# RESERVE REQUIREMENT IMPACTS OF MICROGRID INTEGRATION OF WIND, SOLAR, AND OCEAN WAVE POWER GENERATION

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7/23/2016

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# 1. Introduction

The ocean wave energy is a free and abundant resource which has led to exploring new methods to take advantage of the energy in an efficient and profitable way. The wave energy harnessing techniques are not as mature as other renewable energy resources ones such as wind or solar. Nevertheless, in recent years wave energy converters (WECs) have been gaining attention and restoring confidence worldwide in their role to meet the increasing demands and strict environmental standards Ocean wave power, considered a third generation renewable energy, is maturing in a fast pace to compete with other energy sources and is establishing as a core member of some renewable portfolios. [1]

Different WEC projects are being and have been carried out throughout the world using different WEC technologies such as the Orkney Wave Farm in Scotland [2] or the Aguçadoura Wave Farm in Portugal [3]. These projects are of different sizes, some are utility scale projects while others are smaller projects which could be implemented in a Microgrid. In particular, an Oscillating Water Column (OWC) plant with an installed capacity of 250 kW has been deployed in Mutriku, Spain. [4]

Mutriku is located in the coast of the Basque Country, in the north of Spain. In this region there are also 5 offshore wind turbines [5] and there is enough solar resource for PV panels to be profitable. This situation has inspired this study where the possibility of having a Microgrid in which the three renewable resources exist is possible.

In [1] a study of the impact that wave power energy has on the required reserves is done and the conclusion is that when combining solar, wind and ocean wave energy resources together in a large scale power system the reserve requirements decrease and therefore the cost of operating the grid also decreases. This happens because of the nature of the different renewable energy sources which tend to compensated each other's volatility.

The goal of this research is to study how the reserve requirements are impacted by the combination of PV, wind and wave energy in the case of a Microgrid.

## 2. Methodology

The methodology for this study consists on solving the unit commitment and economic dispatch problem for different cases of renewable generation based real data and the probability distributions of the output power for the different generators in order to determine a reasonable amount of reserve requirement taking the volatility of the renewable energy sources into account. The problem will be solved with and without wave energy generation in order to determine if the combination of solar, wind and ocean wave energy sources reduces the reserve requirements compared to a Microgrid that only consists of solar and wind generation as its renewable energy.

Mixed Integer Linear Programming (MILP) will be used to solve the unit commitment and economic dispatch problem. The equations used are explained in section 4. Section 5 includes the system parameters used and how the output power is calculated for each generator.

In order to determine the different scenarios the error probability distributions are going to be used. Based on the actual values obtained, which will be explained in section 6, the different scenarios will be created using random numbers that follow the error probability distributions.

## 3. Study Case

This study has been inspired by the deployment that WECs are currently having and the outlook for the future they have. In Mutriku, the Basque Energy Entity (*Ente de la Energia Vasca*) has installed a 250 kW OWC plant and even though it is connected to the grid instead of being part of a Microgrid, the geography of that location presents the opportunity of doing so.

Not far from Mutriku there is are 5 offshore wind turbines located in the port of Bilbao. A combination of these two renewable energy source generators in an area with the same geographical characteristics is feasible and including solar generation is also feasible due to the characteristics of solar panels, the can be situated in any geographical area.

Therefore it is reasonable to assume that a Microgrid with WECs, wind turbines and solar PV panels can be feasible in costal locations. The case that is going to be studied is going to be a hypothetical Microgrid but based on the characteristics of the coast in the Basque Country, Spain. This hypothetical Microgrid is based on real data in order to make the study realistic. The data used for the study is explained in section 6.

*Figure 1. Mutriku's WEC location*

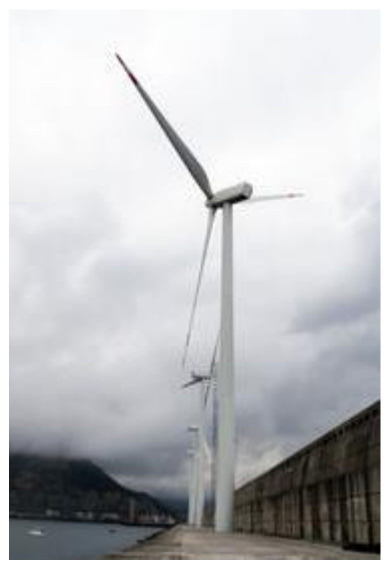

*Figure 2 Bilbao's port Wind Farm*

## 3.1. Wind Energy

The wind turbines are based on the wind turbines the port of Bilbao, Spain (*Parque de energías renovables del Puerto de Bilbao*). There are 5 wind turbines, listed in the next section, in the plant and the project was done by *Acciona* [6].

### 3.1.1. Wind Turbines

The wind turbines that are installed are the *GAMESA G80-2.0 MW* produced by *GAMESA* with a rated power of 2.0 MW. Table 1 and figure 3 represent the power curve which will be used [7].

| Speed (m/s) | Power (kW) | Speed (m/s) | Power (kW) | Speed (m/s) | Power (kW) |
|---|---|---|---|---|---|
| 4 | 66.3 | 11 | 1598 | 18 | 2000 |
| 5 | 152 | 12 | 1818 | 19 | 2000 |
| 6 | 280 | 13 | 1935 | 20 | 2000 |
| 7 | 457 | 14 | 1980 | 21 | 2000 |
| 8 | 690 | 15 | 1995 | 22 | 2000 |
| 9 | 978 | 16 | 1999 | 23 | 2000 |
| 10 | 1296 | 17 | 2000 | 25 | 2000 |

*Table 1. Power Curve Gamesa G80-2.0 MW (for an air density of 1,225 kg/m3)*

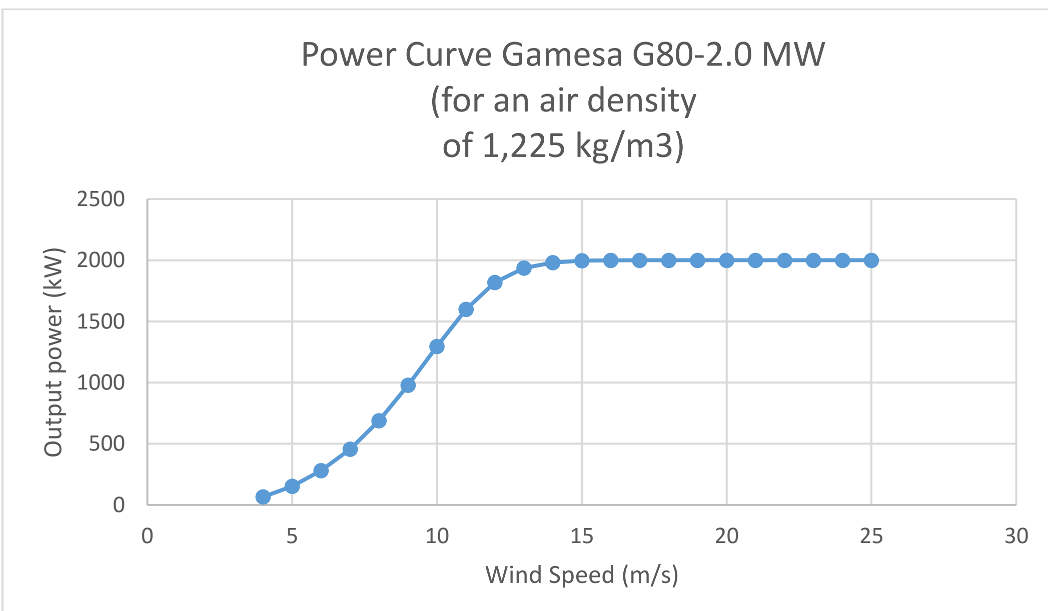


*Figure 3. Power Curve Gamesa G80-2.0 MW (for an air density of 1,225 kg/m3)*

### 3.2. Solar Energy

The solar energy has been based on the irradiation data obtained and the PV panels used are the *PV-MLU250HC* produced by MITSUBISHI ELECTRIC which have a maximum rated power of 250 W and an area of 1.7 $m^2$ each [9]. The irradiation data has been taken from Pasaia's Metocean Station [8]

### 3.3. Wave energy

The WECs used are inspired by the OWCs in Mutriku. The wave energy data (wave height and period) has been taken from [8].

#### 3.3.1. OWC

In order to determine the power output in function of the wave height and the period the Conversion matrix for the oscillating water column has been used obtained from [10].

| **Significant Wave Height (m)** | **Wave Period (s)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** |
| **1** | 8 | 17 | 27 | 42 | 6 | 59 | 52 | 44 | 40 | 38 | 40 | 38 | 30 |
| **1.5** | 17 | 39 | 61 | 96 | 126 | 132 | 117 | 99 | 89 | 87 | 89 | 85 | 66 |
| **2** | 30 | 69 | 108 | 170 | 224 | 235 | 208 | 177 | 159 | 154 | 159 | 151 | 118 |
| **2.5** | 47 | 108 | 169 | 266 | 350 | 368 | 324 | 276 | 249 | 241 | 248 | 236 | 185 |
| **3** | 68 | 155 | 244 | 383 | 504 | 530 | 467 | 398 | 358 | 347 | 357 | 340 | 266 |
| **3.5** | 93 | 212 | 332 | 521 | 686 | 721 | 636 | 542 | 487 | 472 | 486 | 463 | 362 |
| **4** | 121 | 276 | 433 | 680 | 896 | 942 | 831 | 708 | 636 | 616 | 634 | 605 | 473 |
| **4.5** | 154 | 350 | 548 | 861 | 1130 | 1190 | 1050 | 896 | 805 | 780 | 803 | 765 | 599 |
| **5** | 190 | 432 | 677 | 1060 | 1400 | 1470 | 1300 | 1110 | 994 | 963 | 991 | 945 | 739 |
| **5.5** | 211 | 523 | 819 | 1290 | 1690 | 1780 | 1570 | 1340 | 1200 | 1170 | 1200 | 1140 | 894 |
| **6** | 236 | 622 | 975 | 1530 | 2020 | 2120 | 1870 | 1590 | 1430 | 1390 | 1430 | 1360 | 1860 |
| **6.5** | 264 | 730 | 1140 | 1800 | 2370 | 2490 | 2190 | 1870 | 1680 | 1630 | 1670 | 1600 | 1250 |
| **7** | 297 | 847 | 1330 | 2080 | 2750 | 2880 | 2540 | 2170 | 1950 | 1890 | 1940 | 1850 | 1450 |

*Table 2. Conversion matrix for the oscillating water column*

### 3.4. Load

In order to obtain the load data for the Microgrid, the load for the entire Spanish system was used and scaled (explained in section 5) due to the lack of information of demand in specific locations.

# 4. Unit Commitment

The unit commitment problem is a nonlinear mixed integer minimization problem containing integer variables, the units' status (the unit is either ON or OFF) for example, and continuous variables, the units' output power for example. The objective is to find a feasible solution where the operating cost in minimized, which is represented by nonlinear equations.

The unit commitment problem is usually formulated as a mixed integer linear programing (MILP) model. In this section, a summary of the MILP formulation is explained, including the objective function and the problem constraints [11]

## 4.1. Nomenclature

- "f" is the total operation cost ($)
- "t" is the index of time periods (generally hours) and "T" is the total number of times periods studied
- "j" is the index of dispatchable generator units and "J" is the total number of generator units.
- Cj is the "j" unit's cost function
- Dts is the forecasted system's demand at time "t"
- Ijt is the status variable for unit "j" at time "t" (Binary variable, 0 if the unit is OFF and 1 if it is ON)
- Yjt is the Startup indicator variable for unit "j" at time "t" (Binary variable, 1 the unit is started)
- Zjt is the Shutdown indicator variable for unit "j" at time "t" (Binary variable, 1 if it's turned off)
- TON,j is the minimum time unit "j" has to be turned on immediately after staring it on.
- TOFF,j is the minimum time unit "j" has to be turned off immediately after turning it off.
- Pjt is the power output of unit "j" at time "t" (kW)
- WIt is the forecasted power output from wind generators at time "t" (kW)
- PVt is the forecasted power output from solar generators at time "t" (kW)
- WAt is the forecasted power output from wave generators at time "t" (kW)
- Pj,min Minimum output power of unit "j" (kW)
- Pj,max Maximun output power of unit "j" (kW)
- RRj Ramping rate of unit "j" (kW)
- SUjt is the startup cost of unit "j" at time "t" ($)
- SRt is the systems spinning reserve requirement at time "t", (kW)

- Srallt is the available spinning reserve in the system at time “t” (kW)
- Srujt is the reserve provided by unit “j” at time “t” (kW)
- Srgridt is the reserve provided by the upstream grid at time “t” (kW)
- Cr is the reserve price ($/kWh)
- PgridIn,t is the power imported from the upstream grid at time “t” (kW)
- PgridOut,t is the power exported to the upstream grid at time “t” (kW)
- Pgrid,max is the capacity of the line linking the upstream grid and the microgrid (kW)
- Cgrid is the grid power price ($/kWh)

### 4.2. Objective function

The objective function is to minimize the operation cost of operating the Microgrid. It is the sum of the cost of producing energy plus the cost of the spinning reserve plus the cost of buying energy from the grid.

$$\min f = \sum_{t=1}^{T}\sum_{j=1}^{J}\left(C_j\left(P_{jt}\right) + SU_{jt}\right) + \sum_{t=1}^{T}\left(SRall_t * C_r\right) + \sum_{t=1}^{T}\left(P_{gridIn,t} * C_{grid}\right) \qquad (1)$$

### 4.4. Constraints

**Startup and shutdown indicators**

$$\begin{cases} Y_{jt} - Z_{jt} = I_{jt} - I_{j(t-1)} \\ Y_{jt} + Z_{jt} \leq 1 \end{cases}, \qquad \forall j, t \tag{2}$$

**Capacity Constraints**

$$I_{jt} * P_{j,min} \leq P_{jt} \leq I_{jt} * P_{j,max}, \qquad \forall j, t \tag{3}$$

**Dispatchable generators available spinning reserves**

$$SRu_{jt} = \left(I_{jt} * P_{j,max}\right) - P_{jt}, \qquad \forall j, t \tag{4}$$

$$SRu_{jt} \geq 0, \qquad \forall j, t \tag{5}$$

**Main grid spinning reserve**

$$SRgrid_t = P_{grid,max} - P_{gridIn,t}, \qquad \forall t \tag{6}$$

**Total available spinning reserve**

$$SRall_t = \sum_{j=1}^{J} SRu_{jt} + SRgrid_t, \qquad \forall t \tag{7}$$

**Power Balance**

$$\sum_{j=1}^{J} P_{jt} + WI_t + PV_t + WA_t + P_{gridIn,t} - P_{gridOut,t} = D_t, \qquad \forall t \tag{8}$$

**Dispatchable generators minimum ON time constraint**

$$\sum_{\tau=t}^{t+T_{ON}-1} I_{j\tau} \geq T_{ON,j} * Y_{jt}, \qquad \forall j \tag{9}$$

**Dispatchable generators minimum OFF time constraint**

$$\sum_{\tau=t}^{t+T_{OFF}-1} \left(1 - I_{j\tau}\right) \geq T_{OFF,j} * Z_{jt}, \qquad \forall j \tag{10}$$

**Dispatchable generators ramping constraint**

$$P_{j(t-1)} - RR_j \leq P_{jt} \leq P_{j(t-1)} + RR_j, \qquad \forall j, t \tag{11}$$

**Main grid power limits**

$$0 \leq P_{gridIn,t} \leq P_{grid,max} \tag{12}$$

$$0 \leq P_{gridOut,t} \leq P_{grid,max} \tag{13}$$

Usually the time unit is hours but in order to be more accurate it wil be done in ten minute intervals as explained in section 7.

# 5. Microgrid Parameters

In this section the Microgrid parameters used for the study are explained as well as how the output power for each generator has been calculated. [11] has been used as a reference for determining the size of each generator.

## 5.1. Wind Energy

Table 3 and figure 4 contain the Power Curve for the wind turbine that will be used. One will be used

| Speed (m/s) | Power (kW) | Speed (m/s) | Power (kW) | Speed (m/s) | Power (kW) |
|---|---|---|---|---|---|
| 4 | 66.3 | 11 | 1598 | 18 | 2000 |
| 5 | 152 | 12 | 1818 | 19 | 2000 |
| 6 | 280 | 13 | 1935 | 20 | 2000 |
| 7 | 457 | 14 | 1980 | 21 | 2000 |
| 8 | 690 | 15 | 1995 | 22 | 2000 |
| 9 | 978 | 16 | 1999 | 23 | 2000 |
| 10 | 1296 | 17 | 2000 | 25 | 2000 |

*Table 3. Power Curve Gamesa G80-2.0 MW (for an air density of 1,225 kg/m3)*

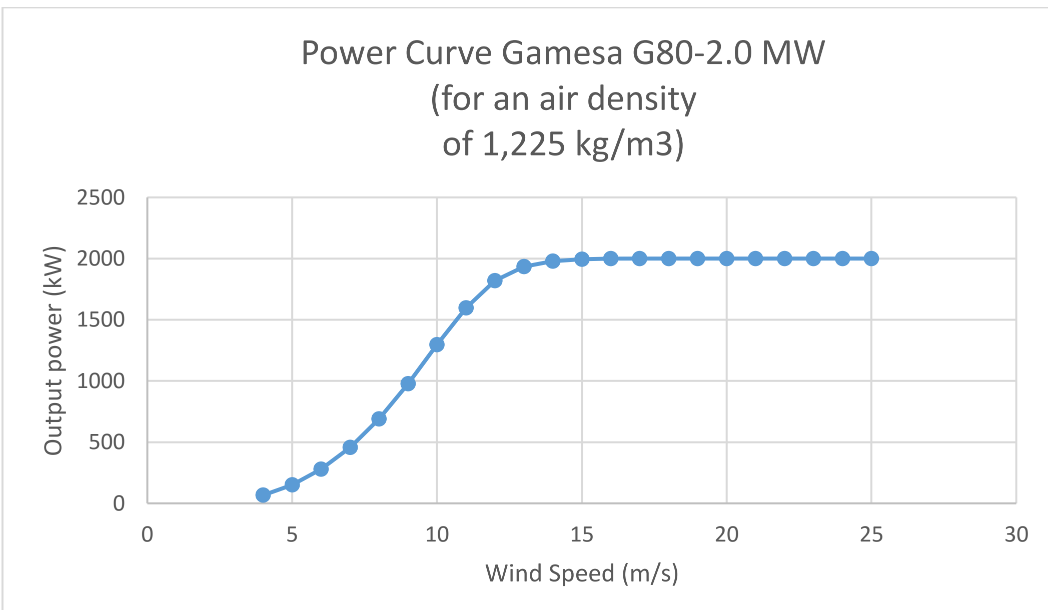


*Figure 4. Power Curve Gamesa G80-2.0 MW (for an air density of 1,225 kg/m3)*

The wind speed data used is captured at 1800cm altitude and therefore it is necessary to calculate the air speed at 100m, the turbines height [12].

$$\frac{v}{v_0} = \frac{ln\left(\frac{H}{z}\right)}{ln\left(\frac{H_0}{Z}\right)} \tag{14}$$

Where

- “v” is the wind speed we want to calculate at height H
- “$v_0$” is the wind speed at height $H_0$
- “z” is the roughness length. (0.0002 for water surface, the study case)

The equation used to calculate the wind speed at 100m using the wind speed data at 18m is

$$v_{100m} = v_{18m} \frac{ln\left(\frac{100}{0.0002}\right)}{ln\left(\frac{18}{0.0002}\right)} \tag{15}$$

The output power will be calculated by using linear interpolation if it is between the cut-in (4m/s) and cut-out (25m/s) speed as follows

$$P = \frac{(P_2 - P_1) * (v - v_1)}{(v_2 - v_1)} + P_1, \qquad P_1 \le P \le P_2 \tag{16}$$

Where:

- v is the actual wind speed
- $v_1$ is the closest and smaller wind speed to v from the power curve
- $v_2$ is the closest and bigger wind speed to v from the power curve
- $P_1$ is the power out corresponding to $v_1$
- $P_2$ is the power out corresponding to $v_2$
- P is the power out corresponding to v

Example:

For a wind speed of 12.4 m/s, the power output is (16)

$$P = \frac{(1935 - 1818) * (12.4 - 12)}{(13 - 12)} + 1818 = 1864.8\ kW$$

## 5.2. Solar Energy

The characteristics of the solar panels used in order to calculate the output power are described in table 4 and equation (17) [9].

| | | |
|---|---|---|
| $P_{max}^{25°C\ and\ 1000W/m^2}$ | $P_{max}$ (kW) at 25°C and 100W/m$^2$ | 0.250 |
| $\eta$ | Efficiency (%) | 15 |
| $c_W$ | Irradiance dependence of $P_{max}$ at 25°C (%/[W/m$^2$]) | 0.1 |
| $c_T$ | Temperature dependence of $P_{max}$ (%/°C) | -0.45 |

*Table 4. Characteristics of the MITSUBISHI PV-MLU250HC*

$$P_{output} = P_{max}^{25°C\ and\ 1000W/m^2} \cdot \left(\frac{c_W}{100} W + \frac{c_T}{100}(T - 25)\right) \quad (17)$$

Where

- $P_{output}$ is the output power obtained at temperature T in kW
- *T* is the temperature in °C
- W is the irradiation in W/m$^2$

The number of panels used for the study is 2000 with a total area of 3311.75 m$^2$

### 5.3. Ocean wave energy

In order to determine the power output in function of the wave height and the period the Conversion matrix for the oscillating water column has been used obtained from [10].

| Significant Wave Height (m) | Wave Period (s) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** |
| **1** | 8 | 17 | 27 | 42 | 6 | 59 | 52 | 44 | 40 | 38 | 40 | 38 | 30 |
| **1.5** | 17 | 39 | 61 | 96 | 126 | 132 | 117 | 99 | 89 | 87 | 89 | 85 | 66 |
| **2** | 30 | 69 | 108 | 170 | 224 | 235 | 208 | 177 | 159 | 154 | 159 | 151 | 118 |
| **2.5** | 47 | 108 | 169 | 266 | 350 | 368 | 324 | 276 | 249 | 241 | 248 | 236 | 185 |
| **3** | 68 | 155 | 244 | 383 | 504 | 530 | 467 | 398 | 358 | 347 | 357 | 340 | 266 |
| **3.5** | 93 | 212 | 332 | 521 | 686 | 721 | 636 | 542 | 487 | 472 | 486 | 463 | 362 |
| **4** | 121 | 276 | 433 | 680 | 896 | 942 | 831 | 708 | 636 | 616 | 634 | 605 | 473 |
| **4.5** | 154 | 350 | 548 | 861 | 1130 | 1190 | 1050 | 896 | 805 | 780 | 803 | 765 | 599 |
| **5** | 190 | 432 | 677 | 1060 | 1400 | 1470 | 1300 | 1110 | 994 | 963 | 991 | 945 | 739 |
| **5.5** | 211 | 523 | 819 | 1290 | 1690 | 1780 | 1570 | 1340 | 1200 | 1170 | 1200 | 1140 | 894 |
| **6** | 236 | 622 | 975 | 1530 | 2020 | 2120 | 1870 | 1590 | 1430 | 1390 | 1430 | 1360 | 1860 |
| **6.5** | 264 | 730 | 1140 | 1800 | 2370 | 2490 | 2190 | 1870 | 1680 | 1630 | 1670 | 1600 | 1250 |
| **7** | 297 | 847 | 1330 | 2080 | 2750 | 2880 | 2540 | 2170 | 1950 | 1890 | 1940 | 1850 | 1450 |

*Table 5. Conversion matrix for the oscillating water column*

The output will be obtained by interpolation if the period and the wave height are between the maximum and minimum values as seen in table 5. It will be done as follows

$$P_1 = \frac{(P_{12} - P_{11}) * (h - h_1)}{(h_2 - h_1)} + P_{11}, \qquad P_{11} \leq P_1 \leq P_{12} \tag{18}$$

$$P_2 = \frac{(P_{22} - P_{11}) * (h - h_1)}{(h_2 - h_1)} + P_{21}, \qquad P_{21} \leq P_2 \leq P_{22} \tag{19}$$

$$P = \frac{(P_2 - P_1) * (p - p_1)}{(p_2 - p_1)} + P_1, \qquad P_1 \leq P \leq P_2 \tag{20}$$

Where:

- h is the actual wave height
- $h_1$ is the closest and smaller wave height to h from the Conversion matrix
- $h_2$ is the closest and bigger wave height to h from the Conversion matrix
- p is the actual wave period

- $p_1$ is the closest and smaller wave period to p from the Conversion matrix
- $p_2$ is the closest and bigger wave period to p from the Conversion matrix
- $P_{11}$ is the power out corresponding to $p_1$ and $h_1$
- $P_{12}$ is the power out corresponding to $p_1$ and $h_2$
- $P_{21}$ is the power out corresponding to $p_2$ and $h_1$
- $P_{22}$ is the power out corresponding to $p_2$ and $h_2$
- $P_1$ is the power out corresponding to $p_1$ and h
- $P_2$ is the power out corresponding to $p_2$ and h
- P is the power out corresponding to p and h

### 5.4. Dispatchable Generators

The dispatchable generators included in the Microgrid are based on [11]. The grid capacity to import and to export power is big enough to assume that there is no maximum output power to the grid or import power but the price is assumed to be higher than the generating price.

| Unit | Pmax (kW) | Pmin (kW) | a ($/Hr) | b ($/kWh) | c ($/kW$^2$h*10$^{-4}$) | MUT (Hr) | MDT (Hr) | HSC ($) |
|---|---|---|---|---|---|---|---|---|
| 1 | 100 | 0 | 5 | 4 | 10 | 5 | 5 | 550 |
| 2 | 100 | 0 | 5 | 6 | 20 | 5 | 5 | 500 |
| 3 | 50 | 0 | 20 | 8 | 25 | 3 | 3 | 450 |
| 4 | 50 | 0 | 30 | 10 | 20 | 2 | 2 | 800 |

*Table 6. Micorgrid's Dispatchable Generators*

# 6. Data

This section includes the data sources used for the renewable energy and the load as well as the output power forecast error probability distributions.

## 6.1. Wind Energy

The wind speed data that has been used has been obtained from Pasaia's Metocean Station [8]. The data used is from 2014 and the altitude at which it is measured is 1800 cm.

The forecast error probability distributions follows a normal distribution as shown in table 6 [13]. In this the forecasting error is analyzed for different countries and how it fits in a normal distribution. The values used correspond to Spain's because it is where the hypothetical Microgrid would be.

| | |
|---|---|
| mean | -0.0018 |
| standard deviation | 0.0133 |

*Table 7. Wind power output forecasting error probability normal distribution*

## 6.2. Solar Energy

The irradiation and temperature data that has been used has been obtained from Pasaia's Metocean Station [8]. The data used is from 2014.

The forecast error probability distribution follows a normal distribution as follows [14]

| | |
|---|---|
| mean | 0 |
| standard deviation | 0.1207 |

*Table 8. Solar power output forecasting error probability normal distribution*

## 6.3. Wave Energy

The wave height and period data that has been used has been obtained from Pasaia's Metocean Station [8]. The data used is from 2014.

The forecast error probability distribution has been calculated for this case because no data regarding this was found. To calculate it the data was collected from [14], the Basque meteorological agency. This agency provides the day ahead forecasted data and the actual data. Using this data, the forecasted error was calculated and fitted into a normal distribution obtaining the error probability shown in table 6.

| | |
|---|---|
| mean | -0.0607 |
| standard deviation | 0.0022 |

*Table 9. Ocean wave power output forecasting error probability normal distribution*

## 6.4. Demand

The demand curve data was taken from *Red Eléctrica de España* [16]. The load for 2014 was used. TO obtain a realistic demand curve for the Microgrid the load was scaled for the Microgrid size as shown in equation (21).

$$Demand_{MICROGRID}(t) = Demand_{SYSTEM}(t) * \frac{Load_{MICROGRID}^{MAX}}{Load_{SYSTEM}^{MAX}} \quad (21)$$

Where

- $Demand_{MICROGRID}(t)$ is the Microgrid's demand at time t
- $Demand_{SYSTEM}(t)$ is the system's demand at time t
- $Load_{MICROGRID}^{MAX}$ is the Microgrid's maximum load
- $Load_{SYSTEM}^{MAX}$ is the system's maximum load

The forecast error probability distribution follows a normal distribution as follows [17]

| | |
|---|---|
| mean | -0.002 |
| standard deviation | 0.026 |

*Table 10. Demand forecasting error probability normal distribution*

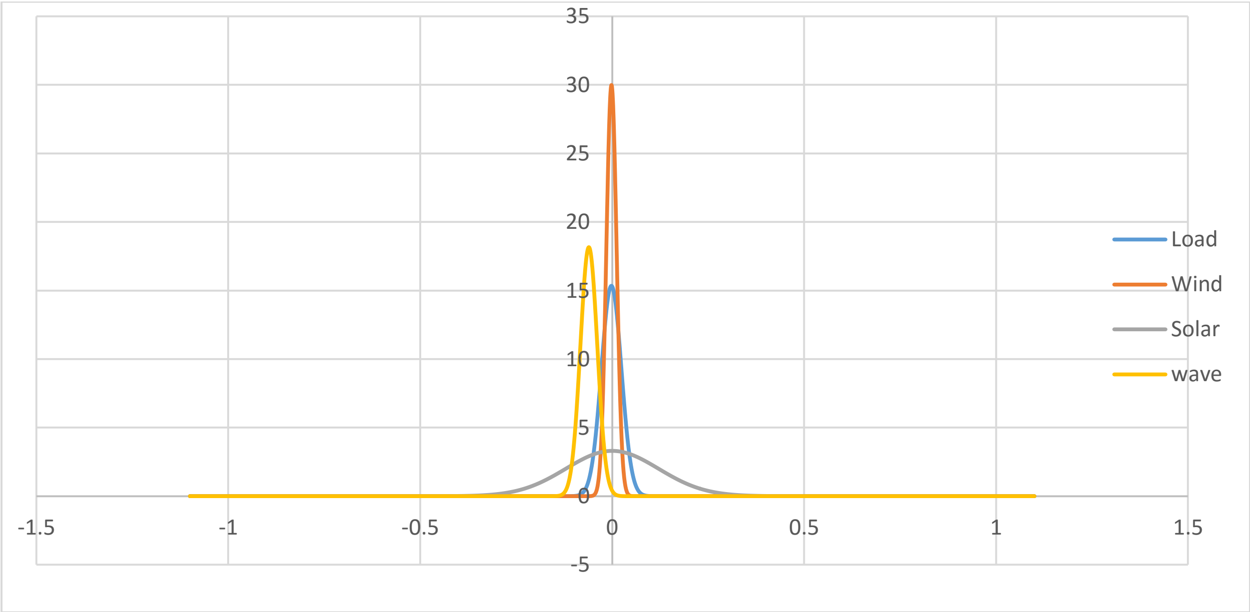


*Figure 5. The probability distribution for the load, wind, solar and wave energy*

## 7. Simulation and Results

The simulation is to perform the unit commitment for 10 min intervals and due of the data capacity the simulation will be performed for single days. For each day, seven scenarios will be simulated, one with the real data and the other six with random data obtained with the probability distributions.

Figures 6,7,8 and 9 compare the reserve requirements for four different days and the Appendix shows all the results obtained.

## 7.1. Day 32. 1st of February

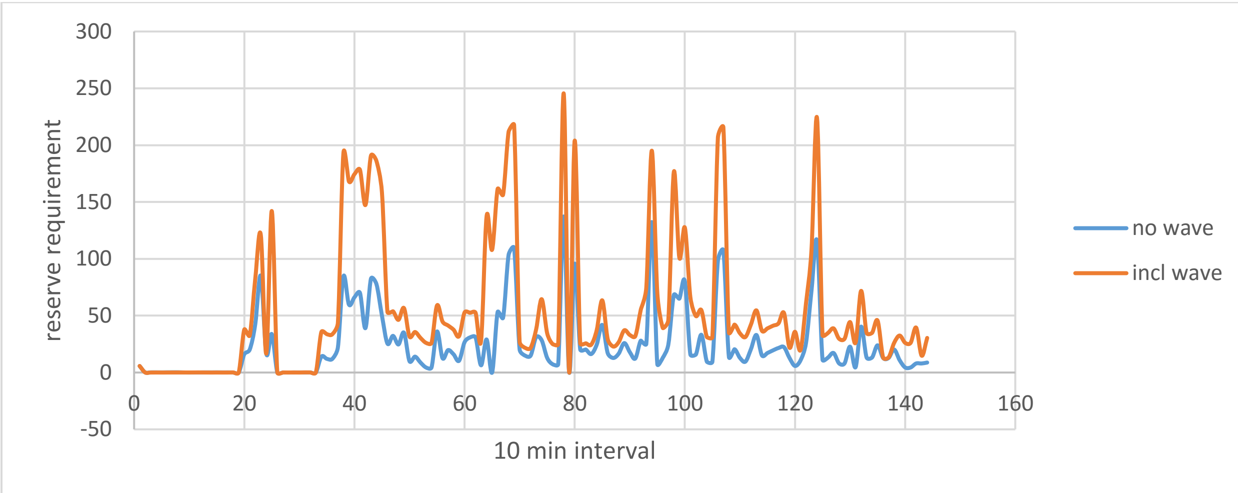


*Figure 6. Reserve Requirement for day 32*

## 7.2. Day 152: 1st of June

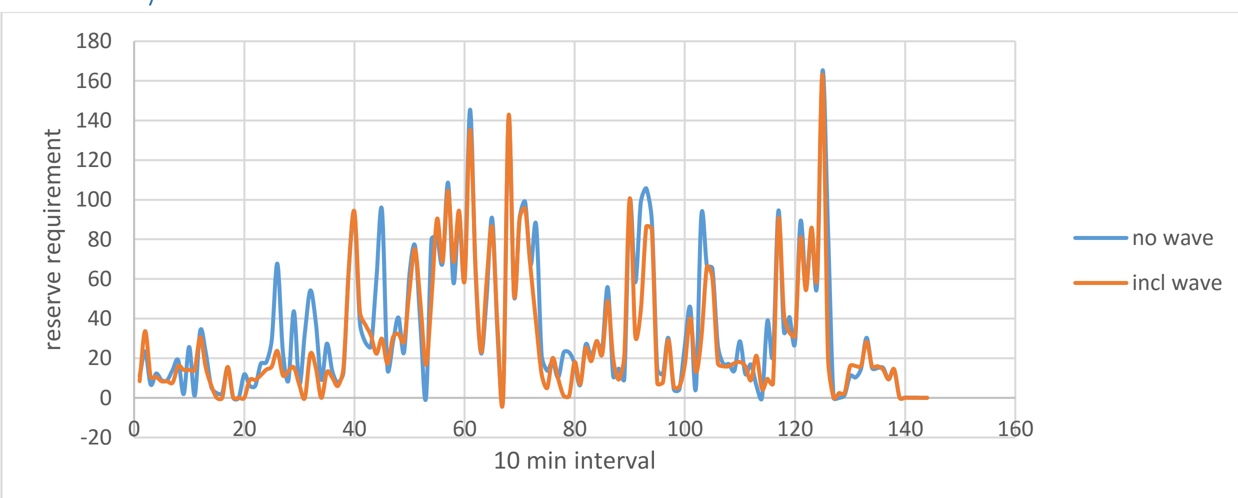


*Figure 7. Reserve Requirement for day 152*

## 7.3. Day 245: 1st of September

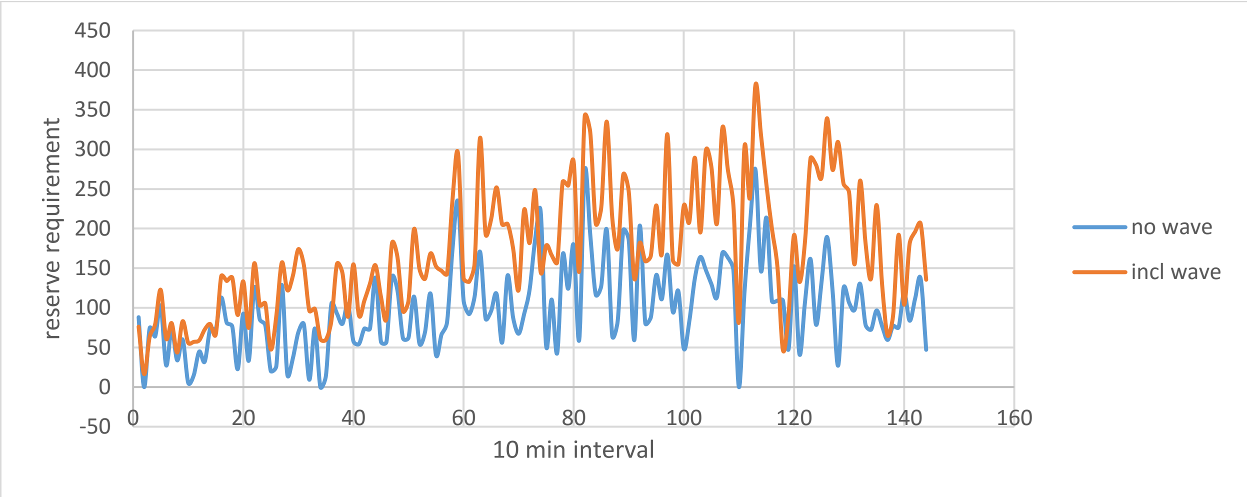


*Figure 8. Reserve Requirement for day 245*

## 7.4. Day 320: 16th of November

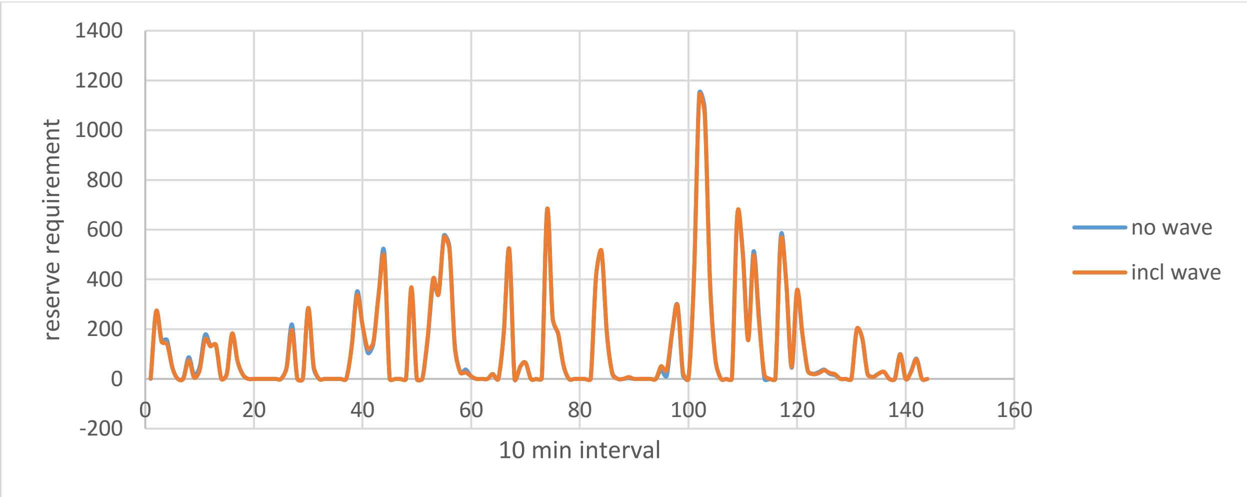


*Figure 9. Reserve Requirement for day 320*

# 8. Conclusion

It can be seen based on the results that including wave energy in the microgrid does not decrease the spinning reserve requirement. The opposite happens in a large sale system where including solar, wind and wave energy reduces the spinning reserve [1].

The reason that including wave energy generation in a large system, along with wind and solar energy, decreases the spinning reserve is because when one of the renewable sources decreases another usually compensates due to the nature of the energy sources due to the nature of the renewable energies. For instances, in a day where the wind energy is less than the forecasted one, the wave energy can be bigger than expected. This explanation is reasonable for a large scale grid but in the case of a Microgrid where all the renewable energy generators are located in the same location this doesn't happen.

Nevertheless, this is not a discouragement to include more renewable sources in Microgrids, because with appropriate energy storage systems it is possible to store energy and therefore regulate the spinning reserve. WEC technology is still a relatively immature technology and hopefully it will be reach the same deployment as wind and solar.

It is worth stating that while doing this research, Mutriku's Wave Farm has set a world record for wave energy generation [18].

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# 10. Appendix

In this Appendix the simulation results for Day 32 with wind generation are displayed in order to explain how the simulations where done. All the units are kW.

## 10.1. Day 32. 1st of February including wave energy

### 10.1.1. Real case

| p1 | p2 | p3 | p4 | pgridin | pgridout | load | wind | pv | wave |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 173 | 1882 | 1934 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 217 | 1869 | 1965 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 247 | 1857 | 1983 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 276 | 1845 | 2000 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 288 | 1833 | 2000 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 300 | 1821 | 2000 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 312 | 1809 | 2000 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 318 | 1803 | 2000 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 324 | 1797 | 1999 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 325 | 1791 | 1995 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 331 | 1785 | 1995 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 338 | 1779 | 1996 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 345 | 1773 | 1997 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 344 | 1771 | 1993 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 346 | 1768 | 1993 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 256 | 1766 | 1901 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 322 | 1764 | 1965 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 213 | 1762 | 1854 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 263 | 1760 | 1901 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 158 | 1763 | 1800 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 123 | 1766 | 1767 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 58 | 1769 | 1706 | 0 | 121 |
| 100 | 58 | 50 | 17 | 703 | 0 | 1772 | 723 | 0 | 121 |
| 100 | 33 | 50 | 33 | 654 | 217 | 1775 | 1000 | 0 | 121 |
| 100 | 100 | 50 | 50 | 892 | 0 | 1778 | 465 | 0 | 121 |
| 0 | 33 | 0 | 33 | 0 | 380 | 1789 | 1981 | 0 | 121 |
| 0 | 0 | 0 | 17 | 0 | 334 | 1799 | 1995 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 311 | 1810 | 2000 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 301 | 1821 | 2000 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 290 | 1831 | 2000 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 280 | 1842 | 2000 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 260 | 1862 | 2000 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 239 | 1882 | 1999 | 0 | 121 |
| 29 | 0 | 0 | 0 | 103 | 0 | 1901 | 1649 | 0 | 121 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 9 | 0 | 0 | 0 | 24 | 0 | 1921 | 1767 | 0 | 121 |
| 9 | 0 | 0 | 17 | 7 | 196 | 1941 | 1983 | 0 | 121 |
| 60 | 33 | 0 | 33 | 293 | 0 | 1961 | 1420 | 0 | 121 |
| 100 | 100 | 50 | 50 | 1062 | 0 | 1981 | 497 | 0 | 121 |
| 100 | 100 | 50 | 50 | 1115 | 0 | 2001 | 465 | 0 | 121 |
| 100 | 100 | 50 | 50 | 1232 | 0 | 2020 | 367 | 0 | 121 |
| 100 | 100 | 50 | 50 | 1345 | 0 | 2040 | 274 | 0 | 121 |
| 100 | 100 | 50 | 50 | 1451 | 0 | 2060 | 187 | 0 | 121 |
| 100 | 100 | 50 | 50 | 1402 | 0 | 2080 | 256 | 0 | 121 |
| 100 | 100 | 50 | 50 | 1121 | 0 | 2100 | 558 | 0 | 121 |
| 100 | 100 | 50 | 50 | 1202 | 0 | 2120 | 497 | 0 | 121 |
| 100 | 33 | 38 | 33 | 604 | 0 | 2141 | 1211 | 0 | 121 |
| 15 | 0 | 0 | 17 | 29 | 20 | 2161 | 2000 | 0 | 121 |
| 15 | 0 | 0 | 0 | 45 | 0 | 2181 | 2000 | 0 | 121 |
| 19 | 0 | 0 | 0 | 62 | 0 | 2201 | 1999 | 0 | 121 |
| 20 | 0 | 0 | 0 | 68 | 0 | 2210 | 2000 | 0 | 121 |
| 22 | 0 | 0 | 0 | 75 | 0 | 2218 | 2000 | 0 | 121 |
| 25 | 0 | 0 | 0 | 85 | 0 | 2226 | 1995 | 0 | 121 |
| 18 | 0 | 0 | 0 | 59 | 2 | 2235 | 2000 | 39 | 121 |
| 18 | 0 | 0 | 0 | 59 | 0 | 2243 | 1995 | 50 | 121 |
| 86 | 0 | 0 | 0 | 331 | 0 | 2251 | 1649 | 64 | 121 |
| 100 | 40 | 0 | 0 | 467 | 0 | 2251 | 1462 | 60 | 121 |
| 16 | 0 | 0 | 0 | 52 | 0 | 2252 | 1983 | 79 | 121 |
| 16 | 0 | 0 | 0 | 52 | 25 | 2252 | 2000 | 88 | 121 |
| 24 | 0 | 0 | 0 | 83 | 0 | 2252 | 1946 | 78 | 121 |
| 85 | 0 | 0 | 0 | 327 | 0 | 2253 | 1649 | 71 | 121 |
| 11 | 0 | 0 | 0 | 29 | 0 | 2253 | 2000 | 92 | 121 |
| 11 | 0 | 0 | 17 | 13 | 30 | 2249 | 2000 | 117 | 121 |
| 58 | 33 | 0 | 33 | 286 | 0 | 2244 | 1618 | 95 | 121 |
| 100 | 100 | 50 | 50 | 1352 | 0 | 2240 | 367 | 99 | 121 |
| 100 | 100 | 50 | 50 | 1441 | 0 | 2236 | 205 | 169 | 121 |
| 100 | 100 | 50 | 50 | 1309 | 0 | 2232 | 297 | 205 | 121 |
| 100 | 100 | 50 | 50 | 814 | 0 | 2227 | 803 | 190 | 121 |
| 100 | 100 | 50 | 50 | 1010 | 0 | 2221 | 558 | 231 | 121 |
| 100 | 100 | 50 | 50 | 824 | 0 | 2214 | 723 | 246 | 121 |
| 0 | 33 | 0 | 33 | 0 | 25 | 2207 | 2000 | 43 | 121 |
| 0 | 0 | 0 | 17 | 0 | 222 | 2200 | 2000 | 284 | 121 |
| 0 | 0 | 0 | 0 | 0 | 87 | 2193 | 1983 | 175 | 121 |
| 0 | 0 | 0 | 0 | 0 | 99 | 2187 | 1999 | 165 | 121 |
| 100 | 24 | 0 | 0 | 435 | 0 | 2180 | 1255 | 245 | 121 |
| 1 | 0 | 0 | 0 | 0 | 9 | 2173 | 2000 | 60 | 121 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 17 | 0 | 108 | 2167 | 2000 | 137 | 121 |
| 0 | 33 | 0 | 33 | 0 | 91 | 2160 | 1999 | 64 | 121 |
| 100 | 100 | 50 | 50 | 1566 | 0 | 2154 | 0 | 167 | 121 |
| 100 | 33 | 50 | 50 | 654 | 1070 | 2147 | 2000 | 209 | 121 |
| 100 | 100 | 50 | 50 | 1540 | 0 | 2145 | 0 | 183 | 121 |
| 0 | 33 | 0 | 33 | 0 | 160 | 2143 | 2000 | 115 | 121 |
| 0 | 0 | 0 | 17 | 0 | 112 | 2141 | 2000 | 115 | 121 |
| 0 | 0 | 0 | 0 | 0 | 79 | 2138 | 1996 | 100 | 121 |
| 0 | 0 | 0 | 0 | 0 | 57 | 2136 | 1971 | 100 | 121 |
| 77 | 0 | 0 | 0 | 296 | 0 | 2134 | 1546 | 93 | 121 |
| 0 | 0 | 0 | 0 | 0 | 59 | 2138 | 2000 | 76 | 121 |
| 0 | 0 | 0 | 0 | 0 | 71 | 2142 | 2000 | 91 | 121 |
| 0 | 0 | 0 | 0 | 0 | 73 | 2146 | 2000 | 97 | 121 |
| 0 | 0 | 0 | 0 | 0 | 65 | 2150 | 2000 | 94 | 121 |
| 0 | 0 | 0 | 0 | 0 | 46 | 2154 | 2000 | 79 | 121 |
| 0 | 0 | 0 | 0 | 0 | 22 | 2158 | 2000 | 60 | 121 |
| 4 | 0 | 0 | 0 | 5 | 0 | 2174 | 1952 | 92 | 121 |
| 28 | 11 | 0 | 0 | 121 | 0 | 2190 | 1824 | 86 | 121 |
| 100 | 77 | 50 | 0 | 742 | 0 | 2206 | 1039 | 77 | 121 |
| 0 | 11 | 9 | 0 | 12 | 3 | 2223 | 2000 | 72 | 121 |
| 0 | 3 | 9 | 17 | 17 | 0 | 2239 | 2000 | 72 | 121 |
| 8 | 33 | 9 | 33 | 123 | 0 | 2255 | 1854 | 73 | 121 |
| 100 | 100 | 50 | 50 | 800 | 0 | 2284 | 1000 | 62 | 121 |
| 100 | 38 | 50 | 33 | 663 | 0 | 2314 | 1255 | 54 | 121 |
| 100 | 69 | 50 | 17 | 726 | 0 | 2343 | 1211 | 49 | 121 |
| 100 | 3 | 17 | 0 | 461 | 111 | 2373 | 1737 | 45 | 121 |
| 100 | 3 | 17 | 0 | 461 | 0 | 2403 | 1649 | 52 | 121 |
| 51 | 0 | 17 | 0 | 261 | 0 | 2432 | 1934 | 48 | 121 |
| 48 | 0 | 17 | 17 | 231 | 0 | 2434 | 2000 | 0 | 121 |
| 48 | 33 | 17 | 33 | 204 | 22 | 2436 | 2000 | 0 | 121 |
| 100 | 100 | 50 | 50 | 2016 | 0 | 2437 | 0 | 0 | 121 |
| 100 | 100 | 50 | 50 | 2018 | 0 | 2439 | 0 | 0 | 121 |
| 65 | 33 | 0 | 33 | 188 | 0 | 2441 | 2000 | 0 | 121 |
| 65 | 0 | 0 | 17 | 240 | 0 | 2442 | 2000 | 0 | 121 |
| 65 | 0 | 0 | 0 | 246 | 0 | 2432 | 2000 | 0 | 121 |
| 63 | 0 | 0 | 0 | 237 | 0 | 2421 | 2000 | 0 | 121 |
| 60 | 0 | 0 | 0 | 229 | 0 | 2410 | 2000 | 0 | 121 |
| 58 | 0 | 0 | 0 | 220 | 0 | 2400 | 2000 | 0 | 121 |
| 56 | 0 | 0 | 0 | 212 | 0 | 2389 | 2000 | 0 | 121 |
| 54 | 0 | 0 | 0 | 203 | 0 | 2378 | 2000 | 0 | 121 |
| 54 | 0 | 0 | 0 | 203 | 12 | 2366 | 1999 | 0 | 121 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 69 | 0 | 0 | 0 | 263 | 0 | 2354 | 1901 | 0 | 121 |
| 100 | 36 | 41 | 0 | 623 | 0 | 2342 | 1420 | 0 | 121 |
| 100 | 0 | 41 | 0 | 551 | 132 | 2329 | 1649 | 0 | 121 |
| 100 | 0 | 41 | 0 | 551 | 0 | 2317 | 1504 | 0 | 121 |
| 100 | 0 | 41 | 0 | 551 | 187 | 2305 | 1679 | 0 | 121 |
| 100 | 0 | 48 | 17 | 580 | 0 | 2287 | 1420 | 0 | 121 |
| 100 | 55 | 50 | 33 | 698 | 0 | 2269 | 1211 | 0 | 121 |
| 100 | 100 | 50 | 50 | 829 | 0 | 2250 | 1000 | 0 | 121 |
| 100 | 33 | 14 | 33 | 510 | 0 | 2232 | 1420 | 0 | 121 |
| 64 | 0 | 0 | 17 | 244 | 0 | 2214 | 1767 | 0 | 121 |
| 47 | 0 | 0 | 0 | 174 | 0 | 2196 | 1854 | 0 | 121 |
| 13 | 0 | 0 | 0 | 38 | 0 | 2172 | 2000 | 0 | 121 |
| 13 | 0 | 0 | 0 | 38 | 20 | 2149 | 1997 | 0 | 121 |
| 74 | 0 | 0 | 0 | 282 | 0 | 2125 | 1649 | 0 | 121 |
| 74 | 0 | 0 | 0 | 282 | 371 | 2101 | 1996 | 0 | 121 |
| 93 | 0 | 0 | 0 | 359 | 0 | 2078 | 1504 | 0 | 121 |
| 10 | 0 | 0 | 0 | 28 | 103 | 2054 | 1998 | 0 | 121 |
| 10 | 0 | 0 | 0 | 28 | 0 | 2030 | 1870 | 0 | 121 |
| 5 | 0 | 0 | 0 | 8 | 0 | 2005 | 1870 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 122 | 1980 | 1981 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 118 | 1955 | 1952 | 0 | 121 |
| 0 | 0 | 0 | 0 | 0 | 92 | 1931 | 1901 | 0 | 121 |
| 24 | 0 | 0 | 0 | 82 | 0 | 1906 | 1679 | 0 | 121 |
| 20 | 0 | 0 | 0 | 66 | 0 | 1886 | 1679 | 0 | 121 |
| 20 | 0 | 0 | 0 | 66 | 47 | 1865 | 1706 | 0 | 121 |
| 100 | 9 | 0 | 0 | 404 | 0 | 1845 | 1211 | 0 | 121 |
| 100 | 33 | 0 | 0 | 355 | 331 | 1825 | 1546 | 0 | 121 |
| 100 | 100 | 19 | 0 | 662 | 0 | 1805 | 803 | 0 | 121 |

### 10.1.2. Scenario 1

| p1 | p2 | p3 | p4 | pgridin | pgridout | load | wind | pv | wave |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 187 | 1835 | 1912 | 0 | 110 |
| 0 | 0 | 0 | 0 | 0 | 192 | 1910 | 1994 | 0 | 108 |
| 0 | 0 | 0 | 0 | 0 | 224 | 1836 | 1950 | 0 | 110 |
| 0 | 0 | 0 | 0 | 0 | 295 | 1795 | 1987 | 0 | 103 |
| 0 | 0 | 0 | 0 | 0 | 307 | 1802 | 2004 | 0 | 105 |
| 0 | 0 | 0 | 0 | 0 | 251 | 1842 | 1986 | 0 | 107 |
| 0 | 0 | 0 | 0 | 0 | 373 | 1785 | 2053 | 0 | 105 |
| 0 | 0 | 0 | 0 | 0 | 265 | 1869 | 2032 | 0 | 102 |
| 0 | 0 | 0 | 0 | 0 | 310 | 1775 | 1985 | 0 | 100 |
| 0 | 0 | 0 | 0 | 0 | 346 | 1754 | 1989 | 0 | 111 |
| 0 | 0 | 0 | 0 | 0 | 329 | 1788 | 2007 | 0 | 110 |
| 0 | 0 | 0 | 0 | 0 | 374 | 1726 | 1992 | 0 | 109 |
| 0 | 0 | 0 | 0 | 0 | 305 | 1788 | 1987 | 0 | 106 |
| 0 | 0 | 0 | 0 | 0 | 382 | 1745 | 2019 | 0 | 108 |
| 0 | 0 | 0 | 0 | 0 | 261 | 1809 | 1961 | 0 | 109 |
| 0 | 0 | 0 | 0 | 0 | 229 | 1811 | 1928 | 0 | 113 |
| 0 | 0 | 0 | 0 | 0 | 405 | 1675 | 1972 | 0 | 107 |
| 0 | 0 | 0 | 0 | 0 | 276 | 1696 | 1858 | 0 | 113 |
| 0 | 0 | 0 | 0 | 0 | 306 | 1725 | 1932 | 0 | 99 |
| 43 | 0 | 0 | 0 | 60 | 0 | 1729 | 1515 | 0 | 112 |
| 19 | 0 | 0 | 0 | 0 | 161 | 1719 | 1753 | 0 | 109 |
| 19 | 19 | 0 | 0 | 0 | 52 | 1789 | 1696 | 0 | 107 |
| 100 | 86 | 50 | 17 | 662 | 0 | 1752 | 728 | 0 | 110 |
| 100 | 33 | 50 | 33 | 559 | 132 | 1737 | 986 | 0 | 107 |
| 100 | 100 | 50 | 50 | 852 | 0 | 1732 | 468 | 0 | 113 |
| 0 | 33 | 0 | 33 | 0 | 395 | 1742 | 1963 | 0 | 107 |
| 0 | 0 | 0 | 17 | 0 | 205 | 1863 | 1943 | 0 | 109 |
| 0 | 0 | 0 | 0 | 0 | 261 | 1827 | 1982 | 0 | 107 |
| 0 | 0 | 0 | 0 | 0 | 304 | 1785 | 1977 | 0 | 112 |
| 0 | 0 | 0 | 0 | 0 | 220 | 1903 | 2007 | 0 | 116 |
| 0 | 0 | 0 | 0 | 0 | 342 | 1774 | 2009 | 0 | 107 |
| 0 | 0 | 0 | 0 | 0 | 212 | 1910 | 2008 | 0 | 114 |
| 0 | 0 | 0 | 0 | 0 | 151 | 1905 | 1948 | 0 | 108 |
| 58 | 0 | 0 | 0 | 129 | 0 | 1940 | 1651 | 0 | 102 |
| 23 | 0 | 0 | 0 | 0 | 25 | 1882 | 1766 | 0 | 118 |
| 23 | 0 | 0 | 17 | 0 | 172 | 1942 | 1979 | 0 | 95 |
| 100 | 33 | 4 | 33 | 369 | 0 | 2049 | 1397 | 0 | 112 |
| 100 | 100 | 50 | 50 | 975 | 0 | 1884 | 496 | 0 | 113 |
| 100 | 100 | 50 | 50 | 1074 | 0 | 1936 | 462 | 0 | 100 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 100 | 100 | 50 | 50 | 1174 | 0 | 1954 | 369 | 0 | 111 |
| 100 | 100 | 50 | 50 | 1289 | 0 | 1961 | 273 | 0 | 99 |
| 100 | 100 | 50 | 50 | 1500 | 0 | 2106 | 195 | 0 | 112 |
| 100 | 100 | 50 | 50 | 1379 | 0 | 2038 | 250 | 0 | 109 |
| 100 | 100 | 50 | 50 | 1082 | 0 | 2040 | 560 | 0 | 97 |
| 100 | 100 | 50 | 50 | 1154 | 0 | 2047 | 493 | 0 | 100 |
| 100 | 74 | 50 | 33 | 636 | 0 | 2206 | 1200 | 0 | 113 |
| 61 | 8 | 0 | 17 | 109 | 189 | 2142 | 2027 | 0 | 110 |
| 61 | 0 | 0 | 0 | 133 | 0 | 2326 | 2021 | 0 | 110 |
| 75 | 0 | 0 | 0 | 196 | 0 | 2337 | 1960 | 0 | 106 |
| 47 | 0 | 0 | 0 | 81 | 68 | 2204 | 2039 | 0 | 106 |
| 47 | 0 | 0 | 0 | 81 | 0 | 2211 | 1978 | 0 | 105 |
| 44 | 0 | 0 | 0 | 61 | 0 | 2239 | 2017 | 0 | 117 |
| 41 | 0 | 0 | 0 | 49 | 0 | 2260 | 2016 | 41 | 113 |
| 41 | 0 | 0 | 0 | 45 | 99 | 2151 | 1988 | 59 | 118 |
| 100 | 36 | 0 | 0 | 371 | 0 | 2316 | 1657 | 53 | 100 |
| 100 | 21 | 0 | 0 | 341 | 0 | 2097 | 1471 | 63 | 101 |
| 37 | 0 | 0 | 0 | 42 | 0 | 2206 | 1934 | 86 | 107 |
| 37 | 0 | 0 | 0 | 45 | 66 | 2254 | 2032 | 102 | 104 |
| 39 | 0 | 0 | 0 | 38 | 0 | 2227 | 1952 | 81 | 118 |
| 100 | 31 | 0 | 0 | 353 | 0 | 2295 | 1645 | 58 | 109 |
| 40 | 0 | 0 | 0 | 45 | 0 | 2294 | 2007 | 85 | 116 |
| 40 | 0 | 0 | 17 | 33 | 40 | 2271 | 1984 | 125 | 112 |
| 73 | 33 | 0 | 33 | 252 | 0 | 2208 | 1623 | 85 | 109 |
| 100 | 100 | 50 | 50 | 1279 | 0 | 2133 | 359 | 83 | 113 |
| 100 | 100 | 50 | 50 | 1449 | 0 | 2239 | 203 | 174 | 112 |
| 100 | 100 | 50 | 50 | 1259 | 0 | 2158 | 300 | 193 | 106 |
| 100 | 100 | 50 | 50 | 873 | 0 | 2265 | 796 | 186 | 110 |
| 100 | 100 | 50 | 50 | 1047 | 0 | 2199 | 564 | 182 | 106 |
| 100 | 100 | 50 | 50 | 878 | 0 | 2224 | 718 | 219 | 109 |
| 18 | 33 | 0 | 33 | 29 | 0 | 2207 | 1944 | 38 | 111 |
| 0 | 0 | 0 | 17 | 0 | 169 | 2227 | 1980 | 291 | 109 |
| 0 | 0 | 0 | 0 | 0 | 204 | 2076 | 1990 | 180 | 110 |
| 38 | 0 | 0 | 0 | 37 | 0 | 2301 | 1961 | 149 | 116 |
| 100 | 34 | 0 | 0 | 361 | 0 | 2131 | 1248 | 280 | 107 |
| 35 | 0 | 0 | 0 | 26 | 0 | 2244 | 2007 | 62 | 114 |
| 25 | 0 | 0 | 17 | 0 | 177 | 2151 | 2010 | 169 | 108 |
| 25 | 33 | 0 | 33 | 0 | 71 | 2189 | 1975 | 83 | 110 |
| 100 | 100 | 50 | 50 | 1666 | 0 | 2217 | 0 | 144 | 107 |
| 100 | 33 | 50 | 50 | 555 | 1009 | 2062 | 2022 | 149 | 112 |
| 100 | 100 | 50 | 50 | 1491 | 0 | 2092 | 0 | 199 | 102 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 26 | 33 | 0 | 33 | 0 | 132 | 2167 | 1972 | 122 | 113 |
| 26 | 0 | 0 | 17 | 0 | 4 | 2229 | 1976 | 108 | 107 |
| 25 | 0 | 0 | 0 | 0 | 15 | 2138 | 1930 | 86 | 112 |
| 25 | 0 | 0 | 0 | 0 | 15 | 2192 | 1981 | 88 | 114 |
| 100 | 24 | 0 | 0 | 345 | 0 | 2206 | 1550 | 84 | 103 |
| 12 | 0 | 0 | 0 | 0 | 111 | 2063 | 1974 | 81 | 107 |
| 12 | 0 | 0 | 0 | 0 | 66 | 2156 | 2008 | 89 | 114 |
| 12 | 0 | 0 | 0 | 0 | 78 | 2119 | 1986 | 82 | 117 |
| 19 | 0 | 0 | 0 | 0 | 34 | 2164 | 1986 | 80 | 112 |
| 19 | 0 | 0 | 0 | 0 | 48 | 2175 | 2016 | 77 | 111 |
| 32 | 0 | 0 | 0 | 27 | 0 | 2235 | 2014 | 61 | 102 |
| 32 | 0 | 0 | 17 | 7 | 34 | 2126 | 1923 | 77 | 105 |
| 32 | 33 | 0 | 33 | 0 | 21 | 2144 | 1870 | 86 | 111 |
| 100 | 100 | 50 | 50 | 720 | 0 | 2211 | 1024 | 54 | 113 |
| 0 | 33 | 23 | 33 | 0 | 43 | 2235 | 2031 | 56 | 102 |
| 0 | 0 | 23 | 33 | 0 | 139 | 2104 | 2009 | 72 | 106 |
| 40 | 33 | 23 | 33 | 216 | 0 | 2339 | 1826 | 63 | 105 |
| 100 | 100 | 50 | 50 | 843 | 0 | 2300 | 986 | 58 | 113 |
| 100 | 100 | 50 | 50 | 709 | 0 | 2432 | 1250 | 59 | 114 |
| 100 | 100 | 50 | 50 | 734 | 0 | 2384 | 1199 | 39 | 112 |
| 100 | 33 | 3 | 33 | 365 | 0 | 2373 | 1684 | 42 | 112 |
| 100 | 20 | 3 | 17 | 338 | 0 | 2279 | 1645 | 44 | 113 |
| 88 | 0 | 3 | 17 | 256 | 64 | 2395 | 1944 | 44 | 107 |
| 88 | 0 | 3 | 17 | 264 | 0 | 2449 | 1979 | 0 | 99 |
| 88 | 33 | 3 | 33 | 210 | 62 | 2437 | 2023 | 0 | 109 |
| 100 | 100 | 50 | 50 | 2005 | 0 | 2430 | 0 | 0 | 125 |
| 100 | 100 | 50 | 50 | 2005 | 0 | 2422 | 0 | 0 | 117 |
| 100 | 33 | 0 | 33 | 264 | 0 | 2488 | 1956 | 0 | 101 |
| 100 | 7 | 0 | 17 | 296 | 0 | 2512 | 1975 | 0 | 118 |
| 70 | 0 | 0 | 0 | 169 | 0 | 2318 | 1970 | 0 | 109 |
| 70 | 0 | 0 | 0 | 166 | 91 | 2295 | 2039 | 0 | 112 |
| 80 | 0 | 0 | 0 | 212 | 0 | 2379 | 1978 | 0 | 110 |
| 58 | 0 | 0 | 0 | 127 | 51 | 2222 | 1982 | 0 | 106 |
| 58 | 0 | 0 | 0 | 119 | 0 | 2291 | 2000 | 0 | 114 |
| 78 | 0 | 0 | 0 | 200 | 0 | 2371 | 1982 | 0 | 111 |
| 95 | 0 | 0 | 0 | 269 | 0 | 2466 | 1991 | 0 | 112 |
| 95 | 9 | 0 | 0 | 271 | 19 | 2353 | 1896 | 0 | 100 |
| 100 | 76 | 50 | 0 | 645 | 0 | 2374 | 1396 | 0 | 107 |
| 100 | 9 | 44 | 0 | 454 | 65 | 2312 | 1657 | 0 | 113 |
| 100 | 2 | 44 | 0 | 476 | 0 | 2251 | 1526 | 0 | 103 |
| 100 | 0 | 44 | 17 | 461 | 26 | 2359 | 1664 | 0 | 98 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 100 | 33 | 44 | 33 | 529 | 0 | 2263 | 1424 | 0 | 100 |
| 100 | 100 | 50 | 50 | 744 | 0 | 2340 | 1193 | 0 | 103 |
| 100 | 100 | 50 | 50 | 815 | 0 | 2230 | 1005 | 0 | 111 |
| 100 | 33 | 24 | 33 | 452 | 0 | 2138 | 1386 | 0 | 109 |
| 86 | 0 | 0 | 17 | 217 | 70 | 2168 | 1810 | 0 | 108 |
| 86 | 0 | 0 | 0 | 238 | 0 | 2299 | 1871 | 0 | 104 |
| 38 | 0 | 0 | 0 | 48 | 0 | 2217 | 2025 | 0 | 105 |
| 38 | 0 | 0 | 0 | 50 | 34 | 2156 | 1998 | 0 | 103 |
| 100 | 9 | 0 | 0 | 312 | 0 | 2203 | 1675 | 0 | 106 |
| 100 | 0 | 0 | 0 | 296 | 421 | 2049 | 1970 | 0 | 104 |
| 100 | 23 | 0 | 0 | 336 | 0 | 2063 | 1495 | 0 | 109 |
| 31 | 0 | 0 | 0 | 13 | 181 | 1946 | 1970 | 0 | 113 |
| 31 | 0 | 0 | 0 | 18 | 0 | 2024 | 1867 | 0 | 108 |
| 31 | 0 | 0 | 0 | 19 | 0 | 2030 | 1873 | 0 | 106 |
| 0 | 0 | 0 | 0 | 0 | 188 | 1916 | 1993 | 0 | 112 |
| 0 | 0 | 0 | 0 | 0 | 184 | 1927 | 1998 | 0 | 112 |
| 22 | 0 | 0 | 0 | 0 | 22 | 2004 | 1892 | 0 | 112 |
| 45 | 0 | 0 | 0 | 72 | 0 | 1886 | 1659 | 0 | 110 |
| 44 | 0 | 0 | 0 | 75 | 0 | 1893 | 1671 | 0 | 102 |
| 44 | 0 | 0 | 0 | 70 | 69 | 1857 | 1704 | 0 | 108 |
| 100 | 33 | 15 | 0 | 416 | 0 | 1891 | 1217 | 0 | 110 |
| 100 | 33 | 15 | 0 | 408 | 364 | 1859 | 1548 | 0 | 118 |
| 100 | 100 | 33 | 0 | 627 | 0 | 1753 | 787 | 0 | 106 |

### 10.1.3. Scenario 2

| p1 | p2 | p3 | p4 | pgridin | pgridout | load | wind | pv | wave |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 70 | 180 | 1875 | 1944 |
| 0 | 0 | 0 | 0 | 0 | 0 | 41 | 143 | 1934 | 1975 |
| 0 | 0 | 0 | 0 | 0 | 0 | 195 | 303 | 1780 | 1975 |
| 0 | 0 | 0 | 0 | 0 | 0 | 242 | 346 | 1769 | 2011 |
| 0 | 0 | 0 | 0 | 0 | 0 | 175 | 282 | 1786 | 1960 |
| 0 | 0 | 0 | 0 | 0 | 0 | 231 | 335 | 1797 | 2028 |
| 0 | 0 | 0 | 0 | 0 | 0 | 260 | 358 | 1768 | 2028 |
| 0 | 0 | 0 | 0 | 0 | 0 | 205 | 308 | 1812 | 2016 |
| 0 | 0 | 0 | 0 | 0 | 0 | 221 | 334 | 1727 | 1948 |
| 0 | 0 | 0 | 0 | 0 | 0 | 183 | 288 | 1814 | 1997 |
| 0 | 0 | 0 | 0 | 0 | 0 | 208 | 315 | 1780 | 1988 |
| 0 | 0 | 0 | 0 | 0 | 0 | 182 | 283 | 1843 | 2025 |
| 0 | 0 | 0 | 0 | 0 | 0 | 236 | 347 | 1775 | 2011 |
| 0 | 0 | 0 | 0 | 0 | 0 | 216 | 314 | 1774 | 1990 |
| 0 | 0 | 0 | 0 | 0 | 0 | 309 | 402 | 1715 | 2024 |
| 0 | 0 | 0 | 0 | 0 | 0 | 66 | 166 | 1783 | 1849 |
| 0 | 0 | 0 | 0 | 0 | 0 | 202 | 306 | 1766 | 1967 |
| 0 | 0 | 0 | 0 | 0 | 0 | 132 | 234 | 1726 | 1857 |
| 0 | 0 | 0 | 0 | 0 | 0 | 193 | 302 | 1720 | 1911 |
| 68 | 0 | 0 | 0 | 0 | 167 | 0 | 0 | 1819 | 1480 |
| 16 | 0 | 0 | 17 | 0 | 0 | 123 | 187 | 1746 | 1788 |
| 16 | 33 | 0 | 33 | 0 | 0 | 0 | 103 | 1791 | 1702 |
| 100 | 100 | 50 | 50 | 46 | 744 | 0 | 0 | 1852 | 706 |
| 100 | 33 | 50 | 50 | 0 | 559 | 204 | 204 | 1727 | 1031 |
| 100 | 100 | 50 | 50 | 85 | 780 | 0 | 0 | 1651 | 467 |
| 0 | 33 | 0 | 33 | 0 | 0 | 224 | 403 | 1775 | 1999 |
| 0 | 0 | 0 | 17 | 0 | 0 | 120 | 242 | 1853 | 1973 |
| 0 | 0 | 0 | 0 | 0 | 0 | 219 | 326 | 1799 | 2018 |
| 0 | 0 | 0 | 0 | 0 | 0 | 85 | 197 | 1865 | 1950 |
| 0 | 0 | 0 | 0 | 0 | 0 | 110 | 224 | 1880 | 1989 |
| 0 | 0 | 0 | 0 | 0 | 0 | 111 | 221 | 1874 | 1984 |
| 0 | 0 | 0 | 0 | 0 | 0 | 82 | 195 | 1915 | 1997 |
| 0 | 0 | 0 | 0 | 0 | 0 | 156 | 263 | 1850 | 2005 |
| 65 | 0 | 0 | 0 | 0 | 154 | 0 | 0 | 1969 | 1646 |
| 24 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 1913 | 1791 |
| 24 | 0 | 0 | 17 | 0 | 0 | 152 | 179 | 1952 | 1981 |
| 80 | 33 | 0 | 33 | 0 | 282 | 0 | 0 | 1943 | 1408 |
| 100 | 100 | 50 | 50 | 364 | 1050 | 0 | 0 | 1973 | 509 |
| 100 | 100 | 50 | 50 | 433 | 1125 | 0 | 0 | 1991 | 458 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 100 | 100 | 50 | 50 | 590 | 1282 | 0 | 0 | 2063 | 373 |
| 100 | 100 | 50 | 50 | 736 | 1434 | 0 | 0 | 2110 | 274 |
| 100 | 100 | 50 | 50 | 748 | 1435 | 0 | 0 | 2035 | 188 |
| 100 | 100 | 50 | 50 | 776 | 1466 | 0 | 0 | 2134 | 258 |
| 100 | 100 | 50 | 50 | 488 | 1184 | 0 | 0 | 2149 | 561 |
| 100 | 100 | 50 | 50 | 573 | 1267 | 0 | 0 | 2173 | 500 |
| 100 | 56 | 50 | 33 | 0 | 600 | 0 | 0 | 2141 | 1190 |
| 40 | 0 | 0 | 17 | 0 | 49 | 0 | 0 | 2202 | 1984 |
| 38 | 0 | 0 | 0 | 0 | 43 | 66 | 66 | 2104 | 1983 |
| 38 | 0 | 0 | 0 | 0 | 49 | 0 | 0 | 2243 | 2055 |
| 45 | 0 | 0 | 0 | 0 | 72 | 0 | 0 | 2231 | 2004 |
| 41 | 0 | 0 | 0 | 0 | 45 | 99 | 99 | 2119 | 2010 |
| 41 | 0 | 0 | 0 | 0 | 53 | 0 | 0 | 2209 | 2002 |
| 15 | 0 | 0 | 0 | 0 | 0 | 0 | 53 | 2146 | 2032 |
| 15 | 0 | 0 | 0 | 0 | 0 | 26 | 78 | 2142 | 2050 |
| 100 | 9 | 16 | 0 | 0 | 369 | 0 | 0 | 2306 | 1636 |
| 100 | 67 | 16 | 0 | 0 | 481 | 0 | 0 | 2264 | 1437 |
| 36 | 0 | 0 | 0 | 0 | 42 | 0 | 0 | 2291 | 2027 |
| 36 | 0 | 0 | 0 | 0 | 43 | 63 | 63 | 2237 | 2038 |
| 39 | 0 | 0 | 0 | 0 | 37 | 0 | 0 | 2233 | 1954 |
| 100 | 14 | 0 | 0 | 0 | 330 | 0 | 0 | 2270 | 1648 |
| 63 | 0 | 0 | 0 | 0 | 145 | 0 | 0 | 2333 | 1929 |
| 63 | 0 | 0 | 17 | 0 | 128 | 277 | 277 | 2179 | 1996 |
| 86 | 33 | 0 | 33 | 0 | 297 | 0 | 0 | 2281 | 1626 |
| 100 | 100 | 50 | 50 | 562 | 1259 | 0 | 0 | 2129 | 361 |
| 100 | 100 | 50 | 50 | 728 | 1429 | 0 | 0 | 2221 | 208 |
| 100 | 100 | 50 | 50 | 633 | 1324 | 0 | 0 | 2221 | 299 |
| 100 | 100 | 50 | 50 | 90 | 782 | 0 | 0 | 2178 | 774 |
| 100 | 100 | 50 | 50 | 393 | 1093 | 0 | 0 | 2281 | 561 |
| 100 | 100 | 50 | 50 | 94 | 787 | 0 | 0 | 2166 | 721 |
| 16 | 33 | 0 | 33 | 0 | 20 | 0 | 0 | 2240 | 1992 |
| 15 | 0 | 0 | 17 | 0 | 0 | 82 | 155 | 2189 | 1946 |
| 15 | 0 | 0 | 0 | 0 | 0 | 0 | 47 | 2184 | 1945 |
| 15 | 0 | 0 | 0 | 0 | 0 | 27 | 71 | 2225 | 2017 |
| 100 | 67 | 8 | 0 | 0 | 457 | 0 | 0 | 2173 | 1225 |
| 16 | 0 | 0 | 0 | 0 | 0 | 0 | 49 | 2125 | 1990 |
| 0 | 0 | 0 | 17 | 0 | 0 | 32 | 160 | 2133 | 2023 |
| 0 | 33 | 0 | 33 | 0 | 0 | 30 | 193 | 2044 | 2000 |
| 100 | 100 | 50 | 50 | 908 | 1592 | 0 | 0 | 2160 | 0 |
| 100 | 33 | 50 | 50 | 0 | 565 | 1106 | 1106 | 2025 | 1995 |
| 100 | 100 | 50 | 50 | 858 | 1549 | 0 | 0 | 2164 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 33 | 0 | 33 | 0 | 0 | 0 | 89 | 2143 | 1965 |
| 0 | 0 | 0 | 17 | 0 | 0 | 9 | 138 | 2094 | 1976 |
| 0 | 0 | 0 | 0 | 0 | 0 | 63 | 172 | 2046 | 1984 |
| 37 | 0 | 0 | 0 | 0 | 46 | 0 | 0 | 2224 | 1934 |
| 100 | 5 | 0 | 0 | 0 | 295 | 0 | 0 | 2170 | 1556 |
| 18 | 0 | 0 | 0 | 0 | 0 | 24 | 55 | 2168 | 2028 |
| 18 | 0 | 0 | 0 | 0 | 0 | 0 | 42 | 2219 | 2037 |
| 18 | 0 | 0 | 0 | 0 | 0 | 9 | 48 | 2183 | 2008 |
| 37 | 0 | 0 | 0 | 0 | 50 | 0 | 0 | 2210 | 1933 |
| 33 | 0 | 0 | 0 | 0 | 38 | 0 | 0 | 2196 | 1945 |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 59 | 2127 | 2007 |
| 13 | 0 | 0 | 0 | 0 | 0 | 48 | 105 | 2091 | 1996 |
| 50 | 9 | 0 | 0 | 0 | 106 | 0 | 0 | 2198 | 1843 |
| 100 | 76 | 50 | 0 | 0 | 647 | 0 | 0 | 2108 | 1040 |
| 0 | 9 | 41 | 0 | 0 | 46 | 0 | 0 | 2223 | 1956 |
| 0 | 0 | 41 | 17 | 0 | 33 | 82 | 82 | 2206 | 2006 |
| 0 | 33 | 41 | 33 | 0 | 94 | 0 | 0 | 2230 | 1833 |
| 100 | 100 | 50 | 50 | 190 | 889 | 0 | 0 | 2364 | 1016 |
| 100 | 43 | 50 | 50 | 0 | 582 | 0 | 0 | 2245 | 1266 |
| 100 | 100 | 50 | 50 | 59 | 756 | 0 | 0 | 2382 | 1180 |
| 100 | 33 | 7 | 33 | 0 | 366 | 0 | 0 | 2396 | 1701 |
| 100 | 20 | 7 | 17 | 0 | 362 | 0 | 0 | 2317 | 1657 |
| 100 | 0 | 7 | 17 | 0 | 320 | 0 | 0 | 2467 | 1880 |
| 90 | 0 | 7 | 17 | 0 | 279 | 0 | 0 | 2492 | 1994 |
| 90 | 33 | 7 | 33 | 0 | 231 | 85 | 85 | 2466 | 2045 |
| 100 | 100 | 50 | 50 | 1313 | 2004 | 0 | 0 | 2413 | 0 |
| 100 | 100 | 50 | 50 | 1354 | 2044 | 0 | 0 | 2454 | 0 |
| 88 | 33 | 0 | 33 | 0 | 172 | 65 | 65 | 2354 | 1978 |
| 88 | 0 | 0 | 17 | 0 | 224 | 0 | 0 | 2425 | 1984 |
| 97 | 0 | 0 | 0 | 0 | 274 | 0 | 0 | 2476 | 1989 |
| 92 | 0 | 0 | 0 | 0 | 266 | 0 | 0 | 2494 | 2032 |
| 90 | 0 | 0 | 0 | 0 | 250 | 0 | 0 | 2427 | 1975 |
| 81 | 0 | 0 | 0 | 0 | 218 | 0 | 0 | 2384 | 1977 |
| 79 | 0 | 0 | 0 | 0 | 213 | 0 | 0 | 2411 | 2016 |
| 64 | 0 | 0 | 0 | 0 | 150 | 0 | 0 | 2327 | 2008 |
| 64 | 0 | 0 | 0 | 0 | 137 | 41 | 41 | 2281 | 2003 |
| 100 | 0 | 12 | 0 | 0 | 338 | 0 | 0 | 2456 | 1898 |
| 100 | 66 | 29 | 0 | 0 | 539 | 0 | 0 | 2259 | 1415 |
| 100 | 24 | 29 | 0 | 0 | 465 | 0 | 0 | 2356 | 1638 |
| 100 | 0 | 29 | 0 | 0 | 406 | 23 | 23 | 2174 | 1551 |
| 100 | 0 | 29 | 0 | 0 | 411 | 0 | 0 | 2315 | 1669 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 100 | 28 | 50 | 17 | 0 | 543 | 0 | 0 | 2250 | 1398 |
| 100 | 68 | 50 | 33 | 0 | 621 | 0 | 0 | 2189 | 1203 |
| 100 | 100 | 50 | 50 | 202 | 898 | 0 | 0 | 2299 | 997 |
| 100 | 33 | 42 | 33 | 0 | 522 | 0 | 0 | 2280 | 1436 |
| 82 | 0 | 0 | 17 | 0 | 216 | 18 | 18 | 2163 | 1755 |
| 82 | 0 | 0 | 0 | 0 | 220 | 0 | 0 | 2269 | 1860 |
| 27 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 2124 | 1987 |
| 27 | 0 | 0 | 0 | 0 | 11 | 88 | 88 | 2086 | 2037 |
| 100 | 18 | 0 | 0 | 0 | 332 | 0 | 0 | 2161 | 1607 |
| 100 | 0 | 0 | 0 | 0 | 289 | 375 | 375 | 2089 | 1964 |
| 100 | 65 | 0 | 0 | 0 | 421 | 0 | 0 | 2214 | 1519 |
| 30 | 0 | 0 | 0 | 0 | 6 | 147 | 147 | 2047 | 2041 |
| 30 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 2030 | 1878 |
| 34 | 0 | 0 | 0 | 0 | 26 | 0 | 0 | 1987 | 1820 |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 2034 | 1967 |
| 13 | 0 | 0 | 0 | 0 | 0 | 28 | 83 | 1983 | 1944 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 43 | 1941 | 1858 |
| 49 | 0 | 0 | 0 | 0 | 97 | 0 | 0 | 1887 | 1640 |
| 40 | 0 | 0 | 0 | 0 | 57 | 0 | 0 | 1867 | 1668 |
| 40 | 0 | 0 | 0 | 0 | 53 | 25 | 25 | 1889 | 1715 |
| 100 | 33 | 2 | 0 | 0 | 366 | 0 | 0 | 1826 | 1218 |
| 100 | 33 | 2 | 0 | 0 | 364 | 314 | 314 | 1840 | 1547 |
| 100 | 100 | 35 | 0 | 0 | 631 | 0 | 0 | 1777 | 802 |

### 10.1.4. Scenario 3

| p1 | p2 | p3 | p4 | pgridin | pgridout | load | wind | pv | wave |
|---|---|---|---|---|---|---|---|---|---|
| 6 | 0 | 0 | 0 | 0 | 79 | 1953 | 1924 | 0 | 102 |
| 0 | 0 | 0 | 0 | 0 | 194 | 1908 | 1991 | 0 | 111 |
| 0 | 0 | 0 | 0 | 0 | 204 | 1915 | 2011 | 0 | 108 |
| 0 | 0 | 0 | 0 | 0 | 232 | 1821 | 1944 | 0 | 109 |
| 0 | 0 | 0 | 0 | 0 | 273 | 1862 | 2028 | 0 | 106 |
| 0 | 0 | 0 | 0 | 0 | 337 | 1750 | 1985 | 0 | 102 |
| 0 | 0 | 0 | 0 | 0 | 318 | 1795 | 2012 | 0 | 101 |
| 0 | 0 | 0 | 0 | 0 | 329 | 1777 | 1998 | 0 | 108 |
| 0 | 0 | 0 | 0 | 0 | 248 | 1855 | 2003 | 0 | 101 |
| 0 | 0 | 0 | 0 | 0 | 315 | 1755 | 1965 | 0 | 104 |
| 0 | 0 | 0 | 0 | 0 | 349 | 1818 | 2061 | 0 | 106 |
| 0 | 0 | 0 | 0 | 0 | 381 | 1718 | 1988 | 0 | 110 |
| 0 | 0 | 0 | 0 | 0 | 362 | 1737 | 1995 | 0 | 104 |
| 0 | 0 | 0 | 0 | 0 | 424 | 1706 | 2018 | 0 | 112 |
| 0 | 0 | 0 | 0 | 0 | 370 | 1741 | 2000 | 0 | 111 |
| 0 | 0 | 0 | 0 | 0 | 305 | 1716 | 1913 | 0 | 108 |
| 0 | 0 | 0 | 0 | 0 | 252 | 1771 | 1919 | 0 | 104 |
| 0 | 0 | 0 | 0 | 0 | 230 | 1702 | 1826 | 0 | 106 |
| 0 | 0 | 0 | 0 | 0 | 290 | 1757 | 1926 | 0 | 122 |
| 44 | 0 | 0 | 0 | 65 | 0 | 1730 | 1511 | 0 | 110 |
| 2 | 0 | 0 | 12 | 0 | 151 | 1736 | 1762 | 0 | 111 |
| 2 | 33 | 0 | 29 | 0 | 159 | 1718 | 1703 | 0 | 109 |
| 100 | 100 | 50 | 46 | 691 | 0 | 1814 | 718 | 0 | 109 |
| 100 | 33 | 50 | 46 | 562 | 106 | 1787 | 998 | 0 | 105 |
| 100 | 100 | 50 | 50 | 897 | 0 | 1774 | 469 | 0 | 108 |
| 0 | 33 | 0 | 33 | 0 | 386 | 1708 | 1923 | 0 | 105 |
| 0 | 0 | 0 | 17 | 0 | 293 | 1830 | 2001 | 0 | 105 |
| 0 | 0 | 0 | 0 | 0 | 301 | 1786 | 1985 | 0 | 102 |
| 0 | 0 | 0 | 0 | 0 | 294 | 1829 | 2005 | 0 | 118 |
| 0 | 0 | 0 | 0 | 0 | 263 | 1793 | 1948 | 0 | 107 |
| 0 | 0 | 0 | 0 | 0 | 175 | 1907 | 1982 | 0 | 100 |
| 0 | 0 | 0 | 0 | 0 | 259 | 1807 | 1954 | 0 | 112 |
| 0 | 0 | 0 | 0 | 0 | 131 | 1932 | 1955 | 0 | 108 |
| 53 | 0 | 0 | 0 | 105 | 0 | 1893 | 1627 | 0 | 107 |
| 43 | 0 | 0 | 0 | 56 | 0 | 1961 | 1746 | 0 | 115 |
| 43 | 0 | 0 | 17 | 49 | 338 | 1872 | 1996 | 0 | 106 |
| 89 | 33 | 0 | 33 | 316 | 0 | 1978 | 1400 | 0 | 107 |
| 100 | 100 | 50 | 50 | 1116 | 0 | 2011 | 491 | 0 | 104 |
| 100 | 100 | 50 | 50 | 1189 | 0 | 2057 | 462 | 0 | 107 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 100 | 100 | 50 | 50 | 1310 | 0 | 2081 | 362 | 0 | 109 |
| 100 | 100 | 50 | 50 | 1362 | 0 | 2046 | 277 | 0 | 107 |
| 100 | 100 | 50 | 50 | 1380 | 0 | 1972 | 187 | 0 | 105 |
| 100 | 100 | 50 | 50 | 1499 | 0 | 2161 | 255 | 0 | 107 |
| 100 | 100 | 50 | 50 | 1214 | 0 | 2173 | 554 | 0 | 106 |
| 100 | 100 | 50 | 50 | 1176 | 0 | 2077 | 493 | 0 | 107 |
| 100 | 33 | 41 | 33 | 529 | 0 | 2047 | 1209 | 0 | 101 |
| 32 | 0 | 0 | 17 | 13 | 71 | 2082 | 1991 | 0 | 100 |
| 32 | 0 | 0 | 0 | 21 | 0 | 2198 | 2036 | 0 | 108 |
| 32 | 0 | 0 | 0 | 16 | 75 | 2107 | 2020 | 0 | 113 |
| 52 | 0 | 0 | 0 | 95 | 0 | 2222 | 1963 | 0 | 113 |
| 38 | 0 | 0 | 0 | 42 | 37 | 2178 | 2025 | 0 | 110 |
| 38 | 0 | 0 | 0 | 40 | 0 | 2185 | 1996 | 0 | 112 |
| 43 | 0 | 0 | 0 | 63 | 0 | 2247 | 1992 | 41 | 108 |
| 43 | 0 | 0 | 0 | 56 | 24 | 2217 | 1976 | 51 | 115 |
| 100 | 45 | 0 | 0 | 382 | 0 | 2348 | 1647 | 66 | 108 |
| 100 | 65 | 0 | 0 | 425 | 0 | 2196 | 1439 | 62 | 105 |
| 54 | 0 | 0 | 0 | 107 | 0 | 2327 | 1975 | 82 | 109 |
| 54 | 0 | 0 | 0 | 104 | 116 | 2222 | 1977 | 92 | 111 |
| 54 | 0 | 0 | 0 | 118 | 0 | 2256 | 1901 | 83 | 100 |
| 100 | 0 | 0 | 0 | 296 | 0 | 2216 | 1640 | 77 | 104 |
| 51 | 0 | 0 | 0 | 96 | 237 | 2134 | 2019 | 98 | 107 |
| 51 | 0 | 0 | 17 | 73 | 0 | 2391 | 2017 | 121 | 113 |
| 68 | 33 | 0 | 33 | 224 | 0 | 2190 | 1607 | 108 | 116 |
| 100 | 100 | 50 | 50 | 1294 | 0 | 2182 | 367 | 117 | 104 |
| 100 | 100 | 50 | 50 | 1437 | 0 | 2169 | 204 | 126 | 101 |
| 100 | 100 | 50 | 50 | 1372 | 0 | 2301 | 290 | 228 | 112 |
| 100 | 100 | 50 | 50 | 718 | 0 | 2148 | 826 | 199 | 105 |
| 100 | 100 | 50 | 50 | 1092 | 0 | 2284 | 552 | 229 | 111 |
| 100 | 100 | 50 | 50 | 928 | 0 | 2257 | 723 | 196 | 110 |
| 27 | 33 | 0 | 33 | 69 | 0 | 2291 | 1992 | 29 | 106 |
| 7 | 0 | 0 | 17 | 0 | 221 | 2267 | 2022 | 327 | 116 |
| 7 | 0 | 0 | 0 | 0 | 78 | 2227 | 2005 | 187 | 105 |
| 9 | 0 | 0 | 0 | 0 | 67 | 2181 | 1964 | 172 | 102 |
| 100 | 67 | 22 | 0 | 506 | 0 | 2252 | 1217 | 227 | 114 |
| 20 | 0 | 15 | 0 | 40 | 0 | 2213 | 1969 | 66 | 102 |
| 0 | 0 | 15 | 17 | 0 | 116 | 2133 | 1983 | 123 | 111 |
| 0 | 33 | 15 | 33 | 0 | 102 | 2163 | 2007 | 73 | 102 |
| 100 | 100 | 50 | 50 | 1462 | 0 | 2046 | 0 | 176 | 108 |
| 100 | 33 | 50 | 50 | 558 | 911 | 2177 | 1984 | 204 | 108 |
| 100 | 100 | 50 | 50 | 1523 | 0 | 2108 | 0 | 172 | 113 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 33 | 0 | 33 | 0 | 179 | 2083 | 1978 | 103 | 110 |
| 4 | 0 | 0 | 17 | 0 | 88 | 2160 | 2011 | 111 | 104 |
| 4 | 0 | 0 | 0 | 0 | 104 | 2103 | 1989 | 113 | 101 |
| 16 | 0 | 0 | 0 | 0 | 37 | 2155 | 1966 | 108 | 102 |
| 90 | 0 | 0 | 0 | 244 | 0 | 2088 | 1554 | 86 | 115 |
| 29 | 0 | 0 | 0 | 7 | 0 | 2156 | 1960 | 49 | 111 |
| 6 | 0 | 0 | 0 | 0 | 81 | 2171 | 2042 | 100 | 105 |
| 6 | 0 | 0 | 0 | 0 | 89 | 2182 | 2029 | 126 | 110 |
| 8 | 0 | 0 | 0 | 0 | 77 | 2175 | 2040 | 96 | 108 |
| 1 | 0 | 0 | 0 | 0 | 107 | 2089 | 2021 | 63 | 112 |
| 1 | 0 | 0 | 0 | 0 | 101 | 2107 | 2054 | 50 | 103 |
| 43 | 0 | 0 | 17 | 71 | 0 | 2241 | 1919 | 90 | 101 |
| 47 | 33 | 0 | 33 | 155 | 0 | 2251 | 1806 | 77 | 100 |
| 100 | 100 | 50 | 50 | 820 | 0 | 2319 | 1025 | 71 | 103 |
| 0 | 33 | 20 | 33 | 0 | 58 | 2202 | 2003 | 64 | 107 |
| 0 | 0 | 20 | 33 | 0 | 79 | 2185 | 2017 | 70 | 123 |
| 11 | 33 | 20 | 33 | 79 | 0 | 2218 | 1853 | 75 | 112 |
| 100 | 100 | 50 | 50 | 778 | 0 | 2261 | 999 | 74 | 110 |
| 100 | 80 | 50 | 33 | 644 | 0 | 2321 | 1234 | 63 | 117 |
| 100 | 73 | 50 | 17 | 645 | 0 | 2274 | 1224 | 63 | 102 |
| 100 | 7 | 42 | 0 | 470 | 201 | 2297 | 1731 | 38 | 110 |
| 100 | 7 | 42 | 0 | 464 | 0 | 2381 | 1624 | 29 | 116 |
| 58 | 0 | 42 | 0 | 287 | 0 | 2454 | 1909 | 45 | 113 |
| 40 | 0 | 42 | 17 | 197 | 0 | 2421 | 2013 | 0 | 112 |
| 40 | 33 | 42 | 33 | 173 | 26 | 2428 | 2024 | 0 | 109 |
| 100 | 100 | 50 | 50 | 2045 | 0 | 2457 | 0 | 0 | 112 |
| 100 | 100 | 50 | 50 | 2141 | 0 | 2546 | 0 | 0 | 105 |
| 81 | 33 | 0 | 33 | 206 | 0 | 2464 | 2006 | 0 | 105 |
| 81 | 0 | 0 | 17 | 220 | 0 | 2441 | 2021 | 0 | 103 |
| 81 | 0 | 0 | 0 | 210 | 43 | 2367 | 2007 | 0 | 113 |
| 85 | 0 | 0 | 0 | 223 | 0 | 2426 | 2001 | 0 | 117 |
| 83 | 0 | 0 | 0 | 218 | 0 | 2395 | 1979 | 0 | 115 |
| 78 | 0 | 0 | 0 | 206 | 0 | 2358 | 1968 | 0 | 106 |
| 74 | 0 | 0 | 0 | 177 | 20 | 2358 | 2009 | 0 | 119 |
| 74 | 0 | 0 | 0 | 178 | 0 | 2402 | 2032 | 0 | 117 |
| 83 | 0 | 0 | 0 | 226 | 0 | 2393 | 1976 | 0 | 107 |
| 87 | 0 | 0 | 0 | 240 | 0 | 2360 | 1922 | 0 | 110 |
| 100 | 32 | 50 | 0 | 554 | 0 | 2298 | 1453 | 0 | 109 |
| 100 | 7 | 50 | 0 | 510 | 0 | 2383 | 1613 | 0 | 103 |
| 100 | 27 | 50 | 0 | 535 | 0 | 2362 | 1532 | 0 | 118 |
| 100 | 8 | 50 | 0 | 512 | 0 | 2415 | 1641 | 0 | 104 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 100 | 26 | 50 | 17 | 496 | 0 | 2264 | 1467 | 0 | 109 |
| 100 | 93 | 50 | 33 | 682 | 0 | 2240 | 1178 | 0 | 104 |
| 100 | 100 | 50 | 50 | 825 | 0 | 2224 | 992 | 0 | 108 |
| 100 | 33 | 29 | 33 | 481 | 0 | 2229 | 1449 | 0 | 102 |
| 72 | 0 | 0 | 17 | 179 | 7 | 2136 | 1765 | 0 | 110 |
| 72 | 0 | 0 | 0 | 173 | 0 | 2233 | 1872 | 0 | 116 |
| 20 | 0 | 0 | 0 | 0 | 37 | 2119 | 2017 | 0 | 118 |
| 20 | 0 | 0 | 0 | 0 | 79 | 2056 | 2001 | 0 | 114 |
| 100 | 17 | 0 | 0 | 330 | 0 | 2171 | 1619 | 0 | 105 |
| 100 | 0 | 0 | 0 | 300 | 462 | 2030 | 1991 | 0 | 100 |
| 100 | 13 | 0 | 0 | 320 | 0 | 2055 | 1515 | 0 | 107 |
| 1 | 0 | 0 | 0 | 0 | 102 | 2008 | 2008 | 0 | 101 |
| 1 | 0 | 0 | 0 | 0 | 112 | 1916 | 1909 | 0 | 117 |
| 33 | 0 | 0 | 0 | 18 | 0 | 2042 | 1875 | 0 | 115 |
| 0 | 0 | 0 | 0 | 0 | 180 | 1925 | 1991 | 0 | 114 |
| 0 | 0 | 0 | 0 | 0 | 170 | 1904 | 1967 | 0 | 106 |
| 0 | 0 | 0 | 0 | 0 | 193 | 1858 | 1939 | 0 | 112 |
| 42 | 0 | 0 | 0 | 62 | 0 | 1886 | 1674 | 0 | 108 |
| 42 | 0 | 0 | 0 | 63 | 0 | 1907 | 1697 | 0 | 104 |
| 42 | 0 | 0 | 0 | 60 | 95 | 1853 | 1738 | 0 | 107 |
| 100 | 14 | 0 | 0 | 309 | 0 | 1766 | 1225 | 0 | 119 |
| 100 | 33 | 0 | 0 | 280 | 224 | 1827 | 1529 | 0 | 108 |
| 100 | 100 | 44 | 0 | 671 | 0 | 1820 | 801 | 0 | 104 |

### 10.1.5. Scenario 4

| p1 | p2 | p3 | p4 | pgridin | pgridout | load | wind | pv | wave |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 172 | 1859 | 1919 | 0 | 111 |
| 0 | 0 | 0 | 0 | 0 | 243 | 1821 | 1951 | 0 | 114 |
| 0 | 0 | 0 | 0 | 0 | 194 | 1903 | 1994 | 0 | 103 |
| 0 | 0 | 0 | 0 | 0 | 293 | 1811 | 1991 | 0 | 113 |
| 0 | 0 | 0 | 0 | 0 | 198 | 1864 | 1956 | 0 | 105 |
| 0 | 0 | 0 | 0 | 0 | 400 | 1734 | 2027 | 0 | 108 |
| 0 | 0 | 0 | 0 | 0 | 212 | 1867 | 1975 | 0 | 104 |
| 0 | 0 | 0 | 0 | 0 | 241 | 1870 | 2007 | 0 | 103 |
| 0 | 0 | 0 | 0 | 0 | 358 | 1730 | 1983 | 0 | 105 |
| 0 | 0 | 0 | 0 | 0 | 275 | 1820 | 1993 | 0 | 101 |
| 0 | 0 | 0 | 0 | 0 | 303 | 1781 | 1973 | 0 | 111 |
| 0 | 0 | 0 | 0 | 0 | 344 | 1775 | 2014 | 0 | 104 |
| 0 | 0 | 0 | 0 | 0 | 333 | 1819 | 2050 | 0 | 102 |
| 0 | 0 | 0 | 0 | 0 | 258 | 1792 | 1937 | 0 | 113 |
| 0 | 0 | 0 | 0 | 0 | 296 | 1821 | 2006 | 0 | 112 |
| 0 | 0 | 0 | 0 | 0 | 243 | 1740 | 1875 | 0 | 108 |
| 0 | 0 | 0 | 0 | 0 | 291 | 1749 | 1928 | 0 | 113 |
| 0 | 0 | 0 | 0 | 0 | 212 | 1779 | 1879 | 0 | 111 |
| 0 | 0 | 0 | 0 | 0 | 220 | 1797 | 1905 | 0 | 112 |
| 43 | 0 | 0 | 0 | 58 | 0 | 1746 | 1532 | 0 | 113 |
| 22 | 0 | 0 | 0 | 0 | 112 | 1776 | 1755 | 0 | 112 |
| 22 | 29 | 0 | 0 | 0 | 52 | 1812 | 1705 | 0 | 108 |
| 100 | 96 | 50 | 17 | 687 | 0 | 1769 | 714 | 0 | 105 |
| 100 | 33 | 50 | 33 | 552 | 23 | 1858 | 998 | 0 | 115 |
| 100 | 100 | 50 | 50 | 829 | 0 | 1707 | 469 | 0 | 109 |
| 0 | 33 | 0 | 33 | 0 | 382 | 1776 | 1982 | 0 | 109 |
| 0 | 0 | 0 | 17 | 0 | 250 | 1838 | 1960 | 0 | 111 |
| 0 | 0 | 0 | 0 | 0 | 304 | 1816 | 2017 | 0 | 102 |
| 0 | 0 | 0 | 0 | 0 | 342 | 1800 | 2028 | 0 | 114 |
| 0 | 0 | 0 | 0 | 0 | 245 | 1873 | 2010 | 0 | 107 |
| 0 | 0 | 0 | 0 | 0 | 340 | 1805 | 2034 | 0 | 110 |
| 0 | 0 | 0 | 0 | 0 | 176 | 1885 | 1949 | 0 | 111 |
| 0 | 0 | 0 | 0 | 0 | 251 | 1848 | 1989 | 0 | 111 |
| 49 | 0 | 0 | 0 | 91 | 0 | 1891 | 1647 | 0 | 104 |
| 33 | 0 | 0 | 0 | 20 | 0 | 1935 | 1770 | 0 | 112 |
| 33 | 0 | 0 | 17 | 6 | 162 | 2010 | 2007 | 0 | 109 |
| 72 | 33 | 0 | 33 | 249 | 0 | 1906 | 1413 | 0 | 105 |
| 100 | 100 | 50 | 50 | 1159 | 0 | 2051 | 483 | 0 | 109 |
| 100 | 100 | 50 | 50 | 1106 | 0 | 1979 | 461 | 0 | 112 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 100 | 100 | 50 | 50 | 1237 | 0 | 2004 | 361 | 0 | 106 |
| 100 | 100 | 50 | 50 | 1387 | 0 | 2067 | 274 | 0 | 106 |
| 100 | 100 | 50 | 50 | 1416 | 0 | 2008 | 188 | 0 | 104 |
| 100 | 100 | 50 | 50 | 1338 | 0 | 2005 | 256 | 0 | 110 |
| 100 | 100 | 50 | 50 | 1152 | 0 | 2108 | 557 | 0 | 99 |
| 100 | 100 | 50 | 50 | 1169 | 0 | 2066 | 490 | 0 | 107 |
| 100 | 47 | 50 | 33 | 579 | 0 | 2147 | 1224 | 0 | 114 |
| 42 | 0 | 0 | 17 | 42 | 92 | 2172 | 2055 | 0 | 108 |
| 42 | 0 | 0 | 0 | 62 | 0 | 2242 | 2033 | 0 | 105 |
| 42 | 0 | 0 | 0 | 67 | 0 | 2206 | 1996 | 0 | 100 |
| 38 | 0 | 0 | 0 | 47 | 3 | 2170 | 1981 | 0 | 106 |
| 38 | 0 | 0 | 0 | 52 | 0 | 2203 | 2011 | 0 | 101 |
| 47 | 0 | 0 | 0 | 81 | 0 | 2228 | 1993 | 0 | 107 |
| 44 | 0 | 0 | 0 | 65 | 54 | 2208 | 2000 | 42 | 111 |
| 44 | 0 | 0 | 0 | 64 | 0 | 2262 | 1985 | 57 | 112 |
| 100 | 2 | 0 | 0 | 298 | 0 | 2217 | 1653 | 59 | 106 |
| 100 | 69 | 16 | 0 | 497 | 0 | 2287 | 1436 | 63 | 106 |
| 34 | 2 | 0 | 0 | 33 | 0 | 2200 | 1955 | 70 | 106 |
| 31 | 0 | 0 | 0 | 27 | 0 | 2207 | 1968 | 82 | 98 |
| 31 | 0 | 0 | 0 | 7 | 47 | 2139 | 1940 | 89 | 118 |
| 100 | 20 | 0 | 0 | 333 | 0 | 2266 | 1637 | 69 | 107 |
| 24 | 0 | 0 | 0 | 0 | 15 | 2226 | 2008 | 99 | 109 |
| 24 | 0 | 0 | 17 | 0 | 48 | 2195 | 1991 | 110 | 101 |
| 80 | 33 | 0 | 33 | 276 | 0 | 2214 | 1595 | 86 | 111 |
| 100 | 100 | 50 | 50 | 1334 | 0 | 2212 | 376 | 90 | 112 |
| 100 | 100 | 50 | 50 | 1418 | 0 | 2204 | 204 | 169 | 114 |
| 100 | 100 | 50 | 50 | 1315 | 0 | 2218 | 293 | 206 | 104 |
| 100 | 100 | 50 | 50 | 853 | 0 | 2217 | 781 | 173 | 110 |
| 100 | 100 | 50 | 50 | 889 | 0 | 2096 | 544 | 257 | 105 |
| 100 | 100 | 50 | 50 | 883 | 0 | 2231 | 720 | 216 | 111 |
| 25 | 33 | 0 | 33 | 60 | 0 | 2247 | 1944 | 45 | 107 |
| 0 | 0 | 0 | 17 | 0 | 156 | 2273 | 1998 | 305 | 110 |
| 0 | 0 | 0 | 0 | 0 | 153 | 2096 | 1936 | 200 | 114 |
| 13 | 0 | 0 | 0 | 0 | 60 | 2232 | 2010 | 156 | 113 |
| 100 | 56 | 0 | 0 | 403 | 0 | 2166 | 1253 | 244 | 109 |
| 32 | 0 | 0 | 0 | 10 | 0 | 2202 | 1976 | 67 | 117 |
| 16 | 0 | 0 | 17 | 0 | 169 | 2154 | 2030 | 152 | 108 |
| 16 | 33 | 0 | 33 | 0 | 107 | 2126 | 1980 | 62 | 109 |
| 100 | 100 | 50 | 50 | 1583 | 0 | 2184 | 0 | 194 | 107 |
| 100 | 33 | 50 | 50 | 563 | 967 | 2159 | 2029 | 198 | 104 |
| 100 | 100 | 50 | 50 | 1550 | 0 | 2135 | 0 | 181 | 104 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 33 | 0 | 33 | 0 | 31 | 2215 | 1980 | 85 | 111 |
| 1 | 0 | 0 | 17 | 0 | 168 | 2103 | 2025 | 108 | 121 |
| 1 | 0 | 0 | 0 | 0 | 109 | 2099 | 1984 | 112 | 112 |
| 27 | 0 | 0 | 0 | 6 | 0 | 2169 | 1933 | 100 | 103 |
| 90 | 0 | 0 | 0 | 253 | 0 | 2100 | 1552 | 96 | 109 |
| 19 | 0 | 0 | 0 | 0 | 81 | 2086 | 1951 | 90 | 106 |
| 19 | 0 | 0 | 0 | 0 | 31 | 2139 | 1939 | 105 | 107 |
| 17 | 0 | 0 | 0 | 0 | 39 | 2181 | 2008 | 88 | 107 |
| 16 | 0 | 0 | 0 | 0 | 43 | 2178 | 1997 | 99 | 109 |
| 8 | 0 | 0 | 0 | 0 | 106 | 2060 | 1991 | 60 | 107 |
| 8 | 0 | 0 | 0 | 0 | 76 | 2041 | 1949 | 50 | 110 |
| 24 | 0 | 0 | 0 | 0 | 18 | 2160 | 1961 | 81 | 113 |
| 34 | 33 | 0 | 0 | 98 | 0 | 2165 | 1801 | 98 | 102 |
| 100 | 99 | 50 | 0 | 687 | 0 | 2153 | 1019 | 86 | 111 |
| 0 | 33 | 19 | 0 | 0 | 94 | 2151 | 2017 | 59 | 118 |
| 0 | 8 | 19 | 17 | 0 | 30 | 2183 | 1982 | 76 | 111 |
| 4 | 33 | 19 | 33 | 49 | 0 | 2170 | 1849 | 74 | 109 |
| 100 | 100 | 50 | 50 | 761 | 0 | 2222 | 994 | 51 | 116 |
| 100 | 98 | 50 | 33 | 693 | 0 | 2370 | 1236 | 58 | 103 |
| 100 | 88 | 50 | 17 | 667 | 0 | 2296 | 1218 | 47 | 109 |
| 100 | 22 | 34 | 0 | 469 | 156 | 2355 | 1733 | 43 | 111 |
| 100 | 22 | 34 | 0 | 471 | 0 | 2415 | 1640 | 40 | 108 |
| 55 | 0 | 34 | 0 | 251 | 3 | 2396 | 1911 | 43 | 105 |
| 55 | 0 | 34 | 17 | 248 | 0 | 2468 | 2005 | 0 | 108 |
| 55 | 33 | 34 | 33 | 207 | 97 | 2435 | 2062 | 0 | 108 |
| 100 | 100 | 50 | 50 | 2100 | 0 | 2509 | 0 | 0 | 109 |
| 100 | 100 | 50 | 50 | 2029 | 0 | 2445 | 0 | 0 | 116 |
| 90 | 33 | 0 | 33 | 181 | 0 | 2467 | 2018 | 0 | 111 |
| 90 | 0 | 0 | 17 | 233 | 39 | 2431 | 2021 | 0 | 109 |
| 99 | 0 | 0 | 0 | 296 | 0 | 2486 | 1990 | 0 | 100 |
| 73 | 0 | 0 | 0 | 183 | 0 | 2359 | 1993 | 0 | 110 |
| 73 | 0 | 0 | 0 | 190 | 13 | 2297 | 1944 | 0 | 103 |
| 75 | 0 | 0 | 0 | 195 | 0 | 2374 | 1997 | 0 | 107 |
| 83 | 0 | 0 | 0 | 233 | 0 | 2377 | 1960 | 0 | 100 |
| 82 | 0 | 0 | 0 | 224 | 146 | 2305 | 2042 | 0 | 103 |
| 82 | 0 | 0 | 0 | 219 | 0 | 2410 | 2001 | 0 | 109 |
| 100 | 0 | 0 | 0 | 293 | 0 | 2430 | 1928 | 0 | 109 |
| 100 | 63 | 48 | 0 | 623 | 0 | 2373 | 1442 | 0 | 97 |
| 100 | 0 | 48 | 0 | 485 | 124 | 2293 | 1676 | 0 | 108 |
| 100 | 2 | 48 | 0 | 487 | 0 | 2274 | 1527 | 0 | 110 |
| 100 | 0 | 48 | 0 | 488 | 134 | 2293 | 1686 | 0 | 105 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 100 | 31 | 48 | 17 | 530 | 0 | 2292 | 1454 | 0 | 113 |
| 100 | 97 | 50 | 33 | 690 | 0 | 2310 | 1235 | 0 | 104 |
| 100 | 100 | 50 | 50 | 851 | 0 | 2263 | 1002 | 0 | 110 |
| 100 | 33 | 21 | 33 | 443 | 0 | 2149 | 1413 | 0 | 106 |
| 81 | 0 | 0 | 17 | 217 | 0 | 2148 | 1727 | 0 | 107 |
| 67 | 0 | 0 | 0 | 157 | 0 | 2183 | 1849 | 0 | 110 |
| 34 | 0 | 0 | 0 | 29 | 0 | 2164 | 1996 | 0 | 105 |
| 34 | 0 | 0 | 0 | 21 | 5 | 2148 | 1985 | 0 | 114 |
| 100 | 4 | 0 | 0 | 299 | 0 | 2166 | 1654 | 0 | 108 |
| 100 | 0 | 0 | 0 | 301 | 312 | 2128 | 1939 | 0 | 99 |
| 100 | 28 | 0 | 0 | 352 | 0 | 2093 | 1510 | 0 | 104 |
| 45 | 0 | 0 | 0 | 67 | 144 | 2100 | 2019 | 0 | 113 |
| 45 | 0 | 0 | 0 | 69 | 0 | 2033 | 1808 | 0 | 112 |
| 28 | 0 | 0 | 0 | 0 | 2 | 2088 | 1947 | 0 | 115 |
| 0 | 0 | 0 | 0 | 0 | 133 | 1922 | 1952 | 0 | 104 |
| 0 | 0 | 0 | 0 | 0 | 110 | 1949 | 1953 | 0 | 107 |
| 26 | 0 | 0 | 0 | 0 | 13 | 2021 | 1890 | 0 | 118 |
| 46 | 0 | 0 | 0 | 77 | 0 | 1919 | 1686 | 0 | 109 |
| 46 | 0 | 0 | 0 | 73 | 0 | 1911 | 1682 | 0 | 110 |
| 46 | 0 | 0 | 0 | 70 | 2 | 1939 | 1712 | 0 | 113 |
| 100 | 23 | 0 | 0 | 326 | 0 | 1770 | 1202 | 0 | 119 |
| 100 | 33 | 0 | 0 | 326 | 239 | 1833 | 1516 | 0 | 97 |
| 100 | 100 | 34 | 0 | 634 | 0 | 1762 | 792 | 0 | 103 |

### 10.1.6. Scenario 5

| p1 | p2 | p3 | p4 | pgridin | pgridout | load | wind | pv | wave |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 145 | 1888 | 1922 | 0 | 111 |
| 0 | 0 | 0 | 0 | 0 | 211 | 1852 | 1964 | 0 | 99 |
| 0 | 0 | 0 | 0 | 0 | 185 | 1866 | 1940 | 0 | 111 |
| 0 | 0 | 0 | 0 | 0 | 210 | 1890 | 1984 | 0 | 117 |
| 0 | 0 | 0 | 0 | 0 | 230 | 1864 | 1982 | 0 | 112 |
| 0 | 0 | 0 | 0 | 0 | 304 | 1810 | 2011 | 0 | 102 |
| 0 | 0 | 0 | 0 | 0 | 303 | 1774 | 1982 | 0 | 95 |
| 0 | 0 | 0 | 0 | 0 | 307 | 1793 | 1989 | 0 | 110 |
| 0 | 0 | 0 | 0 | 0 | 293 | 1746 | 1925 | 0 | 114 |
| 0 | 0 | 0 | 0 | 0 | 267 | 1783 | 1951 | 0 | 99 |
| 0 | 0 | 0 | 0 | 0 | 299 | 1790 | 1976 | 0 | 113 |
| 0 | 0 | 0 | 0 | 0 | 332 | 1757 | 1985 | 0 | 104 |
| 0 | 0 | 0 | 0 | 0 | 372 | 1727 | 1984 | 0 | 115 |
| 0 | 0 | 0 | 0 | 0 | 311 | 1755 | 1953 | 0 | 113 |
| 0 | 0 | 0 | 0 | 0 | 352 | 1731 | 1980 | 0 | 103 |
| 0 | 0 | 0 | 0 | 0 | 155 | 1824 | 1872 | 0 | 107 |
| 0 | 0 | 0 | 0 | 0 | 234 | 1869 | 2000 | 0 | 103 |
| 0 | 0 | 0 | 0 | 0 | 145 | 1783 | 1824 | 0 | 104 |
| 0 | 0 | 0 | 0 | 0 | 209 | 1790 | 1892 | 0 | 107 |
| 60 | 0 | 0 | 0 | 130 | 0 | 1784 | 1486 | 0 | 109 |
| 5 | 0 | 0 | 0 | 0 | 84 | 1811 | 1787 | 0 | 103 |
| 5 | 28 | 0 | 0 | 0 | 134 | 1741 | 1723 | 0 | 118 |
| 100 | 95 | 50 | 17 | 686 | 0 | 1777 | 725 | 0 | 104 |
| 100 | 33 | 50 | 33 | 546 | 93 | 1778 | 987 | 0 | 121 |
| 100 | 100 | 50 | 50 | 918 | 0 | 1783 | 454 | 0 | 112 |
| 0 | 33 | 0 | 33 | 0 | 381 | 1795 | 1998 | 0 | 112 |
| 0 | 0 | 0 | 17 | 0 | 344 | 1768 | 1976 | 0 | 119 |
| 0 | 0 | 0 | 0 | 0 | 336 | 1760 | 1984 | 0 | 111 |
| 0 | 0 | 0 | 0 | 0 | 336 | 1775 | 2002 | 0 | 108 |
| 0 | 0 | 0 | 0 | 0 | 230 | 1837 | 1955 | 0 | 112 |
| 0 | 0 | 0 | 0 | 0 | 219 | 1890 | 1993 | 0 | 115 |
| 0 | 0 | 0 | 0 | 0 | 279 | 1798 | 1973 | 0 | 103 |
| 0 | 0 | 0 | 0 | 0 | 136 | 1944 | 1975 | 0 | 105 |
| 53 | 0 | 0 | 0 | 109 | 0 | 1913 | 1647 | 0 | 105 |
| 30 | 0 | 0 | 0 | 23 | 0 | 1937 | 1785 | 0 | 99 |
| 30 | 0 | 0 | 17 | 0 | 202 | 1930 | 1979 | 0 | 106 |
| 80 | 33 | 0 | 33 | 281 | 0 | 1961 | 1427 | 0 | 107 |
| 100 | 100 | 50 | 50 | 1071 | 0 | 1971 | 492 | 0 | 107 |
| 100 | 100 | 50 | 50 | 1095 | 0 | 1963 | 462 | 0 | 107 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 100 | 100 | 50 | 50 | 1243 | 0 | 2017 | 370 | 0 | 105 |
| 100 | 100 | 50 | 50 | 1381 | 0 | 2065 | 274 | 0 | 110 |
| 100 | 100 | 50 | 50 | 1474 | 0 | 2077 | 189 | 0 | 114 |
| 100 | 100 | 50 | 50 | 1464 | 0 | 2126 | 250 | 0 | 111 |
| 100 | 100 | 50 | 50 | 1146 | 0 | 2111 | 557 | 0 | 109 |
| 100 | 100 | 50 | 50 | 1182 | 0 | 2082 | 498 | 0 | 101 |
| 100 | 59 | 50 | 33 | 602 | 0 | 2176 | 1217 | 0 | 116 |
| 51 | 0 | 0 | 17 | 85 | 0 | 2279 | 2015 | 0 | 110 |
| 51 | 0 | 0 | 0 | 106 | 0 | 2259 | 2003 | 0 | 100 |
| 40 | 0 | 0 | 0 | 59 | 39 | 2212 | 2051 | 0 | 100 |
| 40 | 0 | 0 | 0 | 51 | 0 | 2158 | 1958 | 0 | 109 |
| 46 | 0 | 0 | 0 | 74 | 0 | 2246 | 2015 | 0 | 111 |
| 55 | 0 | 0 | 0 | 112 | 0 | 2252 | 1977 | 0 | 108 |
| 36 | 0 | 0 | 0 | 34 | 0 | 2194 | 1981 | 34 | 110 |
| 36 | 0 | 0 | 0 | 47 | 77 | 2175 | 2016 | 56 | 97 |
| 96 | 0 | 0 | 0 | 270 | 0 | 2207 | 1662 | 68 | 112 |
| 100 | 67 | 6 | 0 | 448 | 0 | 2237 | 1452 | 54 | 111 |
| 58 | 0 | 0 | 0 | 128 | 0 | 2330 | 1974 | 69 | 102 |
| 41 | 0 | 0 | 0 | 57 | 81 | 2244 | 2013 | 106 | 108 |
| 41 | 0 | 0 | 0 | 61 | 0 | 2226 | 1944 | 77 | 103 |
| 100 | 6 | 0 | 0 | 301 | 0 | 2225 | 1641 | 66 | 111 |
| 43 | 0 | 0 | 0 | 58 | 0 | 2300 | 2005 | 78 | 116 |
| 43 | 0 | 0 | 17 | 40 | 36 | 2291 | 1990 | 119 | 117 |
| 74 | 33 | 0 | 33 | 248 | 0 | 2220 | 1613 | 105 | 114 |
| 100 | 100 | 50 | 50 | 1375 | 0 | 2281 | 371 | 121 | 114 |
| 100 | 100 | 50 | 50 | 1407 | 0 | 2174 | 206 | 156 | 104 |
| 100 | 100 | 50 | 50 | 1294 | 0 | 2183 | 291 | 183 | 114 |
| 100 | 100 | 50 | 50 | 819 | 0 | 2216 | 794 | 197 | 106 |
| 100 | 100 | 50 | 50 | 973 | 0 | 2183 | 569 | 234 | 106 |
| 100 | 100 | 50 | 50 | 948 | 0 | 2296 | 728 | 214 | 106 |
| 11 | 33 | 0 | 33 | 10 | 0 | 2243 | 2010 | 45 | 100 |
| 0 | 0 | 0 | 17 | 0 | 214 | 2212 | 2030 | 273 | 107 |
| 0 | 0 | 0 | 0 | 0 | 124 | 2153 | 2001 | 165 | 111 |
| 21 | 0 | 0 | 0 | 0 | 29 | 2211 | 1969 | 138 | 112 |
| 100 | 67 | 10 | 0 | 472 | 0 | 2197 | 1247 | 200 | 102 |
| 8 | 0 | 10 | 0 | 0 | 35 | 2172 | 2028 | 54 | 107 |
| 8 | 0 | 10 | 17 | 0 | 56 | 2252 | 2018 | 139 | 116 |
| 8 | 33 | 10 | 33 | 0 | 53 | 2193 | 1990 | 63 | 107 |
| 100 | 100 | 50 | 50 | 1566 | 0 | 2133 | 0 | 153 | 114 |
| 100 | 33 | 50 | 50 | 563 | 915 | 2154 | 1985 | 183 | 104 |
| 100 | 100 | 50 | 50 | 1651 | 0 | 2231 | 0 | 174 | 107 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 33 | 0 | 33 | 0 | 155 | 2138 | 2003 | 113 | 110 |
| 0 | 0 | 0 | 17 | 0 | 177 | 2085 | 2009 | 121 | 116 |
| 0 | 0 | 0 | 0 | 0 | 139 | 2081 | 2006 | 117 | 97 |
| 0 | 0 | 0 | 0 | 0 | 123 | 2056 | 1975 | 98 | 106 |
| 83 | 0 | 0 | 0 | 228 | 0 | 2062 | 1550 | 99 | 103 |
| 17 | 0 | 0 | 0 | 0 | 117 | 2087 | 2013 | 77 | 97 |
| 17 | 0 | 0 | 0 | 0 | 35 | 2172 | 2017 | 68 | 104 |
| 21 | 0 | 0 | 0 | 0 | 33 | 2211 | 2003 | 101 | 119 |
| 5 | 0 | 0 | 0 | 0 | 106 | 2102 | 1993 | 91 | 118 |
| 5 | 0 | 0 | 0 | 0 | 78 | 2078 | 1971 | 81 | 98 |
| 7 | 0 | 0 | 0 | 0 | 75 | 2119 | 2020 | 63 | 104 |
| 16 | 0 | 0 | 10 | 0 | 49 | 2112 | 1943 | 81 | 112 |
| 35 | 33 | 0 | 27 | 99 | 0 | 2186 | 1809 | 78 | 106 |
| 100 | 100 | 50 | 44 | 681 | 0 | 2194 | 1030 | 71 | 119 |
| 0 | 33 | 21 | 27 | 0 | 110 | 2153 | 2001 | 73 | 108 |
| 0 | 8 | 21 | 27 | 0 | 4 | 2228 | 2007 | 64 | 105 |
| 19 | 33 | 21 | 33 | 112 | 0 | 2261 | 1854 | 74 | 114 |
| 100 | 100 | 50 | 50 | 803 | 0 | 2264 | 994 | 65 | 102 |
| 100 | 58 | 50 | 50 | 598 | 0 | 2291 | 1264 | 53 | 117 |
| 100 | 100 | 50 | 50 | 743 | 0 | 2407 | 1195 | 48 | 121 |
| 100 | 33 | 7 | 33 | 359 | 1 | 2391 | 1713 | 44 | 102 |
| 100 | 33 | 7 | 17 | 379 | 0 | 2360 | 1654 | 55 | 115 |
| 77 | 0 | 7 | 17 | 228 | 0 | 2470 | 1988 | 44 | 110 |
| 72 | 0 | 7 | 17 | 213 | 63 | 2364 | 2016 | 0 | 103 |
| 72 | 33 | 7 | 33 | 165 | 0 | 2400 | 1980 | 0 | 110 |
| 100 | 100 | 50 | 50 | 2081 | 0 | 2491 | 0 | 0 | 111 |
| 100 | 100 | 50 | 50 | 2079 | 0 | 2485 | 0 | 0 | 105 |
| 73 | 33 | 0 | 33 | 115 | 0 | 2388 | 2020 | 0 | 112 |
| 73 | 0 | 0 | 17 | 179 | 24 | 2420 | 2077 | 0 | 98 |
| 77 | 0 | 0 | 0 | 204 | 0 | 2391 | 2004 | 0 | 106 |
| 94 | 0 | 0 | 0 | 279 | 0 | 2453 | 1984 | 0 | 96 |
| 100 | 0 | 0 | 0 | 289 | 0 | 2510 | 2011 | 0 | 109 |
| 97 | 0 | 0 | 0 | 283 | 0 | 2462 | 1976 | 0 | 106 |
| 93 | 0 | 0 | 0 | 255 | 56 | 2386 | 1978 | 0 | 116 |
| 93 | 0 | 0 | 0 | 261 | 0 | 2466 | 2002 | 0 | 110 |
| 93 | 0 | 0 | 0 | 263 | 149 | 2322 | 2007 | 0 | 109 |
| 100 | 0 | 12 | 0 | 356 | 0 | 2515 | 1955 | 0 | 93 |
| 100 | 50 | 50 | 0 | 598 | 0 | 2339 | 1438 | 0 | 103 |
| 100 | 0 | 50 | 0 | 497 | 193 | 2212 | 1655 | 0 | 103 |
| 100 | 26 | 50 | 0 | 538 | 0 | 2338 | 1511 | 0 | 114 |
| 100 | 0 | 50 | 0 | 488 | 108 | 2303 | 1660 | 0 | 112 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 100 | 59 | 50 | 17 | 613 | 0 | 2336 | 1391 | 0 | 105 |
| 100 | 70 | 50 | 33 | 627 | 0 | 2185 | 1192 | 0 | 113 |
| 100 | 100 | 50 | 50 | 963 | 0 | 2344 | 979 | 0 | 102 |
| 100 | 33 | 47 | 33 | 545 | 0 | 2269 | 1401 | 0 | 109 |
| 74 | 0 | 0 | 17 | 181 | 0 | 2185 | 1798 | 0 | 115 |
| 72 | 0 | 0 | 0 | 183 | 0 | 2214 | 1853 | 0 | 105 |
| 42 | 0 | 0 | 0 | 60 | 118 | 2071 | 1976 | 0 | 110 |
| 42 | 0 | 0 | 0 | 60 | 0 | 2238 | 2025 | 0 | 110 |
| 94 | 0 | 0 | 0 | 271 | 0 | 2127 | 1659 | 0 | 103 |
| 94 | 0 | 0 | 0 | 273 | 391 | 2067 | 1991 | 0 | 102 |
| 100 | 47 | 0 | 0 | 377 | 0 | 2157 | 1514 | 0 | 118 |
| 41 | 0 | 0 | 0 | 60 | 201 | 2032 | 2026 | 0 | 106 |
| 41 | 0 | 0 | 0 | 53 | 0 | 2052 | 1845 | 0 | 113 |
| 18 | 0 | 0 | 0 | 0 | 29 | 1968 | 1876 | 0 | 103 |
| 4 | 0 | 0 | 0 | 0 | 236 | 1872 | 1992 | 0 | 112 |
| 4 | 0 | 0 | 0 | 0 | 89 | 1986 | 1966 | 0 | 105 |
| 6 | 0 | 0 | 0 | 0 | 81 | 1957 | 1925 | 0 | 106 |
| 42 | 0 | 0 | 0 | 56 | 0 | 1898 | 1689 | 0 | 111 |
| 44 | 0 | 0 | 0 | 66 | 0 | 1863 | 1641 | 0 | 111 |
| 44 | 0 | 0 | 0 | 68 | 131 | 1831 | 1740 | 0 | 109 |
| 100 | 33 | 10 | 0 | 397 | 0 | 1843 | 1194 | 0 | 109 |
| 100 | 33 | 10 | 0 | 394 | 448 | 1738 | 1536 | 0 | 112 |
| 100 | 100 | 47 | 0 | 682 | 0 | 1836 | 802 | 0 | 105 |

### 10.1.7. Scenario 6

| p1 | p2 | p3 | p4 | pgridin | pgridout | load | wind | pv | wave |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 164 | 1877 | 1930 | 0 | 111 |
| 0 | 0 | 0 | 0 | 0 | 154 | 1917 | 1971 | 0 | 100 |
| 0 | 0 | 0 | 0 | 0 | 311 | 1806 | 2006 | 0 | 111 |
| 0 | 0 | 0 | 0 | 0 | 282 | 1794 | 1966 | 0 | 110 |
| 0 | 0 | 0 | 0 | 0 | 349 | 1766 | 2008 | 0 | 107 |
| 0 | 0 | 0 | 0 | 0 | 331 | 1755 | 1980 | 0 | 106 |
| 0 | 0 | 0 | 0 | 0 | 291 | 1813 | 1991 | 0 | 113 |
| 0 | 0 | 0 | 0 | 0 | 199 | 1884 | 1979 | 0 | 103 |
| 0 | 0 | 0 | 0 | 0 | 332 | 1763 | 1998 | 0 | 97 |
| 0 | 0 | 0 | 0 | 0 | 317 | 1781 | 1992 | 0 | 105 |
| 0 | 0 | 0 | 0 | 0 | 374 | 1766 | 2030 | 0 | 110 |
| 0 | 0 | 0 | 0 | 0 | 291 | 1772 | 1961 | 0 | 102 |
| 0 | 0 | 0 | 0 | 0 | 389 | 1722 | 2004 | 0 | 107 |
| 0 | 0 | 0 | 0 | 0 | 297 | 1794 | 1983 | 0 | 107 |
| 0 | 0 | 0 | 0 | 0 | 315 | 1798 | 2015 | 0 | 98 |
| 0 | 0 | 0 | 0 | 0 | 247 | 1779 | 1921 | 0 | 105 |
| 0 | 0 | 0 | 0 | 0 | 391 | 1684 | 1956 | 0 | 119 |
| 0 | 0 | 0 | 0 | 0 | 194 | 1767 | 1844 | 0 | 117 |
| 0 | 0 | 0 | 0 | 0 | 284 | 1743 | 1908 | 0 | 118 |
| 43 | 0 | 0 | 0 | 61 | 0 | 1691 | 1476 | 0 | 110 |
| 4 | 0 | 0 | 0 | 0 | 135 | 1725 | 1751 | 0 | 103 |
| 4 | 19 | 0 | 0 | 0 | 109 | 1720 | 1698 | 0 | 108 |
| 100 | 86 | 50 | 17 | 669 | 0 | 1755 | 732 | 0 | 103 |
| 100 | 33 | 50 | 33 | 564 | 139 | 1733 | 988 | 0 | 102 |
| 100 | 100 | 50 | 50 | 939 | 0 | 1804 | 457 | 0 | 108 |
| 0 | 33 | 0 | 33 | 0 | 299 | 1837 | 1954 | 0 | 115 |
| 0 | 0 | 0 | 17 | 0 | 299 | 1809 | 1984 | 0 | 108 |
| 0 | 0 | 0 | 0 | 0 | 277 | 1829 | 2006 | 0 | 100 |
| 0 | 0 | 0 | 0 | 0 | 302 | 1810 | 2007 | 0 | 104 |
| 0 | 0 | 0 | 0 | 0 | 349 | 1824 | 2067 | 0 | 106 |
| 0 | 0 | 0 | 0 | 0 | 218 | 1859 | 1973 | 0 | 104 |
| 0 | 0 | 0 | 0 | 0 | 165 | 1948 | 2004 | 0 | 109 |
| 0 | 0 | 0 | 0 | 0 | 191 | 1934 | 2014 | 0 | 111 |
| 60 | 0 | 0 | 0 | 137 | 0 | 1945 | 1647 | 0 | 101 |
| 40 | 0 | 0 | 0 | 53 | 0 | 1966 | 1764 | 0 | 109 |
| 40 | 0 | 0 | 17 | 38 | 245 | 1900 | 1943 | 0 | 107 |
| 84 | 33 | 0 | 33 | 296 | 0 | 1988 | 1436 | 0 | 106 |
| 100 | 100 | 50 | 50 | 1027 | 0 | 1920 | 494 | 0 | 99 |
| 100 | 100 | 50 | 50 | 1065 | 0 | 1942 | 468 | 0 | 109 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 100 | 100 | 50 | 50 | 1193 | 0 | 1970 | 370 | 0 | 107 |
| 100 | 100 | 50 | 50 | 1393 | 0 | 2065 | 271 | 0 | 100 |
| 100 | 100 | 50 | 50 | 1445 | 0 | 2050 | 186 | 0 | 119 |
| 100 | 100 | 50 | 50 | 1359 | 0 | 2019 | 256 | 0 | 105 |
| 100 | 100 | 50 | 50 | 1147 | 0 | 2100 | 551 | 0 | 103 |
| 100 | 100 | 50 | 50 | 1124 | 0 | 2038 | 505 | 0 | 108 |
| 100 | 59 | 50 | 33 | 613 | 0 | 2151 | 1190 | 0 | 106 |
| 20 | 0 | 0 | 17 | 0 | 84 | 2071 | 2011 | 0 | 107 |
| 20 | 0 | 0 | 0 | 0 | 30 | 2039 | 1940 | 0 | 109 |
| 49 | 0 | 0 | 0 | 78 | 0 | 2214 | 1971 | 0 | 117 |
| 49 | 0 | 0 | 0 | 83 | 71 | 2176 | 2003 | 0 | 111 |
| 58 | 0 | 0 | 0 | 123 | 0 | 2238 | 1950 | 0 | 108 |
| 40 | 0 | 0 | 0 | 59 | 0 | 2222 | 2023 | 0 | 100 |
| 40 | 0 | 0 | 0 | 48 | 68 | 2200 | 2036 | 33 | 111 |
| 40 | 0 | 0 | 0 | 48 | 0 | 2289 | 2026 | 61 | 113 |
| 100 | 13 | 6 | 0 | 347 | 0 | 2269 | 1628 | 72 | 102 |
| 100 | 67 | 6 | 0 | 458 | 0 | 2241 | 1454 | 58 | 98 |
| 50 | 0 | 0 | 0 | 91 | 0 | 2324 | 2006 | 68 | 109 |
| 50 | 0 | 0 | 0 | 93 | 134 | 2195 | 2000 | 78 | 107 |
| 56 | 0 | 0 | 0 | 121 | 0 | 2282 | 1942 | 60 | 102 |
| 100 | 38 | 0 | 0 | 371 | 0 | 2294 | 1615 | 65 | 105 |
| 30 | 0 | 0 | 0 | 13 | 0 | 2258 | 2011 | 94 | 108 |
| 30 | 0 | 0 | 17 | 0 | 98 | 2159 | 1971 | 133 | 105 |
| 84 | 33 | 0 | 33 | 301 | 0 | 2272 | 1637 | 80 | 103 |
| 100 | 100 | 50 | 50 | 1393 | 0 | 2276 | 371 | 103 | 110 |
| 100 | 100 | 50 | 50 | 1445 | 0 | 2216 | 203 | 158 | 110 |
| 100 | 100 | 50 | 50 | 1358 | 0 | 2225 | 296 | 162 | 108 |
| 100 | 100 | 50 | 50 | 845 | 0 | 2292 | 837 | 201 | 109 |
| 100 | 100 | 50 | 50 | 1126 | 0 | 2325 | 551 | 238 | 109 |
| 100 | 100 | 50 | 50 | 786 | 0 | 2191 | 730 | 271 | 104 |
| 22 | 33 | 0 | 33 | 0 | 46 | 2167 | 1966 | 47 | 111 |
| 22 | 0 | 0 | 17 | 0 | 229 | 2251 | 2020 | 300 | 122 |
| 22 | 0 | 0 | 0 | 0 | 18 | 2227 | 1984 | 134 | 105 |
| 22 | 0 | 0 | 0 | 0 | 81 | 2225 | 2029 | 146 | 109 |
| 100 | 67 | 2 | 0 | 426 | 0 | 2189 | 1240 | 239 | 115 |
| 23 | 0 | 2 | 0 | 0 | 6 | 2195 | 2000 | 72 | 104 |
| 18 | 0 | 2 | 17 | 0 | 46 | 2201 | 1979 | 123 | 109 |
| 18 | 33 | 2 | 33 | 0 | 148 | 2115 | 1995 | 69 | 113 |
| 100 | 100 | 50 | 50 | 1718 | 0 | 2271 | 0 | 147 | 106 |
| 100 | 33 | 50 | 50 | 563 | 898 | 2169 | 1952 | 216 | 104 |
| 100 | 100 | 50 | 50 | 1507 | 0 | 2132 | 0 | 211 | 114 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 11 | 33 | 0 | 33 | 0 | 231 | 2054 | 2011 | 87 | 110 |
| 11 | 0 | 0 | 17 | 0 | 79 | 2141 | 1976 | 111 | 105 |
| 21 | 0 | 0 | 0 | 0 | 20 | 2185 | 1979 | 100 | 104 |
| 21 | 0 | 0 | 0 | 0 | 153 | 2095 | 2016 | 92 | 119 |
| 100 | 41 | 0 | 0 | 376 | 0 | 2247 | 1532 | 93 | 105 |
| 23 | 0 | 0 | 0 | 0 | 18 | 2165 | 2000 | 51 | 110 |
| 23 | 0 | 0 | 0 | 0 | 182 | 2060 | 2032 | 76 | 111 |
| 27 | 0 | 0 | 0 | 7 | 0 | 2232 | 1976 | 121 | 101 |
| 27 | 0 | 0 | 0 | 3 | 19 | 2215 | 2000 | 100 | 104 |
| 30 | 0 | 0 | 0 | 10 | 0 | 2217 | 1974 | 95 | 110 |
| 20 | 0 | 0 | 0 | 0 | 31 | 2141 | 1982 | 61 | 109 |
| 20 | 0 | 0 | 0 | 0 | 111 | 2053 | 1945 | 85 | 115 |
| 36 | 27 | 0 | 0 | 93 | 0 | 2155 | 1817 | 75 | 107 |
| 100 | 94 | 50 | 0 | 684 | 0 | 2150 | 1041 | 77 | 104 |
| 0 | 27 | 44 | 0 | 47 | 22 | 2326 | 2047 | 81 | 101 |
| 0 | 7 | 44 | 17 | 67 | 0 | 2285 | 1974 | 71 | 106 |
| 0 | 33 | 44 | 33 | 73 | 0 | 2226 | 1867 | 76 | 100 |
| 100 | 100 | 50 | 50 | 795 | 0 | 2279 | 1008 | 72 | 104 |
| 100 | 44 | 50 | 50 | 575 | 0 | 2252 | 1276 | 42 | 114 |
| 100 | 100 | 50 | 50 | 720 | 0 | 2370 | 1198 | 38 | 114 |
| 100 | 33 | 20 | 33 | 406 | 104 | 2390 | 1750 | 45 | 106 |
| 100 | 33 | 20 | 17 | 434 | 0 | 2409 | 1646 | 49 | 111 |
| 74 | 0 | 20 | 17 | 268 | 0 | 2441 | 1906 | 51 | 106 |
| 67 | 0 | 20 | 17 | 240 | 20 | 2427 | 1996 | 0 | 107 |
| 67 | 33 | 20 | 33 | 196 | 0 | 2468 | 2012 | 0 | 107 |
| 100 | 100 | 50 | 50 | 2122 | 0 | 2536 | 0 | 0 | 113 |
| 100 | 100 | 50 | 50 | 2036 | 0 | 2442 | 0 | 0 | 106 |
| 85 | 33 | 0 | 33 | 165 | 37 | 2394 | 2004 | 0 | 110 |
| 85 | 0 | 0 | 17 | 240 | 0 | 2438 | 1994 | 0 | 102 |
| 79 | 0 | 0 | 0 | 210 | 0 | 2397 | 2002 | 0 | 106 |
| 79 | 0 | 0 | 0 | 210 | 23 | 2374 | 2003 | 0 | 106 |
| 100 | 3 | 0 | 0 | 297 | 0 | 2484 | 1976 | 0 | 109 |
| 100 | 13 | 0 | 0 | 329 | 0 | 2539 | 2001 | 0 | 97 |
| 75 | 0 | 0 | 0 | 202 | 0 | 2393 | 2018 | 0 | 98 |
| 74 | 0 | 0 | 0 | 187 | 0 | 2393 | 2024 | 0 | 109 |
| 74 | 0 | 0 | 0 | 191 | 87 | 2301 | 2018 | 0 | 105 |
| 88 | 13 | 0 | 0 | 264 | 0 | 2391 | 1914 | 0 | 113 |
| 100 | 79 | 50 | 0 | 643 | 0 | 2384 | 1395 | 0 | 116 |
| 100 | 13 | 50 | 0 | 515 | 173 | 2292 | 1677 | 0 | 111 |
| 100 | 20 | 50 | 0 | 528 | 0 | 2322 | 1512 | 0 | 111 |
| 100 | 0 | 50 | 0 | 496 | 63 | 2369 | 1682 | 0 | 104 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 100 | 7 | 50 | 17 | 504 | 0 | 2194 | 1407 | 0 | 110 |
| 100 | 73 | 50 | 33 | 631 | 0 | 2186 | 1182 | 0 | 116 |
| 100 | 100 | 50 | 50 | 854 | 0 | 2275 | 1006 | 0 | 115 |
| 100 | 33 | 43 | 33 | 524 | 0 | 2267 | 1421 | 0 | 113 |
| 99 | 0 | 0 | 17 | 286 | 0 | 2263 | 1750 | 0 | 111 |
| 78 | 0 | 0 | 0 | 195 | 0 | 2239 | 1850 | 0 | 117 |
| 32 | 0 | 0 | 0 | 17 | 0 | 2180 | 2021 | 0 | 110 |
| 32 | 0 | 0 | 0 | 18 | 29 | 2094 | 1965 | 0 | 109 |
| 76 | 0 | 0 | 0 | 199 | 0 | 2053 | 1672 | 0 | 106 |
| 76 | 0 | 0 | 0 | 187 | 150 | 2195 | 1964 | 0 | 118 |
| 100 | 10 | 0 | 0 | 309 | 0 | 2017 | 1488 | 0 | 110 |
| 25 | 0 | 0 | 0 | 0 | 96 | 2036 | 1997 | 0 | 111 |
| 25 | 0 | 0 | 0 | 0 | 12 | 2002 | 1877 | 0 | 111 |
| 51 | 0 | 0 | 0 | 97 | 0 | 2090 | 1836 | 0 | 106 |
| 4 | 0 | 0 | 0 | 0 | 96 | 1994 | 1974 | 0 | 112 |
| 4 | 0 | 0 | 0 | 0 | 125 | 1921 | 1934 | 0 | 108 |
| 5 | 0 | 0 | 0 | 0 | 87 | 1931 | 1905 | 0 | 108 |
| 56 | 0 | 0 | 0 | 113 | 0 | 1966 | 1685 | 0 | 112 |
| 45 | 0 | 0 | 0 | 84 | 0 | 1893 | 1668 | 0 | 96 |
| 45 | 0 | 0 | 0 | 75 | 27 | 1902 | 1705 | 0 | 105 |
| 100 | 33 | 14 | 0 | 414 | 0 | 1866 | 1198 | 0 | 107 |
| 100 | 33 | 14 | 0 | 422 | 373 | 1836 | 1540 | 0 | 99 |
| 100 | 100 | 49 | 0 | 694 | 0 | 1844 | 798 | 0 | 102 |