Preliminary Calculation of the Potential Solar Power from the Second-floor+ Houses in Hung Vuong Street, Hue city, Vietnam

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Abstract. This is the preliminary calculation about the potential of solar power from second-floor+ houses along Hung Vuong Street, Hue city. Research team organized field trips to inventory the houses and areas, number of floors, sunshine direction of the house in accordance with its adjacent houses. We calculated the number of solar panels needed to install and the potential of solar power can be generated from each house from the second floor and more. Research team has chosen photovoltaic solar cell technology (PV) to calculate the actual solar power achieved. The calculated results of solar power reserves are 3GWh/year with an investment of 57 billion VND (not including inverter). This reserves can help to reduce 4.17 million tons of CO₂, 19.08 million tons of nitrogen oxide, 0.06 million tons of sulfur dioxide, 3.12 million tons dust, 1.14 million tons of ash, 9.12 million m³ of water and 2.55 million tons of coal annually, if the lifetime of the solar system is 25 years, the emissions will decrease significantly. This research shows that the potential for solar power conversion is feasible to address the green growth needs of the economy and climate protection in Thua Thien Hue province.

1. Introduction
Hung Vuong street is in the south of Huong river and located between the boundary of Phu Hoi and Phu Nhuan wards. Hung Vuong street starts from Le Loi street at the end of Truong Tien bridge in the south of Huong river. It goes through many crossroads of Tran Cao Van, Nguyen Tri Phuong, city central intersections, Nguyen Hue-Ba Trieu intersection to An Cuu bridge. This is a two way street and it is the main street of Hue city with the presence of many second-floor+ houses as symbols of important socio-economic activities in Hue city.

Hung Vuong Street is located within the plain weather area of Thua Thien Hue province, so it inherits a rich radiation regime, high temperature background of a typical tropical humid hot monsoon climate regime. Hue city has a short rainy season but sunny season lasts 8-10 months, from January to October, equal to 300 sunny days. The total annual sunny hours in a year of Thua Thien Hue fluctuates from 1.700 to 2.000 hours/year and gradually decreases from the coastal plain to the hill areas. From May to July, it is the sunniest time with more than 200 hours/month in plain. From August onwards, sunny hours at first drop quickly (August-September) and reach to the minimum value 69-90 in December, after that, sunny hours will raise rapidly from early year (January, February) [1].
Thua Thien Hue province is targeting to develop solar power on the roofs and this orientation has been supported by local people. Until 11/2019, Hue had more than 100 customers for solar power on the roofs and the number is increasing continuously, customers in Hue city are predominant. Thua Thien Hue Province’s Department of Trade and Industry announced the price for each kWh generated by solar panels in Thua Thien Hue. Namely, for solar power systems installed before 30/06/2019, Thua Thien Hue Power Company will buy with the price of 9.35 UScents/kWh, equal to 2.134 VND. After the 30/06/2019, the price will be adjusted by Vietnam Electricity but new customers are welcomed for equipment and instruction. The paperworks and procedures to obtain a solar power system have been improved a lot since the first days. And customers in Hue city feedback very well about the solar systems, besides the reduction of energy consumption and payment each month, the solar panels on the roofs help the house cooler, especially in extreme heat events.

2. Data and methods

2.1. Data
- The land registry and cadastral data from Phu Hoi ward’s People Committee in 2018 for the left of Hung Vuong street
- The land registry and cadastral data from Phu Nhuan ward’s People Committee in 2018 for the right of Hung Vuong street
- Investigated data about the status of houses on Hung Vuong street, Hue city, Vietnam in June 2018

2.2. Methods

2.2.1. Method of investigation and field trip
From the land registry of Phu Hoi and Phu Nhuan wards, we investigated information about the number level of house, construction area of the house, shadow distribution and status of the roof or top of the houses or buildings. We choose houses with 2 floors or higher to avoid the shadow of the street trees. We assume that the shadow from advertisement boards is not permanent because the owner of the houses can decide to change them.

2.2.2. Method to choose relevant solar technology and solar panel with power capacity
In our research, photovoltaic solar power technology (PV technology) was selected with solar modules that can absorb and directly convert solar energy into direct current due to photoelectric effect. From the power converters (Inverter), direct current (DC) is converted into alternative current (AC) [2]. The advantage of this technology is that it can use both direct and diffuse radiation, even in areas with low direct radiation. Although this PV system only can generate electricity in the day time and power output depends on weather conditions, in return, it can produce a large amount of power on peak sunny days [3]. When houses located in a densely populated residential area, they are suitable for solar system that can integrate into national electricity grid.

Monocrystalline solar cells play the highest efficiency among all silicon solar cells. With high performance, mono solar panels have longer power generation hours, take up less space when installing, but mono panels are 10 to 15% more expensive than other panels. Therefore, in the condition of second-floor+ houses along Hung Vuong street with limited area, less exposure or shadowed roofs, mono solar panels should be used [3]. Mono solar battery not only absorbs to create electricity when sunlight is present, but when it is cool, it still can absorb solar radiation. With the size of 1956x990x50mm, weighing 24kg and having a price of 5.4-6 million VND (200-250 USD), 300wp mono panel will be installed on the rooftop or on the roofs with sloping roofs to the south about 10 - 15o because it is the best angle to get the maximum potential power [4].

To harvest the best solar radiation for the solar power system, we need to know the optimum angle of solar panels on the roofs in Hue city. According to Minh Hoang Solar Power Company, in Central Vietnam, each month has a different optimum angle for solar panels (see Table 1).
To choose the optimal solar system for each house, it depends on the power consumption of each family, 3kWp is for 250-400kWh/month, 5 kWp is for 450-700 kWh/month, 8 kWp is for 700-1000 kWh/month, and higher demand needs to contact the techniques in solar power company [5].

Table 1. Optimum angle of solar panels in different months in Central Vietnam

| Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
|------|------|------|------|------|------|------|------|------|------|------|------|
| 61°  | 69°  | 77°  | 85°  | 93°  | 100° | 93°  | 85°  | 77°  | 69°  | 61°  | 54°  |

[Source: 5]

2.2.3. Building procedures to calculate the potential of solar power from second-floor+ houses along Hung Vuong street

Step 1. Identify the construction area based on the National Technical Regulation on construction planning issued under Decision No. 04/2008/QD-BXD of the Ministry of Construction (see Table 2) and cadastral data of Phu Hoi and Phu Nhuan wards.

Table 2. Maximum construction density of land plots for construction of adjacent houses and individual houses (garden houses, villas ...).

| Land lot area (m²/house) | ≤50 | 75 | 100 | 200 | 300 | 500 | ≥1.000 |
|-------------------------|-----|----|-----|-----|-----|-----|--------|
| Maximum construction density (%) | 100 | 90 | 80 | 70 | 60 | 50 | 40 |

(Source: Decision No. 04/2008 / QD-BXD)

Step 2. Calculation of potential solar power from mono panels of national grid connected network
+ The number of panels needs to install (plate) = (construction area): 2 (2 is the area of a solar panel)
+ Total watts peak (Wp) = (Number of panels to be installed)* 300 (300 is the Wp of each solar panel)
+ The watt-hour (Wh) generated by panels = (Total watts peak) * 4.6
4.6 is the solar radiation in Thua Thien Hue [2].
+ The actual Wh due to system loss = (The watt-hour (Wh) generated by panels): 1.3
1.3 is the safety factor and system loss of 300wp mono solar panel

Step 3. Calculation the price of total mono solar panels
+ Total investment amount: the number of panels to be installed x 5.4 million VND

Note: there is no cost for installing inverter in the calculation formula.

3. Results and discussion

3.1. The preliminary potential of solar power from second-floor+ houses in Hung Vuong street

In this research, we assume that with the same solar radiation in a day, all families agree to install 300Wp mono solar panels to fully cover their roofs with the national grid integrated network. We don’t take the optimum angle of solar radiation into account because we cannot arrange the experiment. Calculation results show that the total amount of solar power from 138/161 houses in Hung Vuong street, we can have 10,709 solar panels on the root to generate about 14,000 kWh / day, due to the loss of the operation system, the actual amount of solar power is about 11,000 kWh / day, and can generate about 3 GWh per year with 300 sunny days (10 months). With a total capital of nearly 57 billion dong (~250,000 USD) (excluding inverter) and the current average electricity price is about 2,500 dong / kWh (equivalent to each household having electricity bill of over 1 million dong), after 5-7 years of running the solar system, house owner can get the payback. In some cases, the payback could be after 9 year [6]. Meanwhile, the life of the solar power system is up to 25-30 years, so households and businesses can get surplus of electricity payment from the next following years after the payback (see Table 3).

Table 3. The potential of solar power from second-floor+ houses along Hung Vuong street.

| House number | Land area (m²) | No. of level | House area (m²) | Number of mono | Watt-peak of | Watt-hour of | The real Watt- | Total price of |
|--------------|----------------|--------------|----------------|----------------|--------------|--------------|--------------|----------------|

3
|   | solar panel (unit) | solar panels (Wp) | solar panels (Wh) | hour due to the system loss (Wb) | solar panels (million dongs) |
|---|--------------------|--------------------|--------------------|----------------------------------|-----------------------------|
| 1 | 110.0              | 2                  | 77.0              | 39                               | 11,700                      | 53,820                     | 41,400                     | 210.6 |
| 3 | 121.7              | 2                  | 85.19             | 43                               | 12,900                      | 59,340                     | 45,646                     | 232.2 |
| 4 | 307.9              | 2                  | 153.95            | 43                               | 23,100                      | 106,260                    | 81,738                     | 415.8 |
| 5 | 54.9               | 3                  | 49.41             | 25                               | 7,500                       | 34,500                     | 26,538                     | 135   |
| 6 | 261.3              | 2                  | 156.78            | 69                               | 23,700                      | 109,020                    | 83,861                     | 426.6 |
| 7 | 53.7               | 2                  | 48.33             | 25                               | 7,500                       | 34,500                     | 26,538                     | 135   |
| 8 | 2000.0             | 11                 | 800               | 400                              | 120,000                     | 552,000                    | 424,615                    | 2,160 |
| 9 | 92.6               | 2                  | 74.08             | 38                               | 14,400                      | 52,440                     | 40,338                     | 205.2 |
| 10 | 218.0              | 3                  | 130.8             | 66                               | 19,800                      | 91,080                     | 70,061                     | 356.4 |
| 11 | 96.6               | 4                  | 77.28             | 39                               | 11,700                      | 53,820                     | 41,400                     | 210.6 |
| 11A | 85.8              | 4                  | 68.64             | 35                               | 10,500                      | 48,300                     | 37,153                     | 189   |
| 12 | 3500.0             | 4                  | 1400              | 700                              | 210,000                     | 966,000                    | 743,076                    | 3,780 |
| 13 | 78.9               | 3                  | 63.2              | 32                               | 9,600                       | 44,160                     | 33,969                     | 172.8 |
| 15 | 136.8              | 3                  | 95.76             | 48                               | 14,400                      | 66,240                     | 50,953                     | 259.2 |
| 17 | 65.8               | 4                  | 59.22             | 30                               | 9,000                       | 41,400                     | 31,846                     | 162   |
| 18 | 168.2              | 6                  | 117.74            | 59                               | 17,700                      | 81,420                     | 62,630                     | 318.6 |
| 19A | 200.0              | 4                  | 140.0             | 70                               | 21,000                      | 96,600                     | 74,307                     | 378.0 |
| 19B | 124.6              | 7                  | 87.22             | 44                               | 13,200                      | 60,720                     | 46,707                     | 237.6 |
| 19C | 48.5               | 2                  | 48.5              | 25                               | 7500                        | 34,500                     | 26,538                     | 135   |
| 20 | 100.0              | 5                  | 80.0              | 40                               | 12,000                      | 55,200                     | 42,461                     | 216   |
| 22 | 84.7               | 3                  | 67.76             | 34                               | 10,200                      | 46,920                     | 36,092                     | 183.6 |
| 24 | 96.4               | 4                  | 77.12             | 39                               | 11,700                      | 53,820                     | 41,400                     | 210.6 |
| 25 | 231.9              | 6                  | 139.14            | 70                               | 21,000                      | 96,600                     | 74,307                     | 378   |
| 26 | 185.8              | 2                  | 130.06            | 66                               | 19,800                      | 91,080                     | 70,061                     | 356.4 |
| 27 | 200.0              | 5                  | 140.0             | 70                               | 21,000                      | 96,600                     | 74,307                     | 378.0 |
| 28 | 163.9              | 3                  | 114.73            | 58                               | 17,400                      | 80,040                     | 61,569                     | 313.2 |
| 29 | 231.9              | 3                  | 139.14            | 70                               | 21,000                      | 96,600                     | 74,307                     | 378   |
| 30 | 201.1              | 10                 | 120.66            | 61                               | 18,300                      | 84,180                     | 64,753                     | 329.4 |
| 31 | 62.1               | 3                  | 55.89             | 28                               | 8,400                       | 38,640                     | 29,723                     | 151.2 |
| 32 | 201.9              | 3                  | 121.14            | 61                               | 18,300                      | 84,180                     | 64,753                     | 329.4 |
| 33 | 72.7               | 6                  | 65.43             | 33                               | 9,900                       | 45,540                     | 35,030                     | 178.2 |
| 35 | 72.7               | 5                  | 65.43             | 33                               | 9,900                       | 45,540                     | 35,030                     | 178.2 |
| 36 | 193.2              | 2                  | 135.24            | 68                               | 20,400                      | 93,840                     | 72,184                     | 367.2 |
| 37 | 170.6              | 2                  | 119.42            | 60                               | 18,000                      | 82,800                     | 63,692                     | 322   |
| 38 | 142.6              | 2                  | 99.82             | 50                               | 15,000                      | 69,000                     | 53,076                     | 270   |
| 39 | 157.6              | 3                  | 110.32            | 56                               | 16,800                      | 77,280                     | 59,446                     | 302.4 |
| 40 | 138.3              | 2                  | 96.81             | 49                               | 14,700                      | 67,620                     | 52,015                     | 264.6 |
| 41 | 163.9              | 6                  | 114.73            | 58                               | 17,400                      | 80,040                     | 61,569                     | 313.2 |
| 42 | 64.2               | 2                  | 57.78             | 29                               | 8,700                       | 40,020                     | 30,784                     | 156.6 |
| 43 | 218.1              | 4.5                | 130.86            | 66                               | 19,800                      | 91,080                     | 70,061                     | 356.4 |
| 44 | 500.0              | 6                  | 250               | 125                              | 37,500                      | 172,500                    | 132,692                    | 675   |
|   | 46   | 48   | 49   | 50   | 50A  | 52   | 53   | 54   | 56   | 57   | 58   | 59   | 60   | 61   | 62   | 63   | 64   | 66   | 67   | 68   | 69   | 70   | 71   | 72   | 74   | 76   | 78   | 79   | 80   | 81   | 83   | 84   | 86   | 89   | 91   | 92   | 93   | 94   | 95   | 96   | 97   | 98   | 100  |
|---|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|   | 200.0 | 47.9 | 67.0 | 800.0 | 3500.0 | 2000.0 | 140.0 | 3000.0 | 1500.0 | 77.0 | 2000.0 | 356.9 | 141.3 | 356.9 | 130.0 | 356.9 | 124.8 | 124.2 | 168.4 | 119.7 | 168.4 | 129.8 | 406.0 | 240.0 | 121.0 | 141.6 | 1000.0 | 600.0 | 700.0 | 600.0 | 500.0 | 42.3 | 46.0 | 66.5 | 51.0 | 32.3 | 210.0 | 79.0 | 51.1 | 40.2 | 93.5 | 41.0 | 145.0 |
| 5 | 140.0 | 5   | 145.5 | 60.3 | 400  | 1400  | 98.0  | 1200  | 600   | 61.6  | 800   | 178.45 | 98.91 | 178.45 | 91.0  | 178.45 | 87.36 | 86.94 | 117.88 | 83.79 | 117.88 | 90.86 | 203   | 144   | 84.7  | 99.12 | 400   | 300   | 350   | 300   | 250   | 42.3 | 46.0 | 59.85 | 45.9 | 32.3 | 126   | 63.2 | 45.99 | 40.2 | 74.8 | 41.0 | 101.5 |
| 102 | 62.0 | 3 | 55.8 | 28 | 8,400 | 38,640 | 29,723 | 151.2 |
|-----|------|---|------|----|--------|--------|--------|-------|
| 103 | 800.0 | 5 | 400  | 200 | 60,000 | 276,000 | 212,307 | 1,080 |
| 104 | 43.7  | 3 | 43.7 | 22  | 6,600  | 30,360  | 23,353  | 118.8 |
| 105A| 700.0 | 16 | 350  | 175 | 52,500 | 241,500 | 185,769 | 945   |
| 105B| 1200.0 | 8 | 480  | 240 | 72,000 | 331,200 | 254,769 | 1,296 |
| 106 | 250.0 | 3 | 150  | 75  | 22,500 | 103,500 | 79,615  | 405   |
| 107 | 46.3  | 2 | 46.3 | 24  | 7,200  | 33,120  | 25,476  | 129.6 |
| 108 | 306.0 | 3 | 153  | 77  | 23,100 | 106,260 | 81,738  | 415.8 |
| 109 | 200.3 | 2 | 120.18 | 61 | 18,300 | 84,180  | 64,753  | 329.4 |
| 110 | 75.6  | 2 | 60.48 | 31 | 9,300  | 42,780  | 32,907  | 167.4 |
| 112 | 75.0  | 2 | 67.5  | 34  | 10,200 | 46,920  | 36,092  | 183.6 |
| 114 | 152.0 | 2 | 106.4 | 54 | 16,200 | 74,520  | 57,323  | 291.6 |
| 116 | 7.1   | 2 | 7.1   | 4   | 1,200  | 5,520   | 4,246   | 21.6  |
| 117 | 175.3 | 2 | 122.71 | 62 | 18,600 | 85,560  | 65,815  | 334.8 |
| 118 | 125.0 | 2 | 87.5  | 44  | 13,200 | 60,720  | 46,707  | 237.6 |
| 119 | 167.1 | 2 | 116.97 | 59 | 17,700 | 81,420  | 62,630  | 318.6 |
| 120 | 84.0  | 4 | 67.2  | 34  | 10,200 | 46,920  | 36,092  | 183.6 |
| 121 | 326.1 | 2 | 163.05 | 82 | 24,600 | 113,160 | 87,046  | 442.8 |
| 122 | 84.0  | 2 | 67.2  | 34  | 10,200 | 46,920  | 36,092  | 183.6 |
| 123 | 72.0  | 2 | 64.8  | 33  | 9,900  | 45,540  | 35,030  | 178.2 |
| 124 | 28.0  | 3 | 28    | 14  | 4,200  | 19,320  | 14,861  | 75.6  |
| 126 | 49.0  | 4 | 49    | 25  | 7,500  | 34,500  | 26,538  | 75.6  |
| 128 | 81.2  | 4 | 64.96 | 33  | 9,900  | 45,540  | 35,030  | 178.2 |
| 129 | 5.2   | 2 | 5.2   | 3   | 900    | 4,140   | 3,184   | 16.2  |
| 130 | 119.2 | 2 | 83.44 | 42  | 12,600 | 57,960  | 44,584  | 226.8 |
| 131 | 5.2   | 2 | 5.2   | 3   | 900    | 4,140   | 3,184   | 16.2  |
| 133 | 38.0  | 2 | 38    | 19  | 5,700  | 26,220  | 20,169  | 102.6 |
| 134 | 69.2  | 2 | 62.28 | 32  | 9,600  | 44,160  | 33,969  | 172.8 |
| 135 | 17.2  | 2 | 17.2  | 9   | 2,700  | 12,420  | 9,553   | 48.6  |
| 136 | 74.7  | 3 | 67.23 | 34  | 10,200 | 46,920  | 36,092  | 183.6 |
| 137 | 26.2  | 2 | 26.2  | 14  | 4,200  | 19,320  | 14,861  | 75.6  |
| 138 | 89.3  | 3 | 71.44 | 36  | 10,800 | 46,680  | 38,215  | 194.4 |
| 139 | 40.0  | 2 | 40    | 20  | 6,000  | 27,600  | 21,230  | 108   |
| 140 | 80.0  | 2 | 64    | 32  | 9,600  | 44,160  | 33,969  | 172.8 |
| 142 | 183.8 | 2 | 128.66 | 65 | 19,500 | 89,700  | 69,000  | 351   |
| 144 | 112.0 | 3 | 78.4  | 40  | 12,000 | 55,200  | 42,461  | 216   |
| 145 | 35.7  | 2 | 35.7  | 18  | 5,400  | 24,840  | 19,107  | 97.2  |
| 146 | 99.8  | 3 | 79.84 | 40  | 12,000 | 55,200  | 42,461  | 216   |
| 147 | 85.8  | 2 | 68.64 | 35  | 10,500 | 48,300  | 37,153  | 189   |
| 148 | 48.1  | 3 | 48.1  | 25  | 7,500  | 34,500  | 26,538  | 135   |
| 150 | 47.1  | 3 | 47.1  | 24  | 7,200  | 33,120  | 25,476  | 129.6 |
| 151 | 600.0 | 2 | 300   | 150 | 45,000 | 207,000 | 159,230 | 810   |
| 152 | 98.8  | 3 | 79.04 | 40  | 12,000 | 55,200  | 42,461  | 216   |
The potential solar power also helps to protect the environment, reduce exploitation and use of fossil fuels and reduce greenhouse gas emissions (see Table 4).

Table 4. The potential emission reduction of solar power system in Hung Vuong street.

| Emission indicators                  | 1 GW (*) | 3GW(***) | 25 years*** |
|--------------------------------------|----------|----------|-------------|
| Reduction of coal (million tons)     | 0.85     | 2.55     | 63.75       |
| Reduction of water (million m³)      | 3.04     | 9.12     | 228         |
| Reduction of ash (million tons)      | 0.38     | 1.14     | 28.5        |
| Reduction of dust (thousand tons)    | 1.04     | 3.12     | 78          |
| Reduction of sulfur dioxide ((million tons) | 0.02     | 0.06     | 1.5         |
| Reduction of nitrogen oxide (thousand tons) | 6.36     | 19.08    | 477         |
| Reduction of carbon dioxide ((million tons) | 1.39     | 4.17     | 104.25      |

[Source: (*) [7]; (**) Self-calculation]

According to Minh Hoa Solar Power Company, each 238 kg CO₂ is equal to 10 trees, so in one year, Hung Vuong street can reduce 4.17 million tons of carbon dioxide which is equal to planting 175,210.084 trees and during 25 years, we can create vast benefits for Hue people and Hue city.

Besides, the solar power systems on the roof can help to reduce the pressure of national grid in hot season, reduce the dusts and air pollution for Hue city as well as the noise pollution in comparison to using the power generated machines. The potential is very relevant for hotels, enterprises and businesses along Hung Vuong street because they can have a stable energy supply during sunny days to cool down their houses and offices and increase their credits in giving green services for customers.

In economic aspect, after 5-10 years of installation, the solar power system can create electricity continuously and households or offices can have free power supply for development activities.

3.2. Discussion

The study is significant to confirm the potential of solar power from second-floor+ houses in Hung Vuong street that might produce an estimated reserves of 3GWh/year. However, this is the preliminary calculation in this research under the above mentioned conditions. There are other factors that can affect the results. The cadastral data has a lot of empty data due to the lack of information on the area, we did not include the calculation. Under the pressure of urbanization, people often maximum their construction area, so the house area will be bigger than in our calculation. In Hue city, climate change affects the length of seasons in which the hot and sunny season is tend to be longer than the rainy season. Therefore, it can be seen that the potential of solar power from buildings on Hung Vuong Street can even bigger than the calculated number. Moreover, if we use tracking systems to track the sun radiation, we can adjust the position of solar panels to receive a higher amount of solar power [8; 9; 10].
On the other hand, there are many factors that we should take into account. The lost of electricity during the transfer has not been calculated as well as the missing of a relevant cool system to maintain the solar power gained over time. And the price of investment does not cover the costs of labors, and investment for enhancing the strength of roofs and other accessories before the installation for a solar power system. In addition, Hue people nowadays have a favor to use the rooftop for advertisement, gardening, worship, coffee shops and restaurants, so the design of solar power system on the rooftop should be integrated with these functions of the rooftop. In addition, awareness about the potential of solar power is not popular in the community in corporation with the reduction of solar electricity’s buying price from Thua Thien Hue Power Company will cause the hesitation of investment from local people. This is the matter of social infrastructure to prepare for the transformation into sustainable development that Thua Thien Hue province needs to improve in the future.

Nevertheless, there are some disadvantages of solar power system that we need to consider. The solar panels need to clean several times in a year to increase the longevity of the solar panel and to maintain the productivity. The investment is still high for many medium families but the productivity strongly depends on the season and weather while they cannot control the power generated.

4. Conclusions
The research shows that the potential to convert to renewable energy in Thua Thien Hue province is feasible. The research has found a way to apply solar energy technology to conditions in Thua Thien Hue province to take advantage of this endless solar energy source for socio-economic development purposes. The project proposed photovoltaic solar power technology (PV) with the installation of national grid connection; 300wp mono panel installed on the rooftop or on the roofs with sloping roofs to the south about 10 - 15°; panels are installed on concrete ceilings or corrugated tiled roofs. The research has calculated the potential of solar power from second-floor+ houses on Hung Vuong street, Hue city which is 11,000 kWh/day, generating about 3 GWh/year in 300 sunny days of a year. Solar power helps utilize second-floor+ space effectively, helping to create the energy needed for socio-economic activities while helping to protect the environment, reducing greenhouse gas emissions and reducing pressure on electricity consumption during extreme heat periods in Hung Vuong Street.

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