87  | 8844.98   | 3.70     | 27.77  | 0.96    | 3.34  | 172.40   |
| Mar   | 23096.17                          | 7937.77  | 11564.97  | 4.84     | 36.30  | 1.58    | 7.26  | 266.63   |
| Apr   | 22545.00                          | 8355.48  | 12173.57  | 5.10     | 38.21  | 1.50    | 6.21  | 260.26   |
| May   | 23296.50                          | 7588.36  | 11055.90  | 4.63     | 34.71  | 1.62    | 7.92  | 268.94   |
| Jun   | 22545.00                          | 7488.13  | 10909.88  | 4.57     | 34.25  | 1.56    | 7.46  | 260.26   |
| Jul   | 23296.50                          | 7199.98  | 10490.05  | 4.39     | 32.93  | 1.65    | 8.48  | 268.94   |
| Aug   | 23296.50                          | 6393.34  | 9314.82   | 3.90     | 29.24  | 1.70    | 9.65  | 268.94   |
| Sep   | 22545.00                          | 6273.84  | 9140.71   | 3.83     | 28.69  | 1.64    | 9.21  | 260.26   |
| Oct   | 17190.85                          | 5379.11  | 7837.13   | 3.28     | 24.60  | 1.21    | 6.17  | 198.45   |
| Nov   | 12015.64                          | 4191.21  | 6106.41   | 2.56     | 19.17  | 0.82    | 3.69  | 138.71   |
| Dec   | 10499.80                          | 3850.97  | 5610.70   | 2.35     | 17.61  | 0.70    | 2.95  | 121.21   |
| Sum   | 227063.31                         | 75269.77 | 109664.73 | 45.90    | 344.25 | 15.72   | 75.35 | 2621.27  |

| Month | SFOC<br>[g/kWh] | EF_CO2 (g/kWh) |        | EF_SOx<br>(g/kWh) |      | EF_PM<br>(g/kWh) |      |
|-------|-----------------|----------------|--------|-------------------|------|------------------|------|
|       |                 | MGO            | HFO    | MGO               | HFO  | MGO              | HFO  |
| Jan   | 300             | 961.80         | 934.20 | 0.59              | 2.93 | 0.16             | 0.43 |
| Feb   | 317             | 1016.30        | 987.14 | 0.62              | 3.10 | 0.16             | 0.37 |
| Mar   | 268             | 859.21         | 834.55 | 0.52              | 2.62 | 0.17             | 0.52 |
| Apr   | 289             | 926.53         | 899.95 | 0.57              | 2.83 | 0.17             | 0.46 |
| May   | 254             | 814.32         | 790.96 | 0.50              | 2.48 | 0.17             | 0.57 |
| Jun   | 259             | 830.35         | 806.53 | 0.51              | 2.53 | 0.17             | 0.55 |
| Jul   | 241             | 772.65         | 750.47 | 0.47              | 2.36 | 0.18             | 0.61 |
| Aug   | 214             | 686.08         | 666.40 | 0.42              | 2.09 | 0.18             | 0.69 |
| Sep   | 217             | 695.70         | 675.74 | 0.42              | 2.12 | 0.18             | 0.68 |
| Oct   | 244             | 782.26         | 759.82 | 0.48              | 2.39 | 0.18             | 0.60 |
| Nov   | 272             | 872.03         | 847.01 | 0.53              | 2.66 | 0.17             | 0.51 |
| Dec   | 286             | 916.92         | 890.60 | 0.56              | 2.80 | 0.17             | 0.47 |

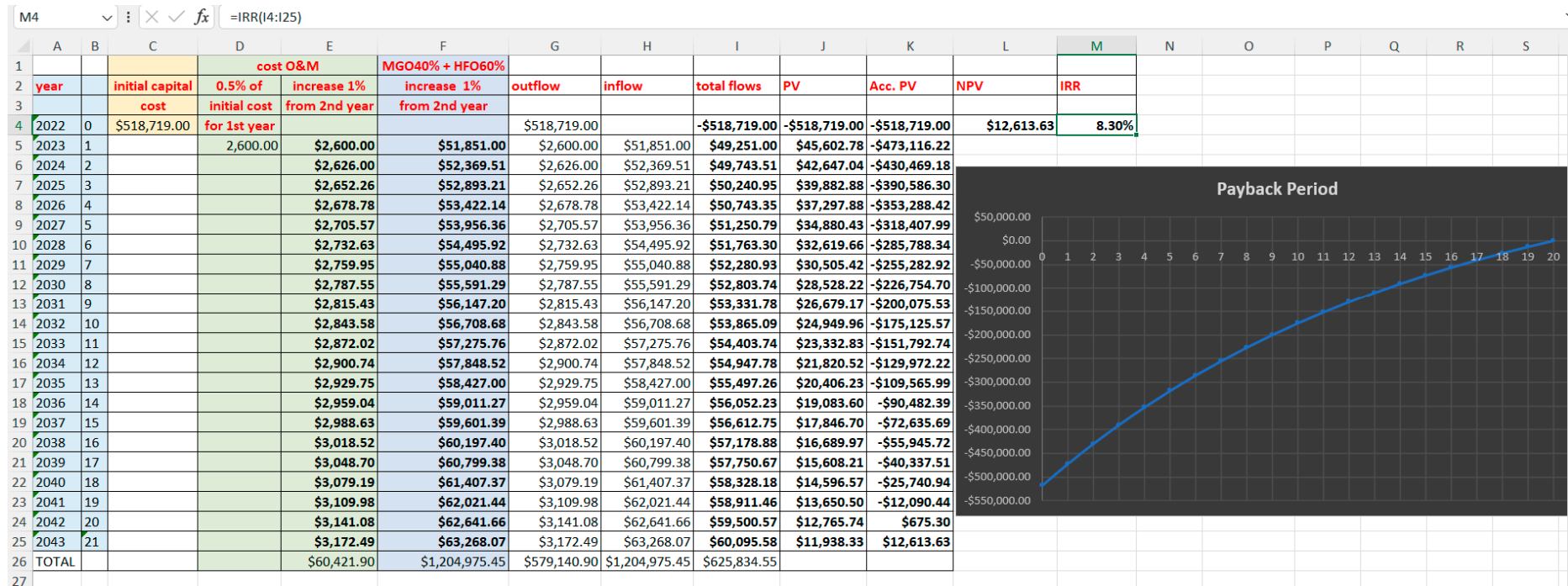
| CO2 (Kg)         | SOx (Kg)      | PM (kg)      | NOx (Kg)       |
|------------------|---------------|--------------|----------------|
| 11156.32         | 23.54         | 3.78         | 136.25         |
| 14915.85         | 31.47         | 4.30         | 172.40         |
| 19502.74         | 41.14         | 8.84         | 266.63         |
| 20529.05         | 43.31         | 7.71         | 260.26         |
| 18644.26         | 39.33         | 9.55         | 268.94         |
| 18398.01         | 38.81         | 9.02         | 260.26         |
| 17690.03         | 37.32         | 10.13        | 268.94         |
| 15708.16         | 33.14         | 11.35        | 268.94         |
| 15414.55         | 32.52         | 10.86        | 260.26         |
| 13216.25         | 27.88         | 7.38         | 198.45         |
| 10297.61         | 21.72         | 4.50         | 138.71         |
| 9461.67          | 19.96         | 3.65         | 121.21         |
| <b>184934.50</b> | <b>390.15</b> | <b>91.07</b> | <b>2621.27</b> |



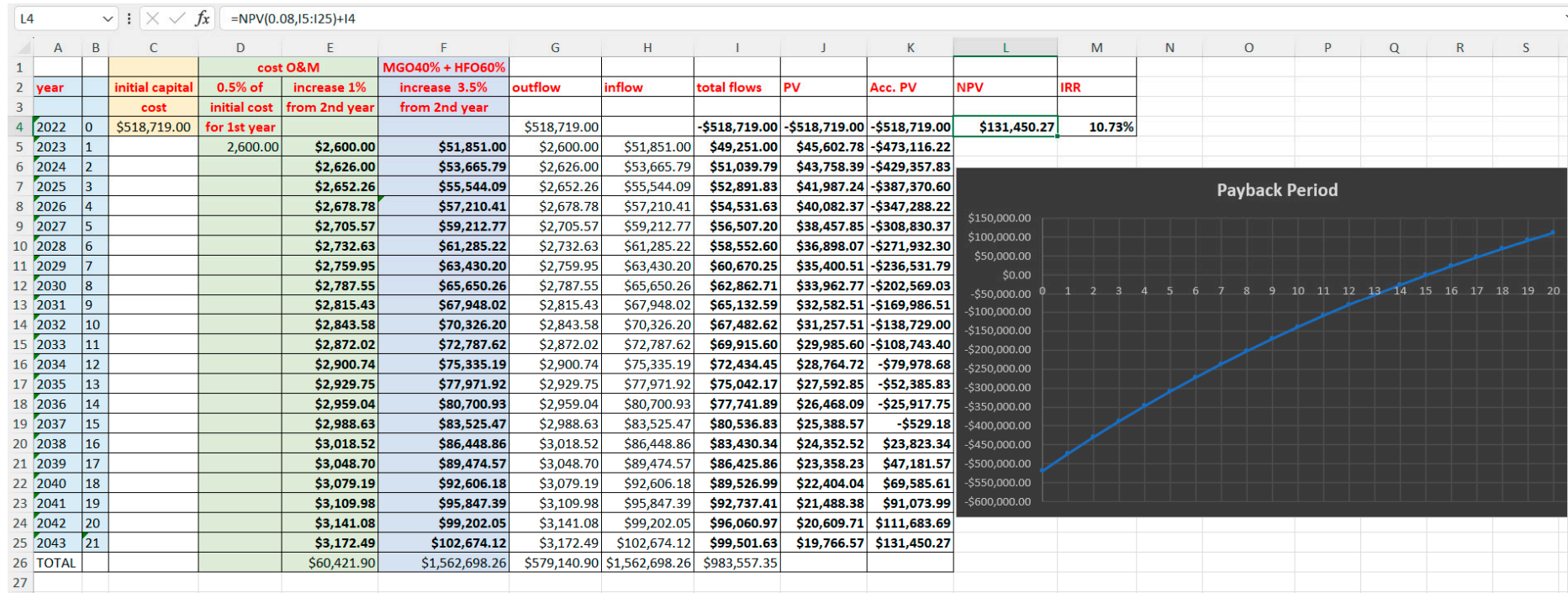
Economic calculations (the vessel consumes 40% MGO and 60% HFO, central scenario):

[illegible]

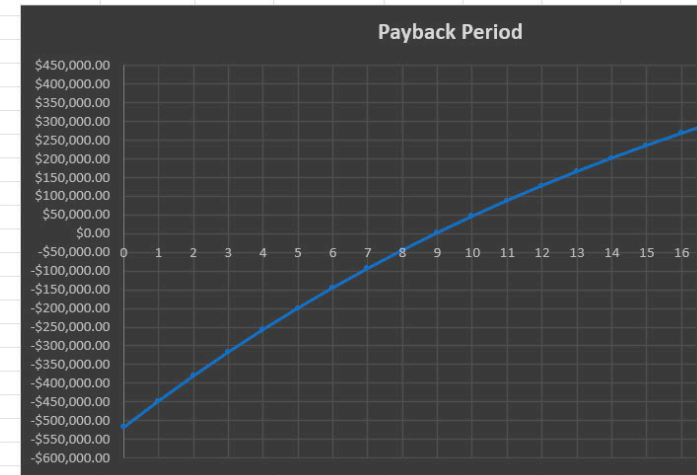
Economic calculations (the vessel consumes 40% MGO and 60% HFO, low scenario):



Economic calculations (the vessel consumes 40% MGO and 60% HFO, high scenario):

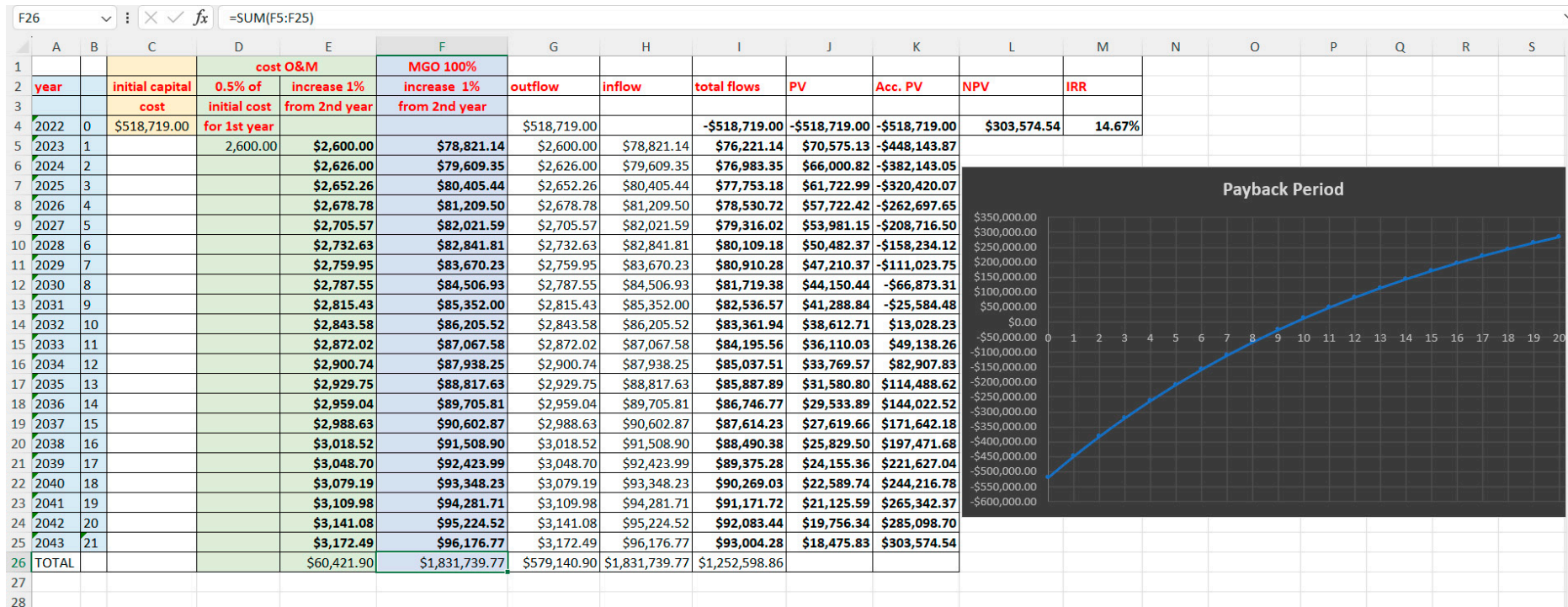


Economic calculations (the vessel consumes only MGO fuel 100%, central scenario):

[illegible]



Economic calculations (the vessel consumes only MGO fuel 100%, low scenario):



Economic calculations (the vessel consumes only MGO fuel 100%, high scenario):

