

Supplementary Material

Section S1

Table S1. Change in technical and economic variables derived from technological progress considering a complete integration of the VCPVIM in the year 2018 and 2040.

| Variable | Cost/Parameter | | Unit | Reference |
|-----------------------------------|--------------------|--------------|--------|--------------------------------|
| | 2018 | 2040 | | |
| MFV efficiency | 18.4 | 24 | % | [1,2] |
| Poy-Si total material consumption | 0.085 | 0.065 | g/μm | |
| Poly-Si use per CFV | 3.0 | 1.5 | g/W | |
| CFV thickness | 160 | 120 | μm | |
| Number of CFV per MFV | 60 | | Celdas | |
| MFV output | 310 | 398 | Wp | |
| Electricity | 0.035 | 0.024 | USD/W | |
| Depreciation | 0.057 | 0.020 | | |
| Labor | 0.016 | 0.013 | | |
| Operation & maintenance | 0.018 | 0.010 | | |
| Total equipment yield | 96 | 99 | % | |
| | | | | |
| VCPVIM link | Total | | | |
| | manufacturing cost | | | |
| | 2018 | 2040 | | |
| MG-Si | 0.015 | 0.013 | USD/W | Own calculation based on [1–5] |
| Poly-Si | 0.048 | 0.02 | | |
| Ingot | 0.035 | 0.015 | | |
| CFV | 0.087 | 0.06 | | |
| MFV | 0.122 | 0.09 | | |
| Total | 0.307 | 0.198 | | |

Table S2. Capex per link of the value chain of the PV industry for the years 2018 and 2040.

| Link | Cost (USD/W) ₂₀₁₈ | | Cost (USD/W) ₂₀₄₀ | | Reference |
|---------|------------------------------|----------|------------------------------|----------|-----------|
| | Equipment | Facility | Equipment | Facility | |
| MFV | 0.05 | 0.04 | 0.009 | 0.068 | [1,6–12] |
| CFV | 0.08 | 0.06 | 0.015 | 0.102 | |
| Ingot | 0.05 | 0.02 | 0.009 | 0.034 | |
| Poly-Si | 0.14 | 0.05 | 0.025 | 0.078 | |
| MG-Si | 0.02 | 0.01 | 0.004 | 0.014 | |

Table S3. Discount rate and number of periods per link to prepare the cash flow.

| PV industry upstream link | Equipment depreciation (years) | Facility depreciation (years) | Subsector | WACC (%) |
|---------------------------|--------------------------------|-------------------------------|-----------------|----------|
| MG-Si | 10 | 25 | Basic resources | 9.94 |
| Poly-Si | 10 | 25 | Chemical | 10.81 |
| Ingot | 10 | 25 | Technological | 11.10 |
| CFV | 5 | 25 | Technological | 11.10 |
| MFV | 5 | 25 | Technological | 11.10 |

Source: [7,10,13].

Section S2

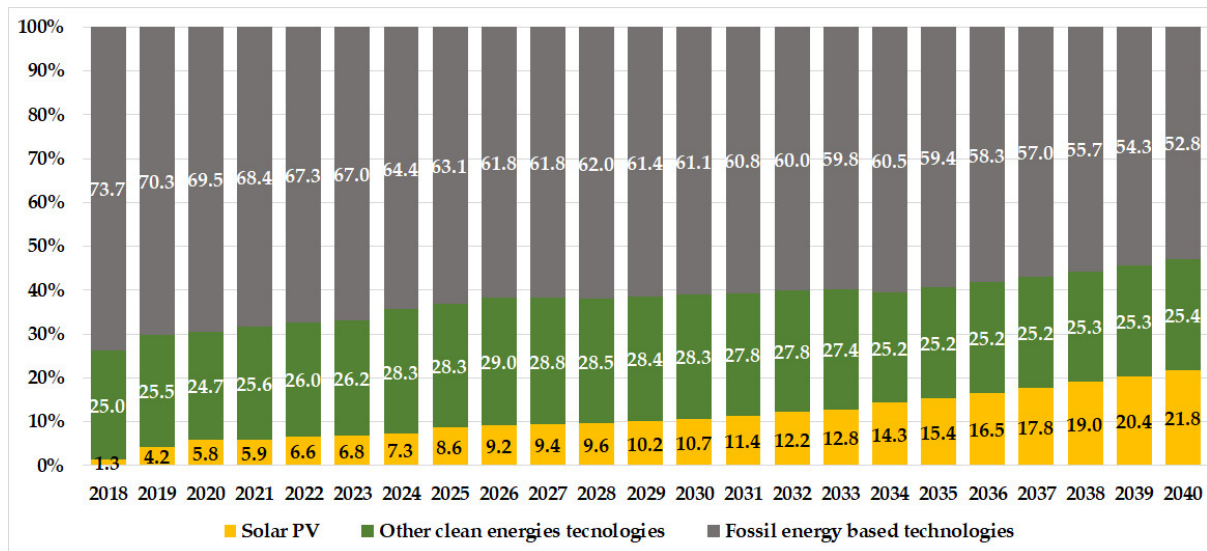


Figure S1. Evolution of the share of PV energy on electricity generation, 2018 - 2040. Source: Own elaboration with information from [14–17].

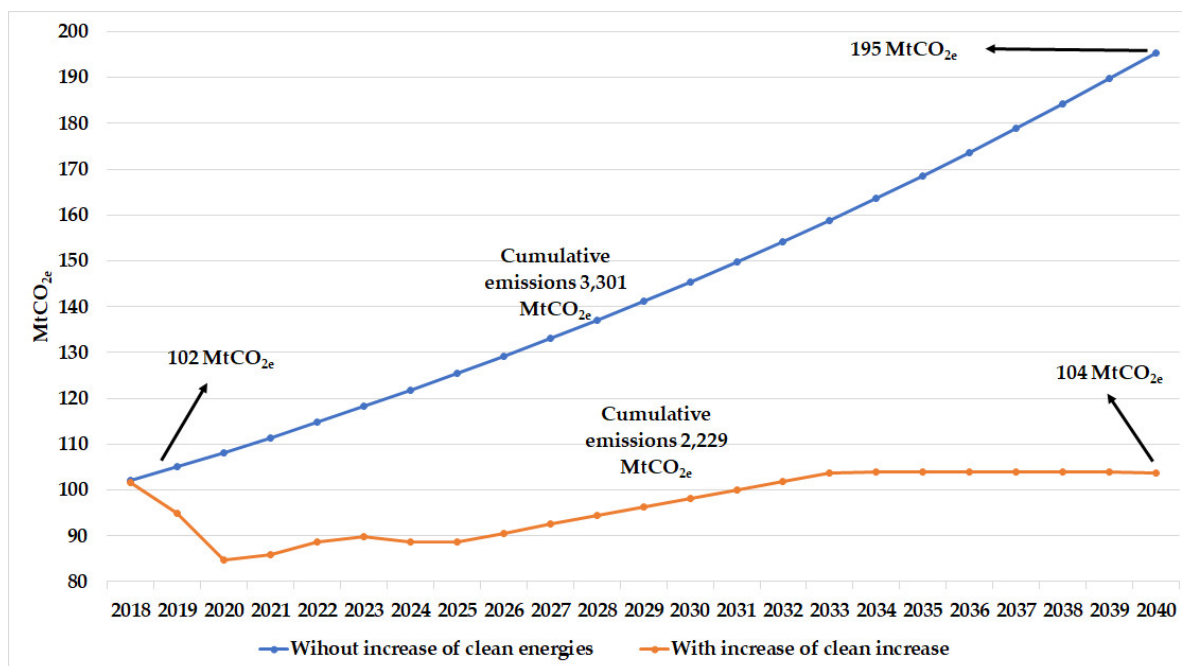


Figure S2. Avoided emissions evolution derived from the increase in the share of clean energies on electricity generation, 2018 – 2040. Source: Own elaboration with information from [14–17].

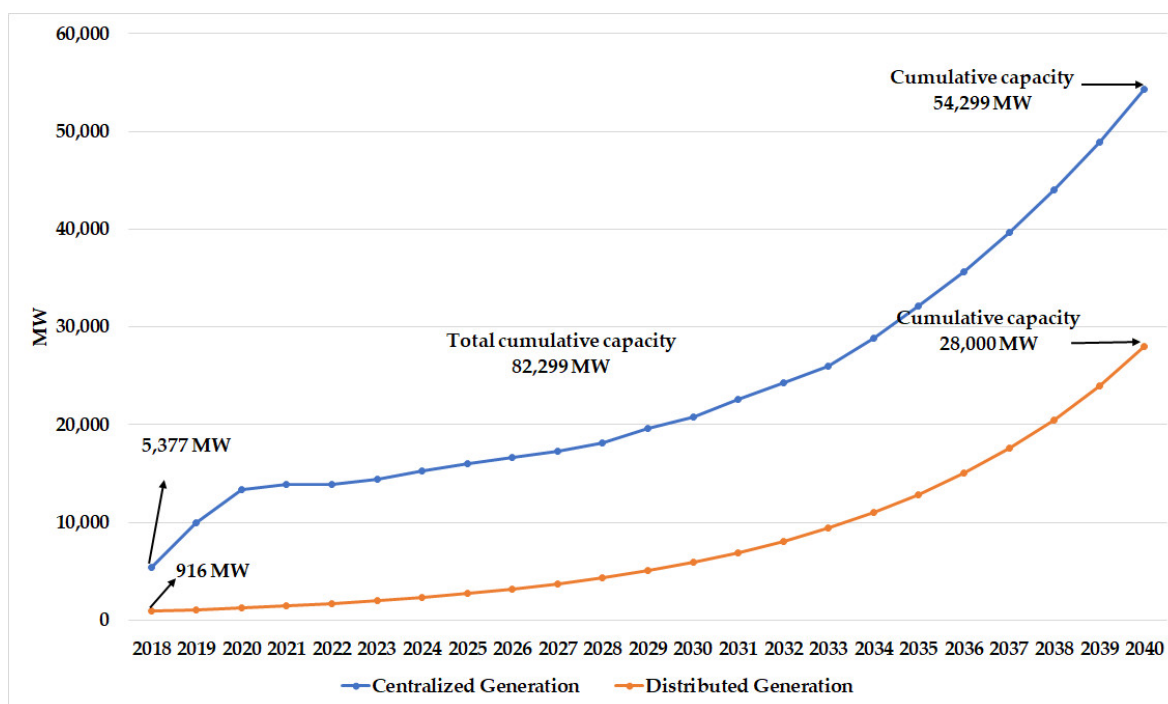


Figure S3. Cumulative capacity evolution of PV generation plants, 2018 – 2040. Source: Own elaboration with information from [14–17].

Table S4. Total socioeconomic benefits of the VCPVIM in the Base Scenario.

| Subsector | Multiplier | | Jobs (#) | Valor added (MUSD) |
|--|------------|-------------|---------------|--------------------|
| | Jobs | Value added | | |
| Non-residential building | 0.00004 | 0.54 | 4,255 | 64.3 |
| Construction for the supply of water, oil, gas, electricity and telecommunications | 0.00003 | 0.49 | 3,229 | 57.9 |
| Division of land and urbanization construction | 0.00002 | 0.47 | 2,882 | 55.6 |
| Other civil engineering constructions | 0.00001 | 0.45 | 1,453 | 53.2 |
| Foundations, assembly of prefabricated structures and exterior work | 0.00003 | 0.78 | 3,192 | 92.8 |
| Facilities and equipment in buildings | 0.00007 | 0.99 | 8,588 | 118.4 |
| Finishing work in buildings | 0.00006 | 0.84 | 7,564 | 100.7 |
| Other specialized construction jobs | 0.00005 | 1.22 | 5,615 | 145.5 |
| Manufacture of cardboard and paper products | 0.000029 | 0.61 | 257 | 4.3 |
| Wholesale of groceries and food | 0.000351 | 6.95 | 5,004 | 88.7 |
| Retail groceries and food | 0.000115 | 2.3 | 1,641 | 29.3 |
| Direct | | | 1,025 | 355.7 |
| Total | | | 44,706 | 1,166.40 |

Table S5. Manufacturing costs derived from the upstream integration of VCPVIM in the Alternative Scenario (extended version).

| Material/input /parameter | VCPVIM upstream integration evolution | | | | |
|---------------------------------|---------------------------------------|----------------------|----------------------|---------------------------------|---------------------------------|
| | 2018 | 2026 | 2031 | 2038 | 2040 |
| | MFV | MFV+ CFV | MFV+CFV+I ngot | MFV+CFV+Ingot+P oly-Si+MG-Si | MFV+CFV+Ingot+P oly-Si+MG-Si |
| | (USD/W) | | | | |
| Depreciation | 0.012 | 0.013 | 0.013 | 0.013 | 0.013 |
| Maintenance | 0.003 | 0.004 | 0.004 | 0.006 | 0.006 |
| Labor | 0.004 | 0.004 | 0.004 | 0.008 | 0.008 |
| Electricity | 0.002 | 0.008 | 0.008 | 0.014 | 0.014 |
| SiO ₂ | - | - | - | 0.00014 | 0.00010 |
| Coal | - | - | - | 0.00044 | 0.00035 |
| Wood | - | - | - | 0.00042 | 0.00035 |
| Coke | - | - | - | 0.00011 | 0.00010 |
| Charcoal | - | - | - | 0.00034 | 0.00025 |
| Natural Gas | - | - | - | 0.00022 | 0.00012 |
| Electrodes ¹ | - | - | - | 0.00189 ¹ | 0.00172 ¹ |
| Oxigen | - | - | - | 0.00017 | 0.00015 |
| Lancets (graphite) | - | - | - | 0.0000004 ¹ | 0.00000 ¹ |
| Water | - | - | - | 0.00132 | 0.00117 |
| MG-Si | - | - | - | - | 0.00000 |
| HCL | - | - | - | 0.00411 | 0.00385 |
| Hidrogen | - | - | - | 0.00008 | 0.00007 |
| Water | - | - | - | 0.00353 | 0.00329 |
| Poly-Si | - | - | 0.01828 ¹ | - | - |
| Crucible | - | - | 0.00395 | 0.00309 | 0.00288 |
| Sawing wire | - | - | 0.00242 ¹ | 0.00210 | 0.00192 |
| Slurry | - | - | 0.00411 | 0.00257 | 0.00237 |
| Wafer | - | 0.03169 ¹ | - | - | - |
| Aluminum paste | - | 0.00105 | 0.00077 | 0.00070 | 0.00058 |
| Silver paste | - | 0.00192 | 0.00135 | 0.00113 | 0.00099 |
| Chemicals | - | 0.02164 | 0.01827 | 0.01379 | 0.01313 |
| Screen printing | - | 0.00001 | 0.00001 | 0.00001 | 0.00001 |
| CFV | 0.09400 ¹ | - | - | - | - |
| Glass | 0.02093 ¹ | 0.00937 | 0.00974 | 0.00795 | 0.00753 |
| Aluminum frame | 0.02544 ¹ | 0.01238 | 0.01184 | 0.00966 | 0.00917 |
| Encapsulant | 0.01139 ¹ | 0.00661 | 0.00530 | 0.00433 | 0.00406 |
| Junction Box & Cables | 0.01537 ¹ | 0.01000 | 0.00715 | 0.00584 | 0.00550 |
| Tabbling | 0.00880 ¹ | 0.00487 | 0.00410 | 0.00334 | 0.00311 |
| Backsheet (EVA) | 0.01225 ¹ | 0.00718 | 0.00570 | 0.00465 | 0.00437 |
| Connection ribbons | 0.00486 ¹ | 0.00224 | 0.00226 | 0.00184 | 0.00168 |
| Packaging | 0.00247 | 0.00165 | 0.00115 | 0.00094 | 0.00081 |
| Total manufacturing cost | 0.217 | 0.140 | 0.127 | 0.115 | 0.110 |

¹Imported materials and / or supplies in the development of the proposed scenarios.

Source: Own elaboration.

Table S6. Total socioeconomic benefits by subsector in the Alternative Scenario for the MFV link.

| Subsector | Jobs (#) | Value added (MUSD) |
|--|---------------------|-------------------------------|
| Metal ore mining | 2,076 | 222.5 |
| Mining related services | 1,724 | 133.5 |
| Non-residential building | 8,335 | 126.0 |
| Construction for the supply of water, oil, gas, electricity and telecommunications | 6,326 | 113.5 |
| Division of land and urbanization construction | 5,646 | 108.9 |
| Other civil engineering constructions | 2,846 | 104.1 |
| Foundations, assembly of prefabricated structures and exterior work | 6,254 | 181.8 |
| Facilities and equipment in buildings | 16,826 | 231.9 |
| Finishing work in buildings | 14,818 | 197.2 |
| Other specialized construction jobs | 11,001 | 285.1 |
| Manufacture of cardboard and paper products | 538 | 11.3 |
| Manufacture of paints, coatings and adhesives | 110 | 3.4 |
| Manufacture of plastic products | 4,747 | 86.8 |
| Manufacture of glass and glass products | 3,438 | 90.3 |
| Basic aluminum industry | 1,534 | 80.5 |
| Manufacture of other electrical equipment and accessories | 1,073 | 45.4 |
| Wholesale of groceries and food | 10,999 | 217.6 |
| Retail groceries and food | 3,607 | 71.9 |
| Direct | 2,591 | 1,372.7 |
| Total | 104,488 | 3,639.7 |

Source: Own elaboration.

Table S7. Total socioeconomic benefits by subsector in the Alternative Scenario for the CFV link.

| Subsector | Jobs (#) | Value added (MUSD) |
|--|---------------------|-------------------------------|
| Metal ore mining | 193 | 23.4 |
| Mining related services | 161 | 14.0 |
| Non-residential building | 14,641 | 221.3 |
| Construction for the supply of water, oil, gas, electricity and telecommunications | 11,112 | 199.3 |
| Division of land and urbanization construction | 9,918 | 191.3 |
| Other civil engineering constructions | 4,999 | 182.9 |
| Foundations, assembly of prefabricated structures and exterior work | 10,985 | 319.3 |
| Facilities and equipment in buildings | 29,554 | 407.4 |
| Finishing work in buildings | 26,028 | 346.4 |
| Other specialized construction jobs | 19,323 | 500.8 |
| Manufacture of basic chemicals | 12,412 | 330.6 |
| Manufacture of other chemicals | 3,766 | 96.2 |
| Basic aluminum industry | 52 | 3.3 |
| Manufacture of other electrical equipment and accessories | 2,447 | 64.0 |
| Wholesale of groceries and food | 10,131 | 158.2 |
| Retail groceries and food | 3,322 | 52.3 |
| Direct | 3,627 | 862.4 |
| Total | 162,672 | 3,973.0 |

Source: Own elaboration.

Table S8. Total socioeconomic benefits by subsector in the Alternative Scenario for the Ingot link.

| Subsector | Jobs (#) | Value added (MUSD) |
|--|---------------------|-------------------------------|
| Non-residential building | 5,094 | 77.0 |
| Construction for the supply of water, oil, gas, electricity and telecommunications | 3,867 | 69.3 |
| Division of land and urbanization construction | 3,451 | 66.6 |
| Other civil engineering constructions | 1,739 | 63.6 |
| Foundations, assembly of prefabricated structures and exterior work | 3,822 | 111.1 |
| Facilities and equipment in buildings | 10,283 | 141.8 |
| Finishing work in buildings | 9,056 | 120.5 |
| Other specialized construction jobs | 6,723 | 174.2 |
| Manufacture of other chemicals | 594 | 14.1 |
| Manufacture of refractory clay and mineral based products | 505 | 10.1 |
| Manufacture of other electrical equipment and accessories | 1,249 | 32.6 |
| Wholesale of groceries and food | 838 | 16.6 |
| Retail groceries and food | 275 | 5.5 |
| Direct | 3,109 | 447.2 |
| Total | 50,606 | 1,350.3 |

Source: Own elaboration.

Table S9. Total socioeconomic benefits by subsector in the Alternative Scenario for the Poly-Si link.

| Subsector | Jobs (#) | Value added (MUSD) |
|--|---------------------|-------------------------------|
| Non-residential building | 12,855 | 194.3 |
| Construction for the supply of water, oil, gas, electricity and telecommunications | 9,757 | 175.0 |
| Division of land and urbanization construction | 8,708 | 168.0 |
| Other civil engineering constructions | 4,389 | 160.6 |
| Foundations, assembly of prefabricated structures and exterior work | 9,645 | 280.3 |
| Facilities and equipment in buildings | 25,948 | 357.7 |
| Finishing work in buildings | 22,853 | 304.1 |
| Other specialized construction jobs | 16,966 | 439.7 |
| Manufacture of other chemicals | 455 | 10.8 |
| Manufacture of electrical power generation and distribution equipment | 1,761 | 42.5 |
| Manufacture of other electrical equipment and accessories | 2,406 | 62.9 |
| Wholesale of groceries and food | 528 | 10.4 |
| Retail groceries and food | 173 | 3.4 |
| Direct | 518 | 383.3 |
| Total | 116,960 | 2,593.1 |

Source: Own elaboration.

Table S10. Total socioeconomic benefits by subsector in the Alternative Scenario for the MG-Si link.

| Subsector | Jobs (#) | Value added (MUSD) |
|---|---------------|-----------------------|
| Felling of trees | 123 | 3.7 |
| Coal mining | 25 | 1.5 |
| Non-metallic mineral mining | 30 | 0.6 |
| Mining related services | 20 | 1.6 |
| Gas supply through pipelines to the final consumer | 0 | 0.4 |
| Non-residential building | 2,245 | 33.9 |
| Construction for the supply of water, oil, gas, electricity and telecommunications | 1,704 | 30.6 |
| Division of land and urbanization construction | 1,521 | 29.3 |
| Other civil engineering constructions | 767 | 28.1 |
| Foundations, assembly of prefabricated structures and exterior work | 1,685 | 49.0 |
| Facilities and equipment in buildings | 4,532 | 62.5 |
| Finishing work in buildings | 3,992 | 53.1 |
| Other specialized construction jobs | 2,963 | 76.8 |
| Manufacture of oil and coal products | 159 | 2.8 |
| Manufacture of basic chemicals | 58 | 1.4 |
| Manufacture of agricultural machinery and equipment, for construction and for the extractive industry | 37 | 1.4 |
| Manufacture of machinery and equipment for the metalworking industry | 339 | 9.6 |
| Manufacture of electrical power generation and distribution equipment | 307 | 7.4 |
| Manufacture of other electrical equipment and accessories | 420 | 11.0 |
| Wholesale of groceries and food | 1,064 | 21.0 |
| Retail groceries and food | 349 | 7.0 |
| Direct | 519 | 159.7 |
| Total | 22,860 | 592.4 |

Source: Own elaboration.

Table S11. Cash flow for the Baseline Scenario, 2018 - 2040.

| Year | Revenues | Manufacturing Cost | Depreciation | Gross income | Tax | Change in NWC | CAPEX | Net income | Retained earnings |
|------|-------------|--------------------|--------------|--------------|------------|---------------|-------------------------|------------|-------------------|
| 2018 | - | - | - | - | - | - | - | - | - |
| 2019 | 280,543,058 | 244,353,004 | - | 36,190,055 | 10,857,016 | - | - | 25,333,038 | 25,333,038 |
| 2020 | 266,709,480 | 232,303,957 | - | 34,405,523 | 10,321,657 | - | - | 24,083,866 | 49,416,904 |
| 2021 | 253,558,036 | 220,849,049 | - | 32,708,987 | 9,812,696 | - | - | 22,896,291 | 72,313,195 |
| 2022 | 241,055,089 | 209,958,982 | - | 31,096,106 | 9,328,832 | - | - | 21,767,275 | 94,080,469 |
| 2023 | 227,222,496 | 197,910,794 | - | 29,311,702 | 8,793,511 | - | - | 20,518,191 | 114,598,661 |
| 2024 | 212,650,717 | 185,218,775 | - | 27,431,943 | 8,229,583 | - | - | 19,202,360 | 133,801,021 |
| 2025 | 199,013,427 | 173,340,695 | - | 25,672,732 | 7,701,820 | - | - | 17,970,912 | 151,771,933 |
| 2026 | 186,250,696 | 162,224,356 | - | 24,026,340 | 7,207,902 | - | - | 16,818,438 | 168,590,371 |
| 2027 | 174,961,322 | 152,391,311 | - | 22,570,011 | 6,771,003 | - | - | 15,799,007 | 184,389,378 |
| 2028 | 173,377,922 | 151,012,170 | - | 22,365,752 | 6,709,726 | - | - | 15,656,026 | 200,045,405 |
| 2029 | 171,808,852 | 149,645,510 | - | 22,163,342 | 6,649,003 | - | - | 15,514,339 | 215,559,744 |
| 2030 | 170,253,982 | 148,291,218 | - | 21,962,764 | 6,588,829 | 4,508,855 | 73,173,778 ^a | 57,799,844 | 157,759,900 |
| 2031 | 310,063,435 | 270,065,252 | 6,640,676 | 33,357,508 | 10,007,252 | 141,994 | - | 29,848,937 | 187,608,837 |
| 2032 | 305,660,534 | 266,230,325 | 6,640,676 | 32,789,533 | 9,836,860 | 139,977 | - | 29,453,372 | 217,062,209 |
| 2033 | 301,320,155 | 262,449,855 | 6,640,676 | 32,229,624 | 9,668,887 | 137,990 | - | 29,063,423 | 246,125,632 |
| 2034 | 297,041,409 | 258,723,067 | 6,640,676 | 31,677,666 | 9,503,300 | 19,979 | - | 28,835,020 | 274,960,652 |
| 2035 | 297,660,898 | 259,262,642 | 6,640,676 | 31,757,580 | 9,527,274 | 237,109 | - | 28,633,872 | 303,594,525 |
| 2036 | 290,308,674 | 252,858,855 | 2,664,694 | 34,785,125 | 10,435,538 | 231,253 | - | 26,783,029 | 330,377,553 |
| 2037 | 283,138,049 | 246,613,241 | 2,664,694 | 33,860,115 | 10,158,034 | 225,541 | - | 26,141,233 | 356,518,787 |
| 2038 | 276,144,540 | 240,521,894 | 2,664,694 | 32,957,952 | 9,887,386 | 219,970 | - | 25,515,290 | 382,034,077 |
| 2039 | 269,323,769 | 234,581,003 | 2,664,694 | 32,078,073 | 9,623,422 | 3,667,753 | 76,044,677 ^b | 50,925,333 | 331,108,744 |
| 2040 | 383,052,532 | 333,638,755 | 7,960,029 | 41,453,748 | 12,436,124 | 12,353,444 | - | 24,624,208 | 355,732,952 |

^aProduction capacity increase to 2.18 GW

^bProduction capacity increase to a 3.18 GW

Source: Own elaboration.

Table S12. Cash flow for the Alternative Scenario, 2018 – 2040.

| Year | Revenues | Manufacturing Cost | Depreciation | Gross income | Tax | Change in NWC | CAPEX | Net income | Retained earnings |
|------|-------------|--------------------|--------------|--------------|------------|---------------|----------------|-------------|-------------------|
| 2018 | - | - | - | - | - | - | - | - | - |
| 2019 | 293,155,315 | 254,714,281 | - | 38,441,034 | 11,532,310 | - | - | 26,908,724 | 26,908,724 |
| 2020 | 289,956,990 | 251,179,542 | - | 38,777,448 | 11,633,234 | - | - | 27,144,214 | 54,052,937 |
| 2021 | 284,775,598 | 245,951,011 | - | 38,824,587 | 11,647,376 | 17,804,964 | 82,678,555a | 45,411,860 | 8,641,077 |
| 2022 | 512,649,816 | 441,429,958 | 10,089,484 | 71,219,858 | 21,365,957 | 863,926 | - | 60,807,311 | 69,448,388 |
| 2023 | 478,870,881 | 411,106,730 | 10,089,484 | 67,764,152 | 20,329,245 | 948,293 | - | 58,472,683 | 127,921,072 |
| 2024 | 443,984,961 | 380,013,980 | 10,089,484 | 63,970,980 | 19,191,294 | 1,014,115 | - | 79,297,088 | 207,218,159 |
| 2025 | 408,550,573 | 348,636,053 | 33,503,286 | 59,914,519 | 17,974,356 | 13,384,947 | 235,289,678b | 159,846,229 | 47,371,931 |
| 2026 | 358,818,192 | 305,278,406 | 33,503,286 | 53,539,786 | 16,061,936 | 6,384 | - | 63,034,010 | 110,405,941 |
| 2027 | 352,951,857 | 299,386,533 | 25,562,544 | 53,565,324 | 16,069,597 | 1,933 | - | 63,056,337 | 173,462,278 |
| 2028 | 347,181,430 | 293,608,373 | 25,562,544 | 53,573,058 | 16,071,917 | 2,361 | - | 63,066,045 | 236,528,323 |
| 2029 | 341,505,345 | 287,941,731 | 25,562,544 | 53,563,614 | 16,069,084 | 6,503 | - | 44,378,600 | 280,906,924 |
| 2030 | 335,922,058 | 282,384,456 | 6,877,568 | 53,537,602 | 16,061,281 | 19,515,745 | 324,502,969c | 251,697,787 | 29,209,137 |
| 2031 | 482,176,981 | 404,114,000 | 35,328,861 | 78,062,981 | 23,418,894 | 82,435 | - | 89,890,513 | 119,099,650 |
| 2032 | 476,808,712 | 398,415,993 | 35,328,861 | 78,392,719 | 23,517,816 | 77,291 | - | 90,126,473 | 209,226,124 |
| 2033 | 471,500,209 | 392,798,327 | 35,328,861 | 78,701,882 | 23,610,565 | 72,264 | - | 90,347,915 | 299,574,038 |
| 2034 | 466,250,809 | 387,259,871 | 35,328,861 | 78,990,938 | 23,697,281 | 67,352 | - | 90,555,166 | 390,129,204 |
| 2035 | 461,059,852 | 381,799,507 | 35,328,861 | 79,260,345 | 23,778,104 | 62,552 | - | 80,410,997 | 470,540,201 |
| 2036 | 455,926,688 | 376,416,133 | 24,991,308 | 79,510,555 | 23,853,166 | 57,863 | - | 80,590,833 | 551,131,034 |
| 2037 | 450,850,674 | 371,108,666 | 24,991,308 | 79,742,008 | 23,922,602 | 32,557,247 | 1,072,777,098d | 918,158,650 | -367,027,615 |
| 2038 | 726,158,989 | 595,930,000 | 98,799,043 | 130,228,989 | 39,068,697 | 317,312 | - | 190,276,647 | -176,750,969 |
| 2039 | 709,343,742 | 580,384,000 | 98,799,043 | 128,959,742 | 38,687,923 | 51,633 | - | 189,122,496 | 12,371,527 |
| 2040 | 698,773,209 | 570,020,000 | 98,799,043 | 128,753,209 | 38,625,963 | - | - | 90,127,247 | 102,498,774 |

^aProduction capacity increase to 2.18 GW

^bCFV link upstream integration

^cProduction capacity increase to 3.18 GW and Ingot link upstream integration

^dProduction capacity increase to 5.18 GW and Poly-Si & MG-Si links upstream integration

Source: Own elaboration.

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