*EVS27*
*Barcelona, Spain, November 17-20, 2013*

# Smart Park in Okinawa Prefectural Peace Memorial Park

Atsushi Mizukoshi
*PUES Corporation, 12-73 Suzaki, Uruma,*
*Okinawa 904-2234, Japan*
*mizukoshi.atsushi@pues.co.jp*
Jo Ushijima
*PUES Corporation, 12-73 Suzaki, Uruma,*
*Okinawa 904-2234, Japan*
*ushijima.jo@pues.co.jp*
Fumiaki Tsuji
*PUES Corporation, 12-73 Suzaki, Uruma,*
*Okinawa 904-2234, Japan*
*tsuji.fumiaki@pues.co.jp*
Takahisa Saito
*PUES Corporation, 12-73 Suzaki, Uruma,*
*Okinawa 904-2234, Japan*
*saito.takahisa@pues.co.jp*
Yuzuru Fukumura
*PUES Corporation, 12-73 Suzaki, Uruma,*
*Okinawa 904-2234, Japan*
*Fukumura.yuzuru@pues.co.jp*

**Abstract**

With the aim to keep natural environments of Okinawa in good condition and plan attractive improvement of the Okinawa sightseeing with promote environmental measures in the tourism industry which is a key industry in Okinawa , as a part of "General ecological promotion business of the sightseeing-related institution" , we developed a system of electric buses and chargers powered by Solar Photovoltaic , in Okinawa Prefectural Peace Memorial Park located southern part in Okinawa Island.

## 1 Introduction

Okinawa Prefectural Peace Memorial Park is located in the Mabuni Hill area of Itoman city ; the southern part of the island where the final battle in Okinawa took place during the Second World War. The park enjoys a pleasant view of the rugged and beautiful coastline on its southeastern border.

The former Ryukyu Government originally initiated the creation of a park on the site , and following Okinawa's reversion to Japan in 1972 ,

full-scale construction of a public park in the area was initiated.

At this park , wartime photographs and objects are displayed at the Peace Memorial Museum , and the names of those who perished during the battle of Okinawa are inscribed on the “Cornerstone of Peace” monument. The Peace Prayer Memorial Statue that prays for the souls of those killed in wars and for everlasting world peace can also be found on the site , and the National War Dead Peace Mausoleum , along with 50 monuments from other prefectures and organizations are all located on Mabuni Hill in the southern region of the park.

Many people visit the park’s sacred grounds , such as tourists from Japan and abroad , groups of those related to the war dead , and students on school excursions , making the Peace Memorial Park a key tourist site. On holidays , families flock to the area to play ball games , have picnics and enjoy various other recreational activities on the open grass.

They at the Okinawa Peace Memorial Park are endeavoring to maintain a park that can satisfy the various needs of the increasing number of people who come to visit , giving their guests a fulfilling experience , while simultaneously offering their prayers for eternal world peace and promoting the park’s role in transmitting the message of peace to the world.

Figure1: Okinawa Prefectural Peace Memorial Park

This park has vast grounds and the visitors used to move around in the park on foot or by diesel microbus.

Figure2: Conventional Loop-Line Bus in the Park

However, the park had faced with decrepit buses and the emission gas issue, which is disputed as one of recent environmental concerns; it was urgent to introduce new transport.

That’s why solar-powered electric buses were planed and produced aiming for an energy shift from fossil fuels to natural energy.

Moreover, the “smart park”, in which renewable natural energy could be efficiently used, was presented. Sunlight is used as source of energy for more than loop-line buses.

## 2 Trial calculation

The annual energy consumption of EVs is estimated approx. 3MWh for operating the loop-line buses in the park and approx. 7MWh for charging the visitors’ private vehicles. To cover the consumption by renewable natural energy, it was designed to generate 10 MWh of photovoltaic energy in the park annually.

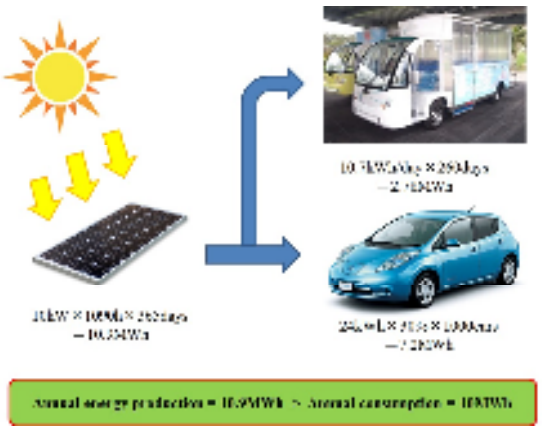


Figure3: Energy Generation and Consumption

## 3 Development of "Smart Park"

Figure 4 shows the schematic block diagram for the "smart park".

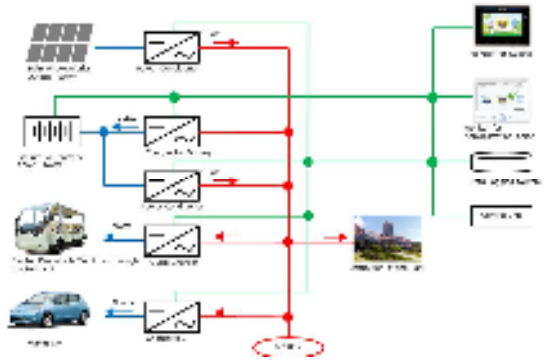


Figure4: Smart Park Schematic

The specifications of units/systems constituting "smart park" are shown in Table 1-5.

Table1:Specifications of PV system

| | |
|---|---|
| Generation System | CIGS Solar Photovoltaic |
| Max Power | 10kW |
| Operational Voltage at Max Power | 433.8V |
| Operational Current at Max Power | 23.4A |
| Output | AC200V 3 $\phi$ |
| Control | with MPPT |
| Dimensions | 10.6m x 9.5m |
| Operational Temperature | -20～40℃ |
| Setting Place | Roof of Carport |
| Quantities | 1 |

Table2:Specifications of Battery system

| | |
|---|---|
| Input | AC200V 3 $\phi$ 10kW |
| Output | AC200V 3 $\phi$ 10kW |
| Voltage | DC360V |
| Capacity | 24kWh |
| Control Signal | CAN |
| Safety | Over Current<br>Over Voltage<br>Temperature |
| Setting Place | Carport |
| Quantities | 1 |

Table3:Specifications of Electric Bus

| | |
|---|---|
| Capacity | 15persons |
| Max Speed | 30km/h |
| Driving Range | 20km |
| Climbing ability | 28% |
| Braking Distance | 5m |
| Min Rotating Radius | 5.7m |
| Min Ground Clearance | 150mm |
| Charging Time | 0.5hrs(Quick Charge)<br>3.0hrs |
| Motor Power | 6kW |
| Battery | Li-ion 72V/6kWh |
| Dimensions | 4960(L) x 1430(W) x 2000(H)mm |
| Quantities | 2 |

Table4:Specifications of Quick Charger

| | |
|---|---|
| Input | AC200V 3 $\phi$ 49kW |
| Max Output Voltage | DC500V |
| Max Output Current | DC125A |
| Connector | JEVS G105-1993 |
| Dimensions | 1840 x 380 x 600 |
| Operating Temperature | -10～40℃ |
| Setting Place | Carport |
| Quantities | 1 |
| Charging Protocol | CHAdeMO |

Table5:Specifications of Charger

| | |
|---|---|
| Input | AC200V 1 $\phi$ 4kW |
| Output Voltage | AC200V |
| Max Output Current | AC20A |
| Connector | IEC 61851-1 mode3 |
| Dimensions | 1500 x 230 x 630 |
| Operating Temperature | -10～40℃ |
| Setting Place | Parking for Visitor |
| Quantities | 2 |

PUES' original Li-ion battery systems were applied in this smart park project, such as for the power battery for the park round buses and the stationary energy storage in the park. Photovoltaic power generating systems were installed also in the buses, which could make efficient use of solar power while moving.

Figure5: Loading of a Solar Panel

Furthermore, to achieve the long-term operation of the smart park, salt pollution control measures were taken in the parts selection and the system construction.

## 4 Progress Report of Smart Park

The smart park started operation and service on April, 2013. Table 6 shows the electricity balance between generation and consumption for the first two months.

Table6: Progress situation of Smart Park

| | Electric Energy [KWh] | | | |
|---|---|---|---|---|
| | Daily Average | Monthly Average | | Sum total |
| | | April | May | |
| 1: Photovoltaic Energy Generation | 42.2 | 1,117 | 1,417 | 2,534 |
| 2: Energy Consumption by the Loop-Line Bus | -19.2 | -576 | -576 | -1,152 |
| 3: Charging Energy Visitors' Private EVs | | -9.5 | -5.7 | -15.2 |
| 1 – (2 + 3) | 22.8 | 531 | 835 | 1,366.8 |

## 5 Conclusions

Our smart park project showed the effectiveness of natural energy; the photovoltaic panels in the park could generate enough electricity to provide power to operate the loop-line buses and to charge the visitors' private EVs. While working on modifications and improvements through a whole year operation, we hope that this smart park concept leads to further conservation of the natural environment and further increase of attractions of sightseeing in Okinawa.

Of course, the smart park concept can be applied to any other cases where green-power generating facilities, stationary storages and movable bodies are able to coexist. For example, in recent years, many Mega-Watt-class solar power plants have been globally constructed, and we expect that this study suggests a possibility to be applied also to such power plants.

## Acknowledgments

The author wishes to express his gratitude to the Okinawa Prefecture and the Okinawa Peace Prayer Foundation with which we've executed this project, companies in Okinawa which carried out the construction work in the park, and local high school students who did the graphic design work for the round buses in the park.

Figure6: Electric bus in Okinawa Prefectural Peace Memorial Park

## References

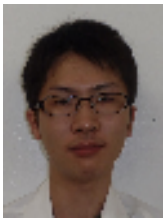
[1] Okinawa Prefectural Peace Memorial Park, http://kouen.heiwa-irei-okinawa.jp

## Authors

Atsushi Mizukoshi , Deputy General Manager, PUES Corporation

Jo Ushijima , Deputy Manager, Manufacturing Engineering, PUES Corporation

Fumiaki Tsuji , Assistant Manager, Manufacturing Engineering, PUES Corporation



Takahisa Saito , Manufacturing Engineering, PUES Corporation

Yuzuru Fukumura , Manufacturing Engineering, PUES Corporation