Data Article

Data supporting the forecast of electricity generation capacity from non-conventional renewable energy sources in Colombia

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Abstract

The data included in this study was calculated based on data provided by the national project registry provided by the Colombian government. The data forecasts the evolution of the power generation capacity registered in non-conventional renewable energy source projects in three scenarios of implementation of the power generation capacity registered in the projects. Results can be used to benchmark non-conventional renewable energy sources in Colombia, interpret the effectiveness of renewable policies, and monitor the evolution of non-conventional renewable-based power generation. The data presented in the article relates to the research study: A look to the electricity generation from non-conventional renewable energy sources in Colombia [1].

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The data presented in the paper, shows the performance of non-conventional renewable energy (NCRE) projects in Colombia, which includes photovoltaic (PV), Eolic, biomass and small hydropower (SHC) renewable sources [1]. The registration of NCRE projects started in 2016, thus a period between 2016 and 2018 is assessed. Based on this data three scenarios forecasting the performance of NCRE based power generation between 2019 and 2023 are developed. Primary data (i.e. the NCRE projects registered between 2016 and 2018) was obtained from the national NCRE projects registry database, which is available from Ref. [2]. The database includes the transit of registered projects through the stages of approval.
Table 1 shows the NCRE projects registered between 2016 and 2018, including their approval stage. It also includes the sum of the power generation capacity (PGC) considered in the registered projects for each approval stage. Moreover, Table 2 shows the PV projects registered or forecasted between 2016 and 2023 in 6 ranges of PGC. Table 3 shows the forecast of PGC integrated into the electric system between 2019 and 2023 for PV projects in three scenarios. Table 4 shows the wind projects registered or forecasted between 2016 and 2023 in four ranges of PGC. Table 5 shows the forecasted PGC integrated into the electric system between 2019 and 2023 for Eolic projects in three scenarios. Table 6 shows the biomass projects registered or forecasted between 2016 and 2023 in five power ranges. Table 7 shows the forecast of PGC integrated into the electric system between 2019 and 2023 for

| Table 1 | Approval stage and power generation capacity (PGC) for projects registered between 2016 and 2018. |
|---------|------------------------------------------------------------------------------------------------|
| Energy source | Project approval stage | 2016 | 2017 | 2018 | 2019 |
| Solar | 1 | 92 | 481.9 | 153 | 1213.8 | 162 | 1435.2 | 434.0 | 3325.9 |
| | 2 | 23 | 428.4 | 37 | 700.3 | 36 | 582.6 | 214.0 | 10331.0 |
| | 3 | 34 | 5.2 | 28 | 433.0 | 13 | 1133.3 | 74.0 | 72.3 |
| Wind | 1 | 5 | 353.9 | 2 | 441.8 | 2 | 492.9 | 12.0 | 1649.2 |
| | 2 | 2 | 39.8 | 1 | 19.9 | 7 | 212.1 | 26.0 | 3038.8 |
| | 3 | 0 | 19.9 | 0 | 39.8 | 0 | 59.7 | 0.0 | 0.0 |
| Biomass | 1 | 8 | 37.6 | 4 | 42.2 | 6 | 63.4 | 13.0 | 230.4 |
| | 2 | 0 | 20.6 | 3 | 65.8 | 3 | 20.3 | 2.0 | 44.0 |
| | 3 | 0 | 0.0 | 3 | 41.6 | 0 | 107.4 | 3.0 | 61.4 |
| SHC | 1 | 31 | 110.5 | 35 | 613.8 | 60 | 945.4 | 263.0 | 2602.1 |
| | 2 | 13 | 260.7 | 26 | 109.4 | 17 | 294.6 | 77.0 | 865.5 |
| | 3 | 4 | 15.1 | 2 | 264.2 | 2 | 373.6 | 23.0 | 212.9 |
| Total | 1 | 136 | 983.9 | 194 | 2311.7 | 230 | 2937.0 | 722.0 | 7807.5 |
| 2 | 38 | 749.5 | 67 | 895.4 | 63 | 1109.6 | 319.0 | 14279.3 |
| 3 | 41 | 40.2 | 33 | 778.6 | 15 | 1674.0 | 100.0 | 346.6 |

| Table 2 | Statistics and forecasts of the power generation capacity registered in PV projects. |
|---------|------------------------------------------------------------------------------------------------|
| Power range (MW) | Approval process stage | PGC registered in projects (MW) | 2016 | 2017 | 2018 | 2019 |
| | | | 2020 | 2021 | 2022 | 2023 |
| 0–1 | 1 | 6.8 | 12.8 | 18.0 | 11.0 | 19.5 | 28.0 | 36.4 | 44.9 |
| | 2 | 0.2 | 3.3 | 6.2 | 2.8 | 11.0 | 19.5 | 28.0 | 36.4 |
| | 3 | 3.3 | 4.8 | 8.0 | 0.0 | 2.8 | 11.0 | 19.5 | 28.0 |
| 1–10 | 1 | 24.9 | 71.4 | 111.4 | 97.8 | 151.0 | 204.1 | 257.3 | 310.5 |
| | 2 | 0.0 | 44.3 | 34.3 | 283.4 | 97.8 | 151.0 | 204.1 | 257.3 |
| | 3 | 2.0 | 0.0 | 44.3 | 69.0 | 283.4 | 97.8 | 151.0 | 204.1 |
| 10–20 | 1 | 398.0 | 211.2 | 295.7 | 157.1 | 341.9 | 526.7 | 711.6 | 896.4 |
| | 2 | 358.2 | 156.6 | 101.4 | 1070.7 | 157.1 | 341.9 | 526.7 | 711.6 |
| | 3 | 0.0 | 358.2 | 514.8 | 39.8 | 1070.7 | 157.1 | 341.9 | 526.7 |
| 20–50 | 1 | 0.0 | 58.0 | 63.8 | 233.0 | 294.7 | 356.5 | 418.2 | 480.0 |
| | 2 | 0.0 | 0.0 | 27.8 | 238.0 | 233.0 | 294.7 | 356.5 | 418.2 |
| | 3 | 0.0 | 0.0 | 0.0 | 0.0 | 238.0 | 233.0 | 294.7 | 356.5 |
| 50–100 | 1 | 52.2 | 55.0 | 60.5 | 449.9 | 557.4 | 664.9 | 772.3 | 879.8 |
| | 2 | 70.0 | 100.0 | 26.4 | 1668.0 | 449.9 | 557.4 | 664.9 | 772.3 |
| | 3 | 0.0 | 70.0 | 170.0 | 0.0 | 1668.0 | 449.9 | 557.4 | 664.9 |
| >100 | 1 | 0.0 | 805.4 | 885.9 | 950.0 | 1409.7 | 1869.3 | 2329.0 | 2788.6 |
| | 2 | 0.0 | 396.2 | 386.6 | 4312.7 | 950.0 | 1409.7 | 1869.3 | 2329.0 |
| | 3 | 0.0 | 0.0 | 396.2 | 0.0 | 4312.7 | 950.0 | 1409.7 | 1869.3 |
| Total | 1 | 481.9 | 1213.8 | 1435.2 | 1898.8 | 2774.2 | 3649.5 | 4524.8 | 5400.2 |
| 2 | 428.4 | 700.3 | 582.6 | 7575.5 | 1898.8 | 2774.2 | 3649.5 | 4524.8 |
| 3 | 5.2 | 433.0 | 1133.3 | 46.7 | 7575.5 | 1898.8 | 2774.2 | 3649.5 |
Table 3
Scenarios of power generation capacities yearly integrated into the electric system. PV projects.

| Power range (MW) | Scenario | Forecasted implementation of PGC (MW) |
|------------------|----------|--------------------------------------|
|                  |          | 2020 | 2021 | 2022 | 2023 |
| 0–1              | i        | 2.8  | 11.0 | 19.5 | 28.0 |
|                  | ii       | 1.4  | 5.5  | 9.7  | 14.0 |
|                  | iii      | 0.7  | 2.8  | 4.9  | 7.0  |
| 1–10             | i        | 283.4| 97.8 | 151.0| 204.1|
|                  | ii       | 141.7| 48.9 | 75.5 | 102.1|
|                  | iii      | 70.9 | 24.5 | 37.7 | 51.0 |
| 10–20            | i        | 1070.7| 157.1| 341.9| 526.7|
|                  | ii       | 535.3| 78.6 | 171.0| 263.4|
|                  | iii      | 267.7| 39.3 | 85.5 | 131.7|
| 20–50            | i        | 238.0| 233.0| 294.7| 356.5|
|                  | ii       | 119.0| 116.5| 147.4| 178.2|
|                  | iii      | 59.5 | 58.3 | 73.7 | 89.1 |
| 50–100           | i        | 1668.0| 449.9| 557.4| 664.9|
|                  | ii       | 834.0| 225.0| 278.7| 332.4|
|                  | iii      | 417.0| 112.5| 139.3| 166.2|
| >100             | i        | 4312.7| 950.0| 1409.7| 1869.3|
|                  | ii       | 2156.3| 475.0| 704.8| 934.7 |
|                  | iii      | 1078.2| 237.5| 352.4| 467.3 |
| **Total**        | i        | 7575.5| 1898.8| 2774.2| 3649.5|
|                  | ii       | 3787.8| 949.4| 1387.1| 1824.8|
|                  | iii      | 1893.9| 474.7| 693.5 | 912.4 |

Table 4
Statistics and forecasts of the power generation capacity registered in wind projects.

| Power range (MW) | Approval process stage | PGC registered in projects (MW) | PGC forecasted in future projects (MW) |
|------------------|------------------------|----------------------------------|---------------------------------------|
|                  |                        | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
| 0–10             | 1                      | 9.9  | 9.9  | 11.9 | 9.9  | 17.3 | 24.6 | 32.0 | 39.3 |
|                  | 2                      | 0.0  | 0.0  | 4.8  | 19.8 | 19.8 | 17.3 | 24.6 | 32.0 |
|                  | 3                      | 0.0  | 0.0  | 0.0  | 0.0  | 19.8 | 17.3 | 24.6 | 32.0 |
| 10–20            | 1                      | 0.0  | 19.9 | 27.9 | 0.0  | 8.5  | 16.9 | 25.4 | 33.8 |
|                  | 2                      | 39.8 | 19.9 | 9.6  | 0.0  | 0.0  | 8.5  | 16.9 | 25.4 |
|                  | 3                      | 19.9 | 39.8 | 59.7 | 0.0  | 0.0  | 8.5  | 16.9 | 25.4 |
| 20–100           | 1                      | 0.0  | 0.0  | 0.0  | 225.0| 0.0  | 225.0| 0.0  | 225.0|
|                  | 2                      | 0.0  | 0.0  | 0.0  | 753.8| 0.0  | 225.0| 0.0  | 225.0|
|                  | 3                      | 0.0  | 0.0  | 0.0  | 0.0  | 753.8| 225.0| 0.0  | 225.0|
| >100             | 1                      | 344.0| 412.0| 453.2| 703.0| 1041.1| 1379.2| 1717.3| 2055.4|
|                  | 2                      | 0.0  | 0.0  | 0.0  | 0.0  | 1041.1| 1379.2| 1717.3| 2055.4|
|                  | 3                      | 0.0  | 0.0  | 0.0  | 0.0  | 1041.1| 703.0 | 1379.2| 1717.3|
| **Total**        | 1                      | 353.9| 441.8| 493.0| 937.9| 1331.6| 1725.3| 2119.0| 2512.7|
|                  | 2                      | 39.8 | 19.9 | 212.2| 1814.8| 937.9 | 1331.6| 1725.3| 2119.0|
|                  | 3                      | 19.9 | 39.8 | 59.7 | 0.0  | 1814.8| 937.9 | 1331.6| 1725.3|

biomass projects in three scenarios. Table 8 shows the SHC projects registered or forecasted between 2016 and 2018 in three power ranges. Table 9 shows the forecasted PGC integrated into the electric system between 2019 and 2023 for SHP projects in three scenarios. Finally, Table 10 summarizes the forecast of PGC integrated into the electric system between 2019 and 2023 for the three scenarios considered.

2. Experimental design, materials, and methods

The PGC of the NCRE projects between 2016 and 2019 shown in Table 1 is used to interpolate the performance of the generation capacity registered in NCRE projects in Colombia. The interpolation is...
used to forecast the PGC in NCRE projects to be registered between 2020 and 2023. Projects in the NCRE database goes through the three approval stages defined by the government [3].

- **Preliminary feasibility assessment**: a preliminary study to develop the environmental impact assessment, and the technical and economic feasibility of the project (it takes around two years).
- **Complete feasibility assessment**: assessment of the technical, economic, environmental and social feasibility of the project (it takes stage takes up to one year).
- **Pre-implementation**: completion of the final design of the project, and definition of the implementation schedule. The project changes to the status “ready for implementation” (it takes up to one year).

| Power range (MW) | Scenario | Forecasted implementation of PGC (MW) |
|------------------|----------|-------------------------------------|
|                  |          | 2020  | 2021  | 2022  | 2023  |
| 0–10             | i        | 19.8  | 9.9   | 17.3  | 24.6  |
|                  | ii       | 9.9   | 5.0   | 8.6   | 12.3  |
|                  | iii      | 5.0   | 2.5   | 4.3   | 6.2   |
| 10–20            | i        | 0.0   | 0.0   | 8.5   | 16.9  |
|                  | ii       | 0.0   | 0.0   | 4.2   | 8.5   |
|                  | iii      | 0.0   | 0.0   | 2.1   | 4.2   |
| 20–100           | i        | 753.8 | 225.0 | 264.8 | 304.6 |
|                  | ii       | 376.9 | 112.5 | 132.4 | 152.3 |
|                  | iii      | 188.5 | 56.3  | 66.2  | 76.1  |
| >100             | i        | 1041.2| 703.0 | 1041.1| 1379.2|
|                  | ii       | 520.6 | 351.5 | 520.6 | 689.6 |
|                  | iii      | 260.3 | 175.8 | 260.3 | 344.8 |
| Total            | i        | 1814.8| 937.9 | 1331.6| 1725.3|
|                  | ii       | 907.4 | 469.0 | 665.8 | 862.6 |
|                  | iii      | 453.7 | 234.5 | 332.9 | 431.3 |

| Power range (MW) | Approval process stage (MW) | PGC registered in projects (MW) | PGC forecasted in future projects (MW) |
|------------------|----------------------------|-------------------------------|---------------------------------------|
|                  |                           | 2016  | 2017  | 2018  | 2019  | 2020  | 2021  | 2022  | 2023  |
| 0–1              | 1                          | 1.7   | 2.6   | 4.0   | 0.5   | 4.2   | 7.9   | 11.6  | 15.3  |
|                  | 2                          | 0.0   | 0.0   | 1.3   | 0.0   | 0.5   | 4.2   | 7.9   | 11.6  |
|                  | 3                          | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 4.2   | 7.9   | 11.6  |
| 1–10             | 1                          | 10.9  | 14.6  | 21.9  | 0.0   | 19.8  | 39.5  | 59.3  | 79.1  |
|                  | 2                          | 0.0   | 20.4  | 7.0   | 28.8  | 0.0   | 19.8  | 39.5  | 59.3  |
|                  | 3                          | 0.0   | 0.0   | 20.4  | 0.0   | 28.8  | 0.0   | 19.8  | 39.5  |
| 10–20            | 1                          | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   |
|                  | 2                          | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   |
|                  | 3                          | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   |
| 20–50            | 1                          | 25.0  | 25.0  | 37.5  | 0.0   | 36.5  | 73.0  | 109.5 | 146.0 |
|                  | 2                          | 20.6  | 45.4  | 12.0  | 25.0  | 0.0   | 36.5  | 73.0  | 109.5 |
|                  | 3                          | 0.0   | 41.6  | 87.0  | 0.0   | 25.0  | 0.0   | 36.5  | 73.0  |
| >50              | 1                          | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   |
|                  | 2                          | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   |
|                  | 3                          | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   |
| Total            | 1                          | 37.6  | 42.2  | 63.4  | 0.5   | 60.5  | 120.5 | 180.4 | 240.4 |
|                  | 2                          | 20.6  | 65.8  | 20.3  | 73.5  | 0.5   | 60.5  | 120.5 | 180.4 |
|                  | 3                          | 0.0   | 41.6  | 107.4 | 0.0   | 73.5  | 0.5   | 60.5  | 120.5 |
In total, it takes about four years between the registration of a project to the database and the clearance of the government for its implementation [3]. In addition, it takes around one year to implement the project after its approval [4,5]. Thus, it takes around 5 years from registering a project to its implementation. This average time is used to forecast the initial exploitation date of the projects registered between 2016 and 2019. The PGC yearly accumulated for each NCRE source is forecasted by adding the generation capacity of the projects after five years, considering the different scenarios of project success.

Overall, between 70 and 75% of the renewable-based power generation projects registered at UPME are approved for implementation [6]. Thus, three scenarios considering a high (100%), medium (50%) and low (25%) implementation of these projects were considered:

i. Scenario 1 (high success): 100% of the power generation capacities of NCRE projects registered are implemented.

### Table 7
Scenarios of power generation capacities yearly integrated into the electric system. Biomass projects.

| Power range (MW) | Scenario | 2019 | 2020 | 2021 | 2022 | 2023 |
|------------------|----------|------|------|------|------|------|
| 0–1              | i        | 0.0  | 0.0  | 4.2  | 7.9  | 0.0  |
|                  | ii       | 0.0  | 0.0  | 2.1  | 3.9  | 0.0  |
|                  | iii      | 0.0  | 0.1  | 1.1  | 2.0  | 0.0  |
| 1–10             | i        | 28.8 | 0.0  | 19.8 | 39.5 | 28.8 |
|                  | ii       | 14.4 | 0.0  | 9.9  | 19.8 | 14.4 |
|                  | iii      | 7.2  | 0.0  | 4.9  | 9.9  | 7.2  |
| 10–20            | i        | 19.8 | 0.0  | 0.0  | 0.0  | 19.8 |
|                  | ii       | 9.9  | 0.0  | 0.0  | 0.0  | 9.9  |
|                  | iii      | 4.9  | 0.0  | 0.0  | 0.0  | 4.9  |
| 20–50            | i        | 25.0 | 0.0  | 36.5 | 73.0 | 25.0 |
|                  | ii       | 12.5 | 0.0  | 18.3 | 36.5 | 12.5 |
|                  | iii      | 6.3  | 0.0  | 9.1  | 18.3 | 6.3  |
| >50              | i        | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  |
|                  | ii       | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  |
|                  | iii      | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  |
| **Total**        | i        | 73.5 | 0.5  | 60.5 | 120.5| 73.5 |
|                  | ii       | 36.8 | 0.3  | 30.2 | 60.2 | 36.8 |
|                  | iii      | 18.4 | 0.1  | 15.1 | 30.1 | 18.4 |

### Table 8
Statistics and forecasts of the power generation capacity registered in SHC projects.

| Power range (MW) | Approval process stage | PGC registered in projects (MW) | PGC forecasted in future projects (MW) |
|------------------|-------------------------|---------------------------------|----------------------------------------|
|                  |                         | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
| 0–1              | 1                       | 1.1  | 1.1  | 1.7  | 1.0  | 3.1  | 5.1  | 7.2  | 9.2  |
|                  | 2                       | 0.0  | 0.0  | 0.5  | 0.8  | 1.0  | 3.1  | 5.1  | 7.2  |
|                  | 3                       | 0.0  | 0.0  | 0.0  | 1.0  | 0.8  | 1.0  | 3.1  | 5.1  |
| 1–10             | 1                       | 109.4| 214.7| 386.5| 73.3 | 402.9| 732.5| 1062.1| 1391.7|
|                  | 2                       | 66.7 | 109.4| 103.1| 19.8 | 73.3 | 402.9| 732.5| 1062.1|
|                  | 3                       | 15.1 | 70.2 | 179.6| 1.0  | 19.8 | 73.3 | 402.9| 732.5 |
| 10–20            | 1                       | 1.0  | 398.0| 557.2| 112.7| 561.7| 1010.6| 1459.6| 1908.6|
|                  | 2                       | 194.0| 0.0  | 191.0| 185.9| 112.7| 561.7| 1010.6| 1459.6|
|                  | 3                       | 0.0  | 194.0| 194.0| 0.0  | 185.9| 112.7| 561.7| 1010.6|
| **Total**        | 1                       | 110.5| 613.8| 945.4| 187.0| 967.6| 1748.2| 2528.9| 3309.5|
|                  | 2                       | 260.7| 109.4| 294.6| 206.5| 187.0| 967.6| 1748.2| 2528.9|
|                  | 3                       | 15.1 | 264.2| 373.6| 2.0  | 206.5| 187.0| 967.6| 1748.2|
ii. Scenario 2 (medium success): 50% of the power generation capacities of NCRE projects registered are implemented.

iii. Scenario 3 (low success): 25% of the power generation capacities of NCRE projects registered are implemented.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.
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