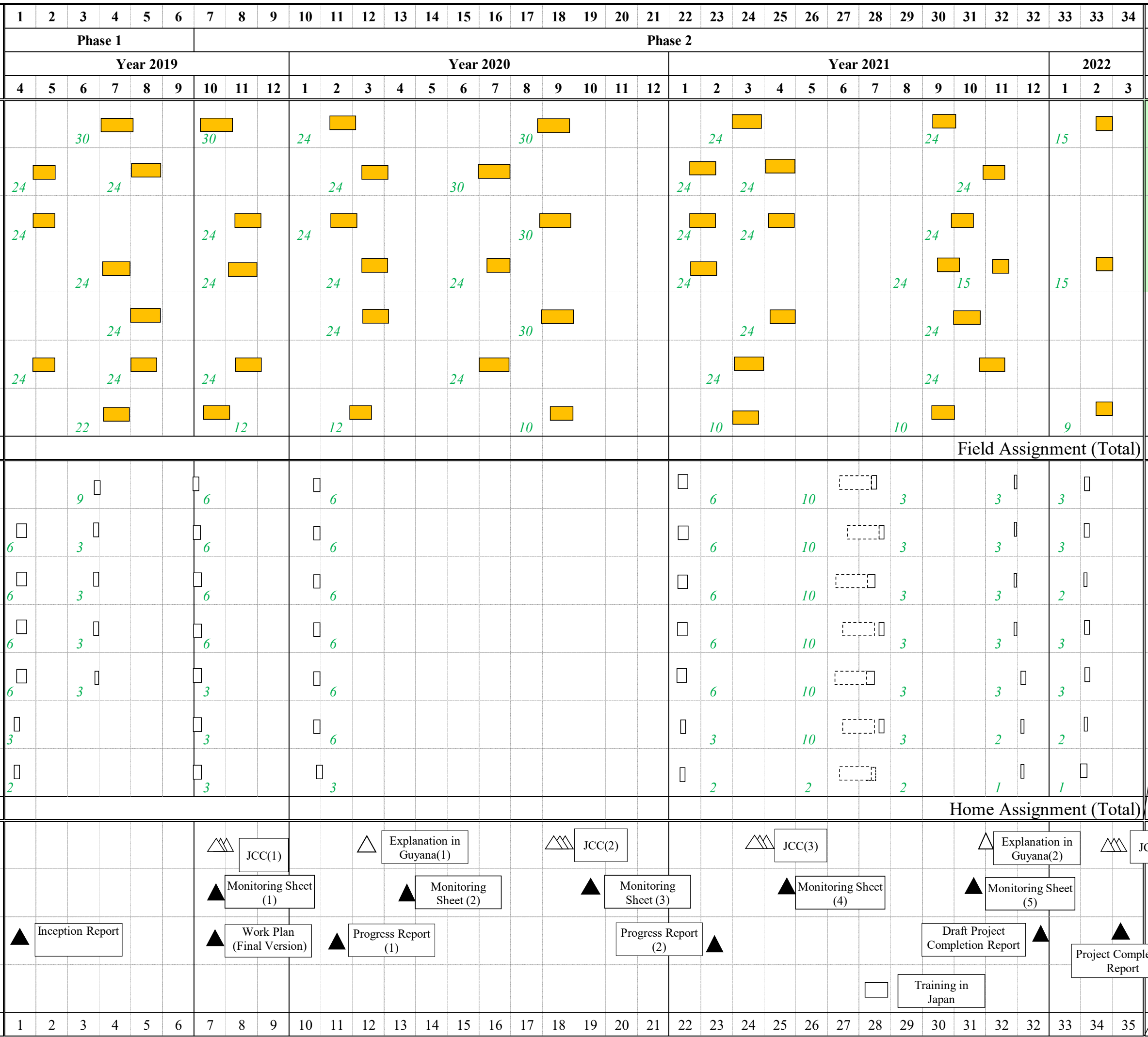
# Appendix 2-1 Resourcing Plan

As of Work Plan

## Expert Schedule



| | Position | Name | Company | Grade | Phase 1 Field | Phase 1 Home | Phase 2 Field | Phase 2 Home | Total Field | Total Home | Nos of Trip |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Field | Chief Advisor/Power System (1) | Ryosuke OGAWA | Nippon Koei Co., Ltd. | 2 | 1.00 | | 4.90 | | 5.90 | | 7 |
| | Subchief Advisor/Power System (2) | Masaaki EBINA | Nippon Koei Co., Ltd. | 3 | 1.60 | | 4.20 | | 5.80 | | 7 |
| | Renewable Energy | Yuka NAKAGAWA | Nippon Koei Co., Ltd. | 3 | 0.80 | | 5.00 | | 5.80 | | 7 |
| | Energy Efficiency | Yasuhiro SAKAMOTO | PADECO Co., Ltd. | 3 | 0.80 | | 5.00 | | 5.80 | | 8 |
| | Grid Stabilization | Hiroshi SUZUKI | Nippon Koei Co., Ltd. | 4 | 0.80 | | 3.40 | | 4.20 | | 5 |
| | Diesel / Gas-turbine Power Plant / Coordinator | Ryota NISHINO | Nippon Koei Co., Ltd. | 5 | 1.60 | | 3.20 | | 4.80 | | 6 |
| | Human Resource Development / Monitoring | Takahiro TANABE | PADECO Co., Ltd. | 4 | 0.73 | | 2.10 | | 2.83 | | 7 |
| | Field Assignment (Total) | | | | 7.33 | | 27.80 | | 35.13 | | |
| Home | Chief Advisor/Power System (1) | Ryosuke OGAWA | Nippon Koei Co., Ltd. | 2 | | 0.45 | | 1.85 | | 2.30 | |
| | Subchief Advisor/Power System (2) | Masaaki EBINA | Nippon Koei Co., Ltd. | 3 | | 0.45 | | 1.85 | | 2.30 | |
| | Renewable Energy | Yuka NAKAGAWA | Nippon Koei Co., Ltd. | 3 | | 0.45 | | 1.80 | | 2.25 | |
| | Energy Efficiency | Yasuhiro SAKAMOTO | PADECO Co., Ltd. | 3 | | 0.45 | | 1.85 | | 2.30 | |
| | Grid Stabilization | Hiroshi SUZUKI | Nippon Koei Co., Ltd. | 4 | | 0.45 | | 1.70 | | 2.15 | |
| | Diesel / Gas-turbine Power Plant / Coordinator | Ryota NISHINO | Nippon Koei Co., Ltd. | 5 | | 0.15 | | 1.45 | | 1.60 | |
| | Human Resource Development / Monitoring | Takahiro TANABE | PADECO Co., Ltd. | 4 | | 0.10 | | 0.70 | | 0.80 | |
| | Home Assignment (Total) | | | | | 2.50 | | 11.20 | | 13.70 | |
| | Joint Coordinating Committee (JCC) / Explanation in Guyana | | | | | | | | | | |
| | Monitoring Sheet | | | | | | | | | | |
| | Submission of Report | | | | | | | | | | |
| | Training in Japan | | | | | | | | | | |
| | Total M/M of both Field and Home Assignment | | | | 7.33 | 2.50 | 27.80 | 11.20 | 35.13 | 13.70 | |
| | | | | | 9.83 | | 39.00 | | 48.83 | | |

Legend:

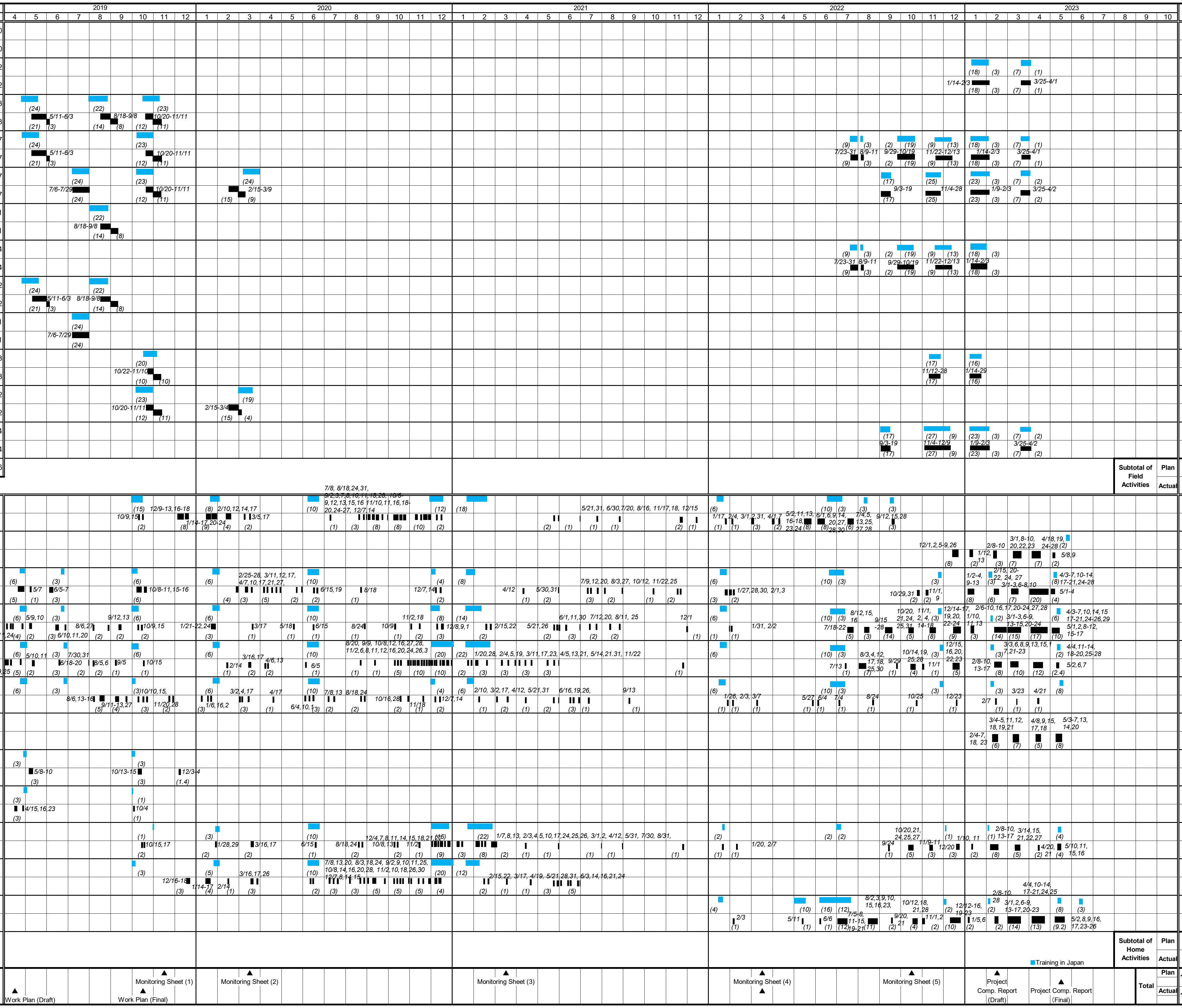
Field: 🟨

Home: ☐

As of Project Completion

## Resource planning

Project Name: TECHNICAL COOPERATION TO PROMOTE ENERGY EFFICIENCY IN CARIBBEAN COUNTRIES



| | Position | Name | Grade | | Number of Trip (Fiscal year) 2019 | 2020 | 2021 | 2022 | Total | Sum of Days | Sum of MM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Field | Team Leader / Power System(1) / Diesel/Gas-turbine Power Plant(2) | Ryosuke OGAWA | 2 | Plan | | | | | 0 | 0 | 0.00 |
| | | Predecessor | | Actual | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| | Team Leader / Power System(1) / Diesel/Gas-turbine Power Plant(2) | Tomoyasu FUKUCHI | 2 | Plan | | | | | 2 | 29 | 0.97 |
| | | Successor | | Actual | 0 | 0 | 0 | 2 | 2 | 29 | 0.97 |
| | Sub Team Leader / Power System (2) | Masaaki EBINA | 3 | Plan | | | | | 3 | 69 | 2.30 |
| | | | | Actual | 3 | 0 | 0 | 0 | 3 | 69 | 2.30 |
| | Renewable Energy | Yuka NAKAGAWA | 3 | Plan | | | | | 7 | 131 | 4.37 |
| | | | | Actual | 2 | 0 | 0 | 5 | 7 | 131 | 4.37 |
| | Energy Efficiency | Yasuhiro SAKAMOTO | 3 | Plan | | | | | 7 | 148 | 4.93 |
| | | | | Actual | 3 | 0 | 0 | 4 | 7 | 148 | 4.93 |
| | Grid Stabilization | Hiroshi SUZUKI | 4 | Plan | | | | | 1 | 22 | 0.73 |
| | | | | Actual | 1 | 0 | 0 | 0 | 1 | 22 | 0.73 |
| | Grid Stabilization | Hisao TAOKA | 4 | Plan | | | | | 4 | 76 | 2.53 |
| | | | | Actual | 0 | 0 | 0 | 4 | 4 | 76 | 2.53 |
| | Diesel / Gas-turbine Power Plant / Coordination | Ryota NISHINO | 5 | Plan | | | | | 2 | 46 | 1.53 |
| | | | | Actual | 2 | 0 | 0 | 0 | 2 | 46 | 1.53 |
| | Human Resource Development / Monitoring | Takahiro TANABE | 4 | Plan | | | | | 1 | 24 | 0.80 |
| | | Predecessor | | Actual | 1 | 0 | 0 | 0 | 1 | 24 | 0.80 |
| | Human Resource Development / Monitoring | Anna MIYAURA | 4 | Plan | | | | | 3 | 53 | 1.77 |
| | | Successor | | Actual | 1 | 0 | 0 | 2 | 3 | 53 | 1.77 |
| | Grid Stabilization (2) / Power Storage System / Asset Management / Coordination (2) | Hiroaki NIIMI | 4 | Plan | | | | | 2 | 42 | 1.40 |
| | | Adiitional Expert, Predecessor | | Actual | 2 | 0 | 0 | 0 | 2 | 42 | 1.40 |
| | Grid Stabilization (2) / Power Storage System / Asset Management / Coordination (2) | Tomoaki TSUJI | 5 | Plan | | | | | 4 | 88 | 2.93 |
| | | Adiitional Expert, Successor | | Actual | 0 | 0 | 0 | 4 | 4 | 88 | 2.93 |
| | | | | Total | 15 | 0 | 0 | 21 | 36 | | |
| | **Subtotal of Field Activities** | | | **Plan** | | | | | | **728** | **24.26** |
| | | | | **Actual** | | | | | | **728** | **24.26** |
| Home | Team Leader / Power System(1) / Diesel/Gas-turbine Power Plant(2) | Ryosuke OGAWA | 2 | Plan | | | | | | 97.0 | 4.85 |
| | | Predecessor | | Actual | | | | | | 97.0 | 4.85 |
| | Team Leader / Power System(1) / Diesel/Gas-turbine Power Plant(2) | Tomoyasu FUKUCHI | 2 | Plan | | | | | | 29.0 | 1.45 |
| | | Successor | | Actual | | | | | | 29.0 | 1.45 |
| | Sub Team Leader / Power System (2) | Masaaki EBINA | 3 | Plan | | | | | | 138.0 | 6.90 |
| | | | | Actual | | | | | | 99.0 | 4.95 |
| | Renewable Energy | Yuka NAKAGAWA | 3 | Plan | | | | | | 105.6 | 5.28 |
| | | | | Actual | | | | | | 144.6 | 7.23 |
| | Energy Efficiency | Yasuhiro SAKAMOTO | 3 | Plan | | | | | | 115.4 | 5.77 |
| | | | | Actual | | | | | | 115.4 | 5.77 |
| | Grid Stabilization | Hiroshi SUZUKI | 4 | Plan | | | | | | 81.6 | 4.08 |
| | | | | Actual | | | | | | 56.0 | 2.80 |
| | Grid Stabilization | Hisao TAOKA | 4 | Plan | | | | | | 0.0 | 0.00 |
| | | | | Actual | | | | | | 25.6 | 1.28 |
| | Diesel / Gas-turbine Power Plant / Coordination | Ryota NISHINO | 5 | Plan | | | | | | 6.0 | 0.30 |
| | | | | Actual | | | | | | 7.4 | 0.37 |
| | Human Resource Development / Monitoring | Takahiro TANABE | 4 | Plan | | | | | | 4.0 | 0.20 |
| | | Predecessor | | Actual | | | | | | 4.0 | 0.20 |
| | Human Resource Development / Monitoring | Anna MIYAURA | 4 | Plan | | | | | | 74.0 | 3.70 |
| | | Successor | | Actual | | | | | | 74.0 | 3.70 |
| | Grid Stabilization (2) / Power Storage System / Asset Management / Coordination (2) | Hiroaki NIIMI | 4 | Plan | | | | | | 50.0 | 2.50 |
| | | Adiitional Expert, Predecessor | | Actual | | | | | | 50.0 | 2.50 |
| | Grid Stabilization (2) / Power Storage System / Asset Management / Coordination (2) | Tomoaki TSUJI | 5 | Plan | | | | | | 85.6 | 4.28 |
| | | Adiitional Expert, Successor | | Actual | | | | | | 84.2 | 4.21 |
| | **Subtotal of Home Activities** | | | **Plan** | | | | | | **786.2** | **39.31** |
| | | | | **Actual** | | | | | | **786.2** | **39.31** |
| | Proposed Period | | | | | | | | | | |
| | **Total** | | | Plan | | | | | | **1,514.2** | **63.57** |
| | | | | Actual | | | | | | **1,514.2** | **63.57** |

Legend

🟦 Plan ■ Actual

# Energy Efficiency & Conservation (EEC) Materiel Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

## - Energy Audit including Walk Through Survey -

Jamaica, February 2023

Nippon Koei Co.
PADECO Co.

# Contents

# 1. Overview of Government Office Building (GOB) in Bridgetown

## 1. Overview of Government Office Building (GOB) in Bridgetown

### Overview of GOB in Bridgetown, Barbados (entrance)

## 1. Overview of Government Office Building (GOB) in Bridgetown

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## 1. Overview of Government Office Building (GOB) in Bridgetown

### Basic Data of the Building

| | |
|---|---|
| Number of floors | 2 |
| Floor area | 966 m2 |
| Building use | Government |
| Annual power consumption | 167,635 kWh |
| Annual power consumption per floor area | 174 kWh/m2 |

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## 1. Overview of Government Office Building (GOB) in Bridgetown

### Bird 'eye view of GOB

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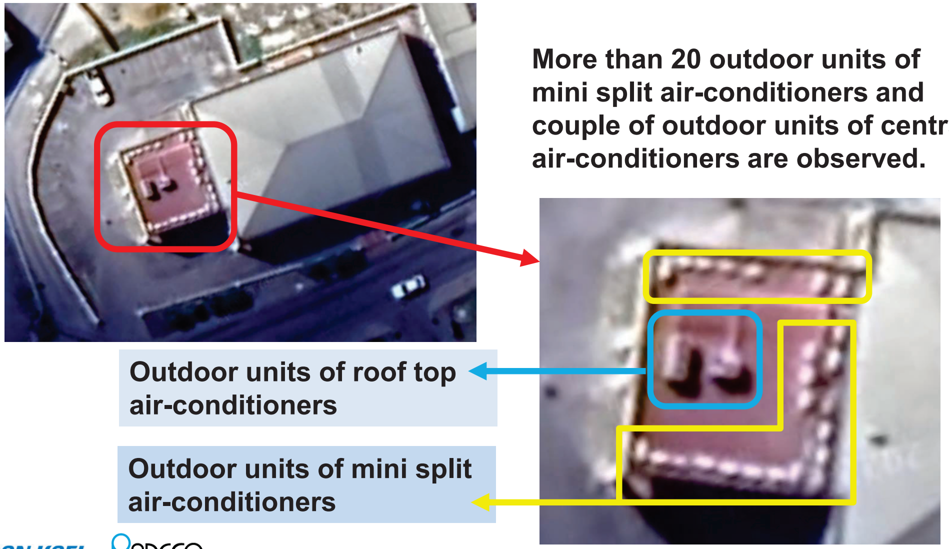
## 1. Overview of Government Office Building (GOB) in Bridgetown

### Bird ’eye view of GOB



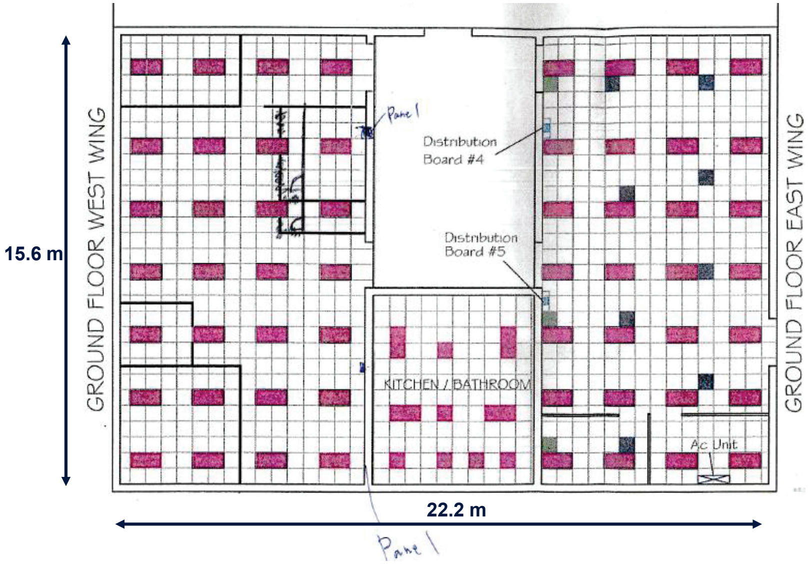
**More than 20 outdoor units of mini split air-conditioners and couple of outdoor units of central air-conditioners are observed.**

**Outdoor units of roof top air-conditioners**

**Outdoor units of mini split air-conditioners**

# 1. Overview of Government Office Building (GOB) in Bridgetown

- **Floor plan of the building (ground floor)**



**Floor area of ground floor = 346 m2**

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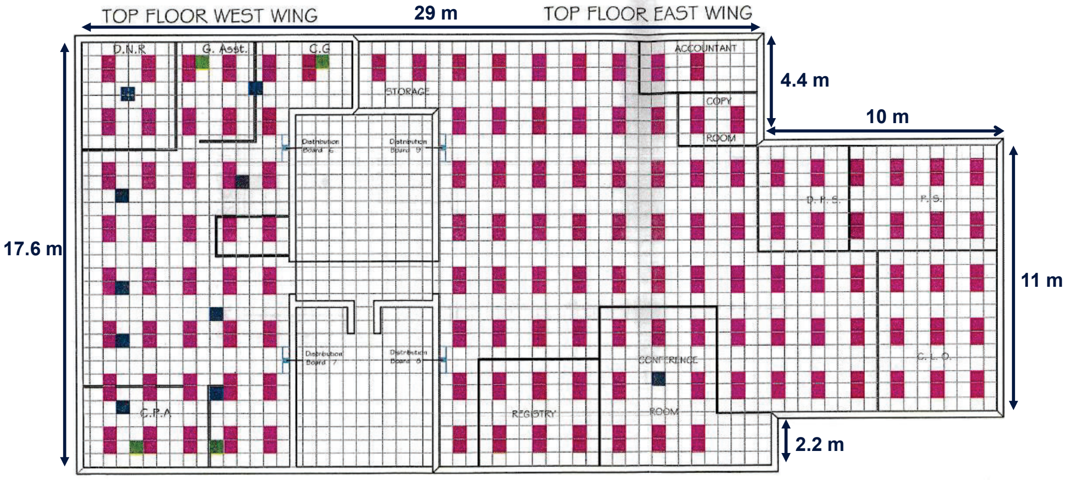
# 1. Overview of Government Office Building (GOB) in Bridgetown

- **Floor plan of the building (top floor)**



**Floor area of top floor = 620 m2** ➡ **Total floor area of the building = 966 m2**

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# 2. Current Situation on Power Consumption

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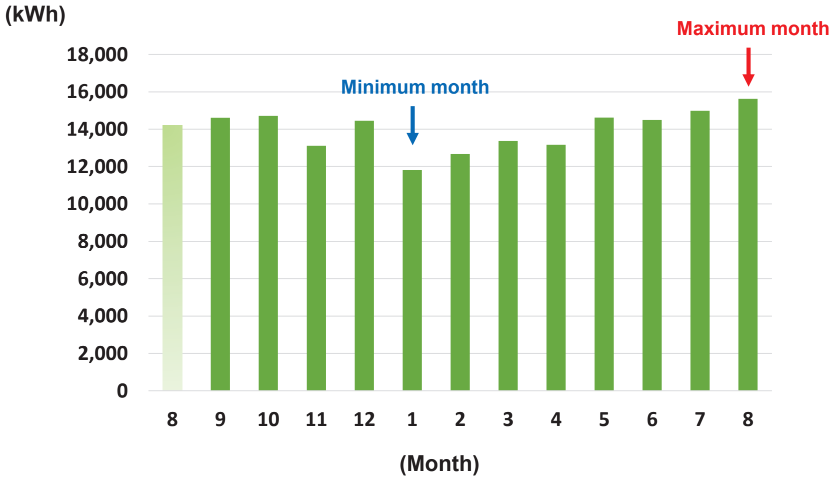
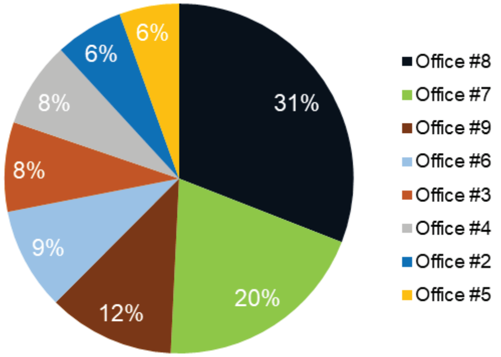
# 2. Current Situation on Power Consumption

**Monthly Power Consumption Trends at GOB (actual data, Aug.2021 - Aug.2022)**



## 2. Current Situation on Power Consumption

### Annual Power Consumption Share by Each Office
### (actual data, Sep.2021 - Aug.2022)



**Office #8 is the largest power consumer and Office #8 and #7 share more than half of the total power consumption.**

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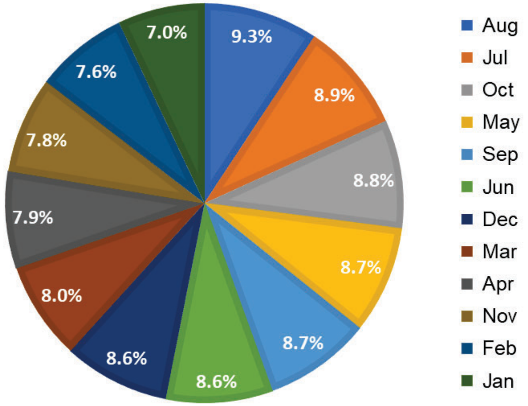
## 2. Current Situation on Power Consumption

### Annual Power Consumption Share by Month
### (actual data, Sep.2021 - Aug.2022)



**Power consumption in August is the largest month through a year. However, there is no significant difference by month.**

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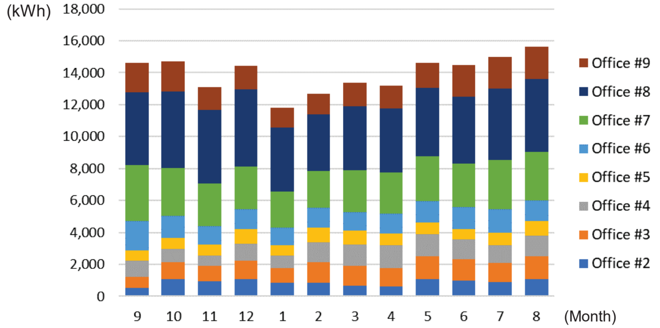
## 2. Current Situation on Power Consumption

### Power Consumption Trends at the Building (actual data, Sep.2021 - Aug.2022)



| | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | TOTAL | AVE | MAX | MIN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Office #2 | 540 | 1,070 | 943 | 1,082 | 846 | 840 | 680 | 596 | 1,055 | 977 | 911 | 1,068 | 10,608 | 884 | 1,082 | 540 |
| Office #3 | 695 | 1,055 | 978 | 1,136 | 929 | 1,275 | 1,209 | 1,186 | 1,455 | 1,342 | 1,166 | 1,442 | 13,868 | 1,156 | 1,455 | 695 |
| Office #4 | 987 | 839 | 620 | 1,060 | 756 | 1,243 | 1,355 | 1,409 | 1,383 | 1,239 | 1,135 | 1,277 | 13,303 | 1,109 | 1,409 | 620 |
| Office #5 | 650 | 692 | 677 | 928 | 676 | 958 | 851 | 758 | 707 | 661 | 767 | 927 | 9,252 | 771 | 958 | 650 |
| Office #6 | 1,854 | 1,402 | 1,186 | 1,233 | 1,091 | 1,236 | 1,169 | 1,215 | 1,335 | 1,384 | 1,453 | 1,310 | 15,868 | 1,322 | 1,854 | 1,091 |
| Office #7 | 3,506 | 2,993 | 2,655 | 2,662 | 2,268 | 2,302 | 2,615 | 2,611 | 2,819 | 2,725 | 3,090 | 3,008 | 33,254 | 2,771 | 3,506 | 2,268 |
| Office #8 | 4,562 | 4,760 | 4,600 | 4,862 | 3,986 | 3,523 | 4,026 | 3,984 | 4,311 | 4,188 | 4,468 | 4,575 | 51,845 | 4,320 | 4,862 | 3,523 |
| Office #9 | 1,820 | 1,905 | 1,456 | 1,490 | 1,252 | 1,290 | 1,463 | 1,410 | 1,560 | 1,973 | 1,998 | 2,020 | 19,637 | 1,636 | 2,020 | 1,252 |
| Total | 14,614 | 14,716 | 13,115 | 14,453 | 11,804 | 12,667 | 13,368 | 13,169 | 14,625 | 14,489 | 14,988 | 15,627 | 167,635 | 13,970 | 15,627 | 11,804 |

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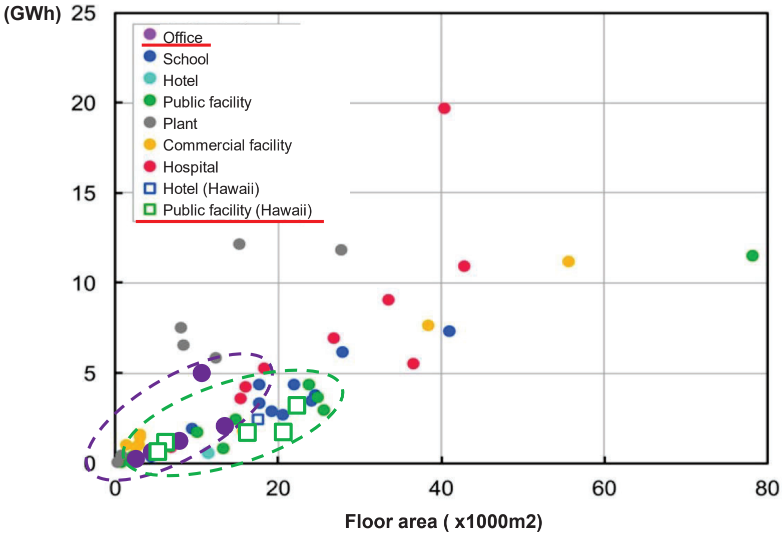
## 2. Comparison with Other Buildings in Tropical Weather

### Annual Power Consumption Data (Okinawa & Hawaii)



## 2. Comparison with Other Buildings in Tropical Weather

### Summary Table of Annual Power Consumption per Floor Area

| Location | Building use | Data number of buildings | Floor area (m2) | Annual power consumption (kWh) | Annual power consumption per floor area (kWh/m2) |
|---|---|---|---|---|---|
| Okinawa | Office | 5 | 7,807 (average) | 7,678,185 | 197 |
| Hawaii | State gvrnt office 1 | 1 | 15,989 | 1,641,600 | 103 |
|  | State gvrnt office 2 | 1 | 5,442 | 618,920 | 114 |
|  | State gvrnt office 3 | 1 | 6,140 | 942,400 | 153 |
|  | State gvrnt office 4 | 1 | 22,146 | 3,184,800 | 144 |
|  | State gvrnt office 5 | 1 | 20,688 | 1,828,400 | 88 |
| Barbados | GOB | 1 | 966 | 167,635 | 174 |

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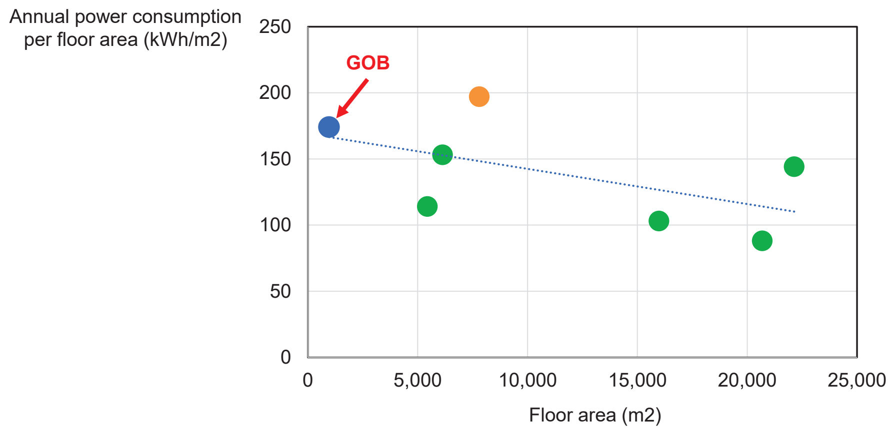
## 2. Comparison with Other Buildings in Tropical Weather

### Graph of Annual Power Consumption per Floor Area



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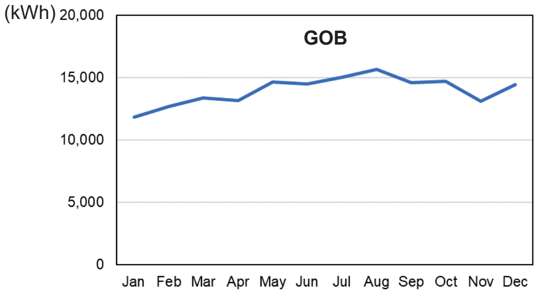
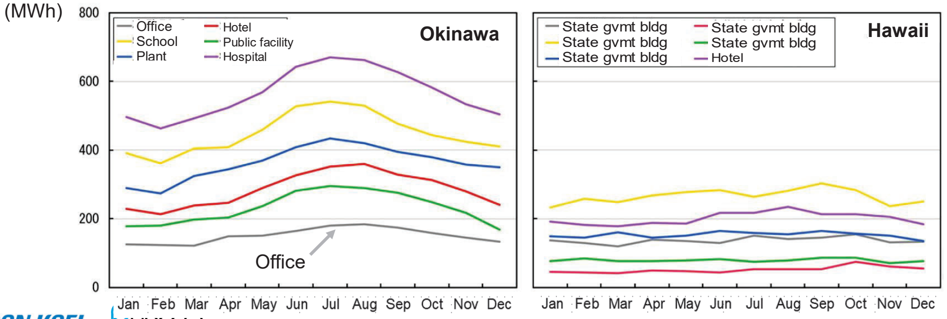
## 2. Comparison with Other Buildings in Tropical Weather

### Monthly Power Consumption

- A bit larger difference has been observed in GOB by season compared with those in Okinawa and Hawaii.





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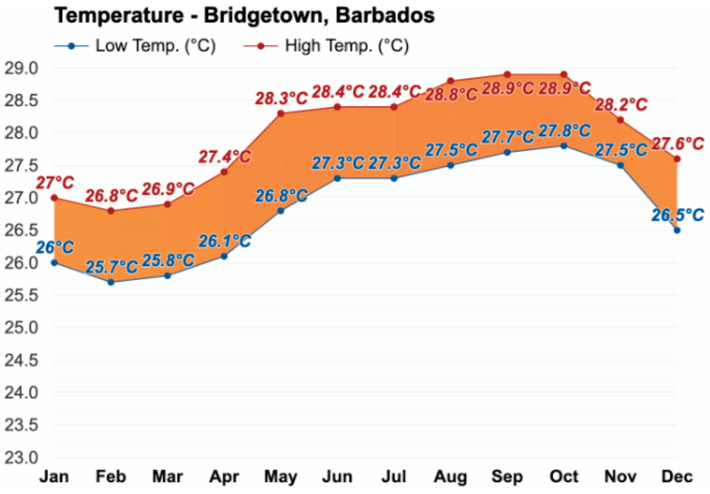
## 2. Comparison with Other Buildings in Tropical Weather

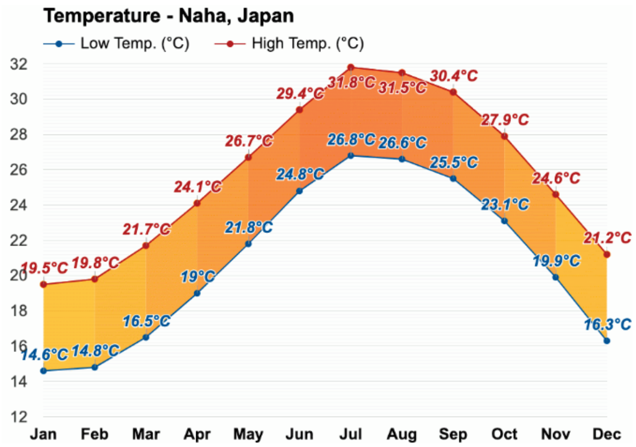
### Average Temperature Bridgetown, Barbados



Source: Weather Atlas

## 2. Comparison with Other Buildings in Tropical Weather

### Average Temperature Naha (Okinawa), Japan



Source: Weather Atlas

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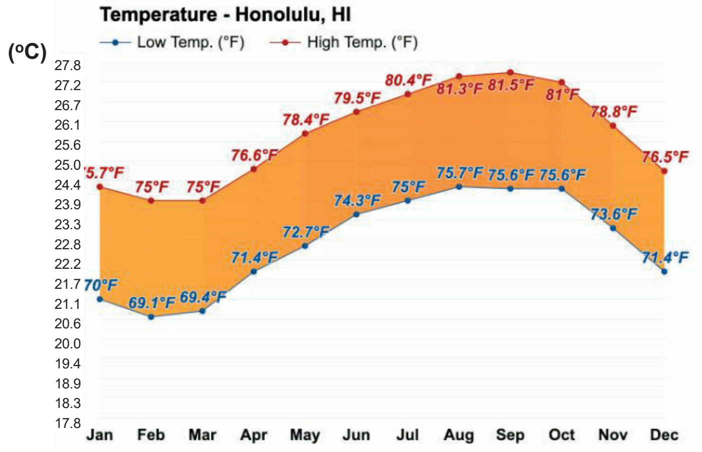
## 2. Comparison with Other Buildings in Tropical Weather

### Average Temperature Honolulu (Hawaii), USA



Source: Weather Atlas

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# 3. Examination of Energy Savings Opportunities

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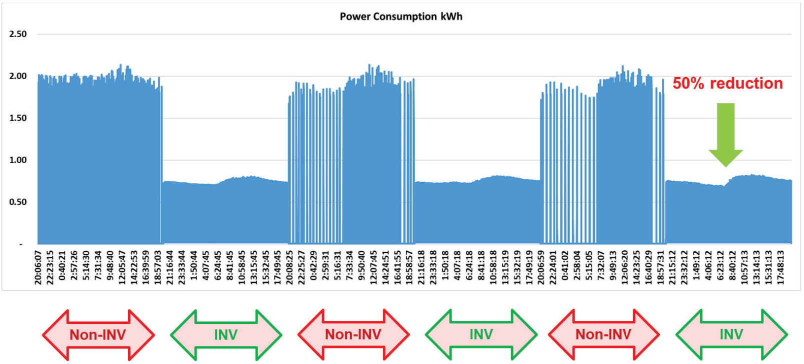
## 3. Examination of Energy Savings Opportunities

☐ **Examination of energy savings by adopting efficient air conditioning technologies and approaches**

**(i-a) Adoption of Inverter mini split air conditioners**

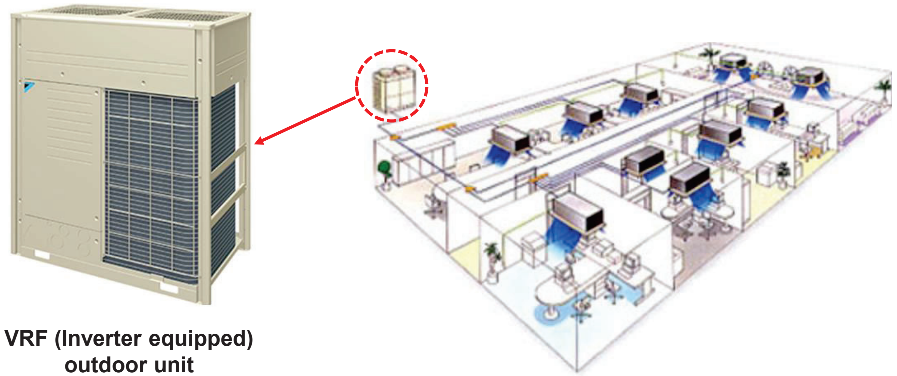
- **Reduction of 50% power consumption**

**Ref: Results of power consumption measurement of Inverter vs Non-Inverter AC**



## 3. Examination of Energy Savings Opportunities

### (i-b) Adoption of Variable Refrigerant Flow (VRF, Inverter always equipped) as an alternative of roof top air conditioners (Non-Inverter)



VRF (Inverter equipped)
outdoor unit

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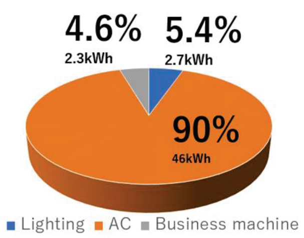
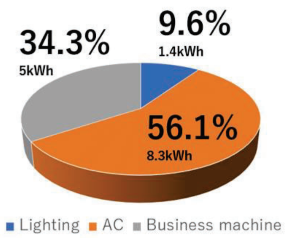
## 3. Examination of Energy Savings Opportunities

### Ref: Measured power consumption data in 2 office rooms on Jun.12.2022 (24 hours, highest temp: 32.2 °C, lowest temp: 26.1 °C)

**Measured Data of Electricity Consumption in Office 1**



**Measured Data of Electricity Consumption in Office 2**



Note: All lighting equipment is LED.

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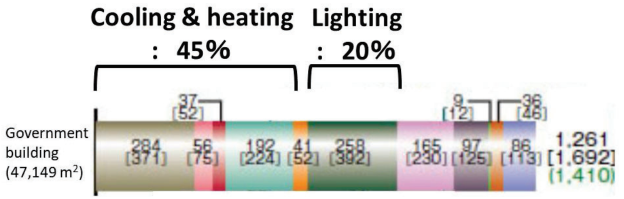
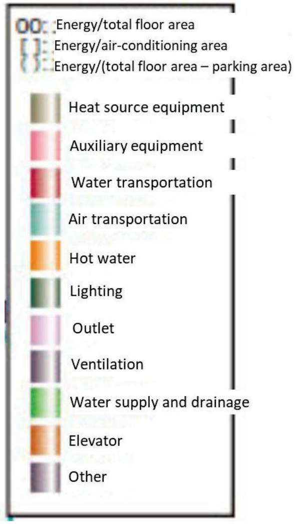
## 3. Examination of Energy Savings Opportunities

### Ref:
### Energy Consumption Data in Office Building, Japan



Source: Energy Conservation Center, Japan



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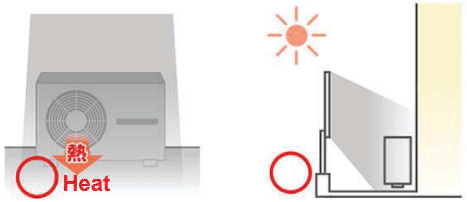
## 3. Examination of Energy Savings Opportunities

### (ii) Heat shielding of outdoor units

➢ 10 % power reduction was observed by heat shielding

Construction of heat shielding

| | Room A inv [kWh] | Room B inv [kWh] | Effect of EE&C [%] |
|---|---|---|---|
| Jan.14 | 150 | 164 | -9% |
| Jan.16 | 207 | 202 | 3% |
| Jan.20 | 93 | 86 | 8% |
| Jan.22 | 115 | 84 | 27% |
| Jan.28 | 146 | 122 | 16% |
| Jan.30 | 129 | 116 | 10% |
| Feb.3 | 148 | 141 | 4% |
| Feb.5 | 119 | 107 | 10% |
| Feb.9 | 152 | 132 | 13% |
| Feb.11 | 129 | 100 | 22% |
| Feb.13 | 126 | 103 | 18% |
| Feb.17 | 108 | 108 | 1% |
| ave. | 135 | 122 | 10% |



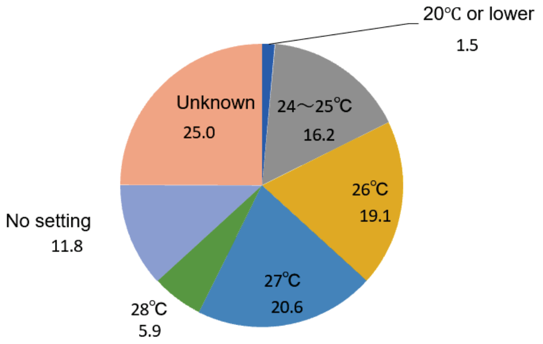
Source: "Data collection survey on energy efficiency in the D.R. final report" (Jan. 2016, JICA)

## (iii) Higher temperature setting of air conditioner

- **10 % power reduction by setting 1 °C higher temperature**

**Note: 13 % of power reduction with setting 1 °C higher temperature (by Ministry of Environment)**

### Ref: Setting temperature of air conditioner in Okinawa



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## ❑ Results of Examination (1) : power & cost savings

| | | Present situation | | |
|---|---|---|---|---|
| Annual power consumption for cooling | kWh | 83,818 | | |
| Power consumption by INV AC | kWh | 27,939 | | |
| Power consumption by Non-INV AC | kWh | 55,879 | | |
| Cooling loads by INV AC | kWh | 139,697 | | |
| Cooling loads by Non-INV AC | kWh | 139,697 | | |
| Total cooling loads | kWh | 279,393 | | |
| | | EE measure (i) | EE measure (i)+(ii) | EE measure (i)+(ii)+(iii) |
| Power consumption after EE measures | kWh | 55,879 | 50,291 | 45,262 |
| Power savings per year | kWh | 27,939 | 33,527 | 38,556 |
| Power saving ratio | % | 33 | 40 | 46 |
| Cost savings per year | $ | 17,881 | 21,457 | 24,676 |
| Annual power consumption per floor area | kWh/ m2 | 145 | 139 | 134 |

**Assumption:**
- 50% of ACs are INVERTER at present
- Efficiency of INV AC = 5 in kW/kW
- Efficiency of Non-INV AC = 2.5 in kW/kW

**Note: Unit rate of power (customer charge + demand charge + energy charge + fuel charge) = $0.64/kWh**

---

## ❑ Results of Examination (2) : Investment in INVERTER ACs

**Estimation of cooling capacity of existing Non-INV ACs**

| Item | Unit | Value |
|---|---|---|
| Total power capacity of building | kVA | 85 |
| Power factor | % | 90 |
| Total power demand of building | kW | 76.5 |
| Power demand of ACs | kW | 38.3 |
| Power demand of INV ACs | kW | 12.8 |
| Power demand of Non-INV ACs | kW | 25.5 |
| **Cooling capacity of Non-INV ACs** | **kW** | **63.8** |

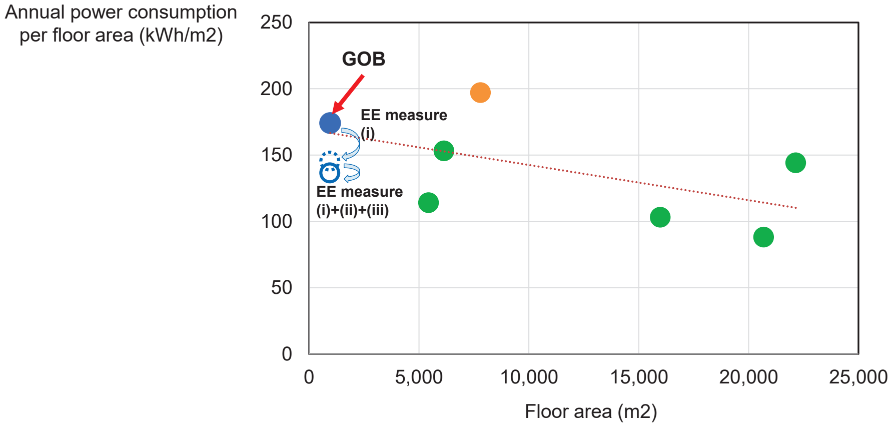
| Item | Unit | Value |
|---|---|---|
| INV AC cost (5.27 kW in cooling capacity) | $ | 1,700 |
| Necessary number of AC | Unit | 13 |
| **Total investment cost of INV AC** | **$** | **22,100** |

**Note: AC market survey conducted in Barbados by JET in 2019**

**Simple payback year = 22,100 / 17,881 = 1.2 year**

---

### Graph of Annual Power Consumption per Floor Area with EE Measures



# 4. References

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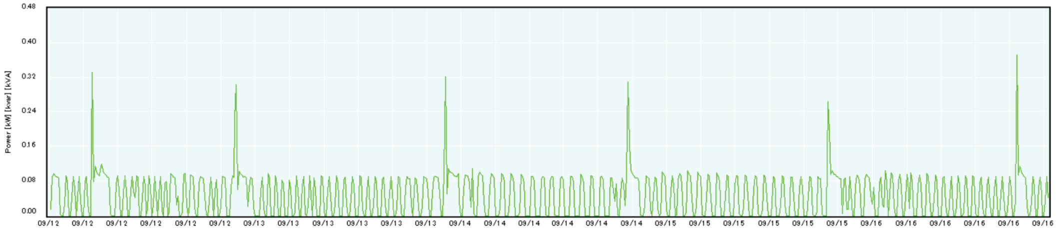
# 4. Reference(1): Power Consumption Data of Refrigerator

## Ref: Measured Power Consumption Data of Refrigerator in GOB (Sep.12 – 16, 2022)



**Existing refrigerator (Non-INVERTER) can be replaced with efficient one with INVERTER**

---

# 4. Reference (2): Illuminance standards for offices

## Illuminance standards for offices in Japan (JIS Z 9110)

| Illuminance (lux) | Place | Work |
|---|---|---|
| 2000 | | --- |
| 1500 | | ● design<br>● drawing<br>● type<br>● calculation<br>● keypunch |
| 1000 | office (a)(*) , sales room, design room, entrance hall (daytime)(**) | |
| 750 | | |

(Note)
(*) In the event that the office is used for **detailed visual work** or where daylight makes the room feel dark inside and bright outside the window, (a) should be selected.
(**) In the entrance hall, the illuminance should be high because the interior of the hall appears dark when the eye is applying the tens of thousands of lux from outdoor natural light during the day. The entrance hall (nighttime) and (daytime) may be adjusted with staged flashing.

---

# 4. References (2): Illuminance standards for offices

| Illuminance (lux) | Place | | | Work |
|---|---|---|---|---|
| 750 | --- | Office (b), boardroom, conference room, printing room, computer room, control room, clinic room<br>• switchboards and instrument panels in electrical and machine rooms, etc.<br>• reception (desk) | | --- |
| 500 | reception room,<br>waiting room,<br>dining room,<br>cooking room,<br>recreation room,<br>guard room,<br>entrance hall (at night),<br>elevator hall | | | |
| 300 | | warehouse, electrical room,<br>auditorium,<br>machine room,<br>miscellaneous workroom,<br>elevator | --- | |
| 200 | --- | | washing area,<br>hot water heating area,<br>bathrooms,<br>corridors,<br>stairs,<br>lavatories | |
| 150 | coffee room, rest room, lodging room, changing rooms, storage, entrance (porch) | | | |
| 100 | | | --- | |
| 75 | indoor emergency staircase | | | |
| 50 | | | | |
| 30 | | | | |

Source: JET based on EEC guidebook for building, 2022 (Energy Efficiency and Conservation Center of Japan)

# 4. References (3): EEC Check Items

## EEC Promotion System

- ✓ Do you have a mechanism for continuous EEC (e.g. EEC committee, etc.)?
- ✓ Are PDCA cycles for EEC activities being implemented with management participation?
- ✓ Have you designated a person or leader responsible for promoting EEC?
- ✓ Have you set EEC targets?
- ✓ Are energy consumption statuses posted for employees to see?
- ✓ Have you established a policy and implementation plan for EEC measures?
- ✓ Do you conduct personnel training and EEC awareness activities?
- ✓ Do you have the time and budget for EEC efforts?

Source: JET based on EEC guidebook for building, 2022 (Energy Conservation Center of Japan)

---

# 4. Reference (3): EEC Check Items

## Measurement, Recording and Maintenance

- ✓ Do you maintain equipment ledger, drawings and other documents?
- ✓ Have you identified equipment that should be intensively managed for EEC?
- ✓ Do you have operation records (daily, monthly, etc.) for major facilities?
- ✓ Have you set values to be managed and their ranges to check operating conditions?
- ✓ Do you perform daily inspection and maintenance of equipment?
- ✓ Are there management standards for major facilities (air conditioning, ventilation, lighting, production facilities, etc.)?
- ✓ Do you perform periodic calibration and inspection of measuring instruments?
- ✓ Are filters, strainers, etc. cleaned and replaced regularly?
- ✓ Do you conduct periodic repairs and leak inspections (water, steam, compressed air, etc.) of piping, etc.?

Source: JET based on EEC guidebook for building, 2022 (Energy Conservation Center of Japan)

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# 4. Reference (3): EEC Check Items

## Energy Management

- ✓ Do you tabulate (graphs, etc.) and visualize energy consumption by month/year?
- ✓ Is energy consumption measured and recorded by type and use, and constantly monitored?
- ✓ Do you measure hourly power usage and manage peak power?
- ✓ Do you analyze energy consumption taking into account outside temperatures and other factors?

## Management of Energy Intensity, etc.

- ✓ Have you calculated a common energy unit cost for the office (e.g. $/kWh, $/litre, $/m3)?
- ✓ Do you manage intensity ("energy use/floor area", "energy cost/floor area", etc.)?
- ✓ Do you manage energy intensity / expenses by each department?

## Management Cycle -PDCA-

- ✓ Are you reviewing your EEC targets?
- ✓ Are you verifying the effectiveness of improvement measures implemented to date?
- ✓ Are you reviewing your plans for implementing future facility improvements and measures?

Source: JET based on EEC guidebook for building, 2022 (Energy Efficiency and Conservation Center of Japan)

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# 4. Reference (3): EEC Check Items

## Improvements of Air Conditioning Efficiency

- ✓ Are outdoor units shaded and watered during the summer months?
- ✓ Are window blinds utilized to reduce heat gain through windows?
- ✓ Are filters cleaned regularly?
- ✓ Are shading films attached to window glass, and has plantings near windows implemented?
- ✓ Is air introduced into the room at night when the outside temperature is cooler (**night purge**)?
- ✓ Can we reduce the size of the air-conditioned area (partitions, high ceiling linings, etc.)
- ✓ Are spot coolers used when the air-conditioned area is large and the number of people is small?
- ✓ Are air-conditioned areas blocking drafts?
- ✓ Are you updating to high-efficiency air conditioners?

Source: JET based on EEC guidebook for building, 2022 (Energy Conservation Center of Japan)

## 4. Reference (3): EEC Check Items

### Lighting Fixture Management and EEC

- ✓ Is the illuminance standard for each room determined and controlled?
- ✓ Are window lights turned off (using daylight)?
- ✓ Are lights turned off when not needed, such as in unoccupied rooms or during lunch breaks?
- ✓ Do you adjust the lighting hours and number of exterior lights according to the hours of daylight?
- ✓ Have you cleaned the lamps and replaced old lamps?
- ✓ Are motion sensors used in restrooms, warehouses, etc.?
- ✓ Is the installation position (height and placement) of the lighting fixture appropriate for the required brightness?
- ✓ Are lighting circuits subdivided so that lights can be turned off in unoccupied areas, etc.?
- ✓ Are lights dimmed or turned off by automatic control?
- ✓ Are you updating to LED lighting?
- ✓ Have you considered task ambient lighting (all room lighting => overall + hand lighting)?

Source: JET based on EEC guidebook for building, 2022 (Energy Conservation Center of Japan)

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Thank you very much for your kind attention !

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# Energy Efficiency & Conservation (EEC) Materiel Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

## Information and knowledge sharing material - Energy Management & Energy Audit -

Jamaica, February 2023

Nippon Koei Co., Ltd.
PADECO Co., Ltd.

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## 1. Energy Management System (EnMS), ISO 50001, and its Case Study

# Key Points of ISO 50001 (EnMS)

## *Key Points*

- ISO 50001 specifies the energy management system (EnMS) requirements for an organization. Successful implementation of an EnMS supports a culture of energy performance improvement that depends upon **commitment from all levels of the organization, especially top management**. In many instances, this involves **cultural changes** within an organization.

- EnMS includes an **energy policy, objectives, energy targets and action plans** related to its energy efficiency, energy use, and energy consumption.

- Energy performance is a concept which is related to energy efficiency, energy use and energy consumption. Energy performance indicators **(EnPIs)** and energy baselines **(EnBs)** are two interrelated elements to enable organizations to demonstrate energy performance improvement.
  - **Energy performance indicators (EnPIs)**
    The organization shall determine EnPIs that:
    - are appropriate for measuring and monitoring its energy performance;
    - enable the organization to demonstrate energy performance improvement.
  - **Energy baseline (EnBs)**
    The organization shall establish (an) EnB(s) using the information from the energy review(s), taking into account a suitable period of time.

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# Key Points of ISO 50001 (EnMS)

## *Plan-Do-Check-Act (PDCA) cycle*

- The EnMS described is based on the Plan-Do-Check-Act (PDCA) continual improvement framework and incorporates energy management into existing organizational practices.

  In the context of energy management, the PDCA approach can be outlined as table below.

| | |
|---|---|
| ***Plan*** | Understand the context of the organization, establish an **energy policy** and an **energy management team**, consider actions to address risks and opportunities, conduct an **energy review**, identify **significant energy uses (SEUs)** and establish energy performance indicators (EnPIs), energy baseline(s) (EnBs), objectives and energy targets, and action plans necessary to deliver results that will improve energy performance in accordance with the organization's energy policy. |
| ***Do*** | Implement the action plans, operational and maintenance controls, and communication, ensure competence and consider energy performance in design and procurement. |
| ***Check*** | Monitor, measure, analyze, evaluate, audit and conduct management review(s) of energy performance and the EnMS. |
| ***Act*** | Take actions to address nonconformities and continually improve energy performance and the EnMS. |

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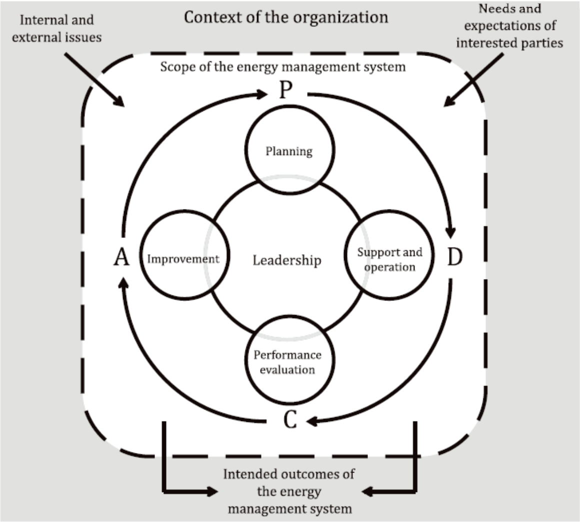
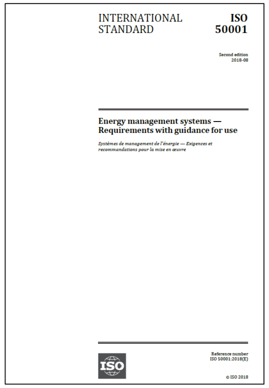
# Key Points of ISO 50001 (EnMS)




INTERNATIONAL STANDARD

ISO 50001

Second edition
2018-08

**Energy management systems — Requirements with guidance for use**

*Systèmes de management de l'énergie — Exigences et recommandations pour la mise en œuvre*

Reference number
ISO 50001:2018(E)

© ISO 2018

**Plan-Do-Check-Act (PDCA) cycle**

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# Case Study of EnMS -ISO 50001-

## *1. Planning for Collection of Energy Data*

- The organization shall ensure that key characteristics of its operations affecting energy performance are identified, measured, monitored and analyzed at planned intervals. The organization shall define and implement an **energy data collection plan** appropriate to its size, its complexity, its resources and its measurement and monitoring equipment.

- The plan shall specify the data necessary to monitor the key characteristics and state how and at what frequency the data shall be collected and retained.

- Data to be collected (or acquired by measurement as applicable) and retained documented information shall include:
  - the relevant variables for **SEUs**;
  - energy consumption related to **SEUs** and to the organization;
  - operational criteria related to **SEUs**;
  - static factors, if applicable;
  - data specified in action plans.

- The energy data collection plan shall be reviewed at defined intervals and updated as appropriate.

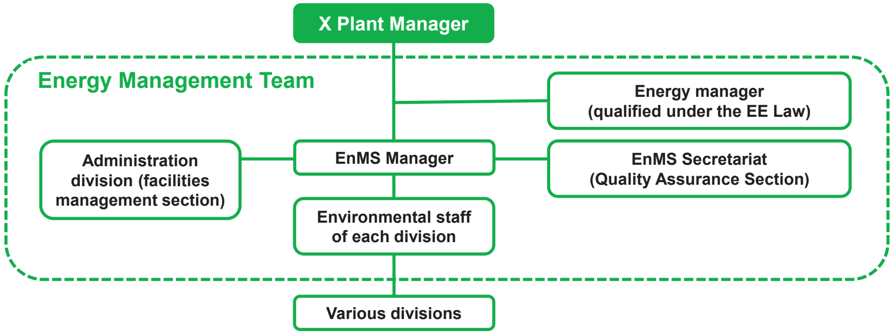
# Case Study of EnMS -ISO 50001-

## 2. Scope of EnMS

The scope of ISO 50001 certification covers the manufacture of automotive undercarriage parts at the X Plant.

## 3. Promotion Structure

The X Plant Manager was appointed as top management to establish an EnMS based on ISO 50001, including an energy manager in accordance with the EE Law, a facility management section in the administration division, and a person in charge of promotion in each division.



**EnMS Promotion Structure at X Plant**

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# Case Study of EnMS -ISO 50001-

## 4. Energy Policy

***Energy Philosophy***

We aim to be the top environmental runner in the automotive industry, and we will do our utmost to build a low-carbon and nature-rich future by deepening each employee's correct understanding of global environmental issues and actively engaging in ongoing environmental conservation activities in all areas of our corporate activities.

***Basic policy***

- ➢ We will continuously implement energy conservation activities in our production activities.
- ➢ Collect appropriate information to achieve our goals and objectives
- ➢ We will strive to use appropriate resources to achieve our goals and objectives
- ➢ We will comply with all laws and regulations related to energy use and other agreed upon requirements.
- ➢ Set objectives and review them regularly.
- ➢ We will strive to install energy-efficient product equipment and utilize energy-efficient services
- ➢ We will develop environmentally conscious people through energy conservation activities.

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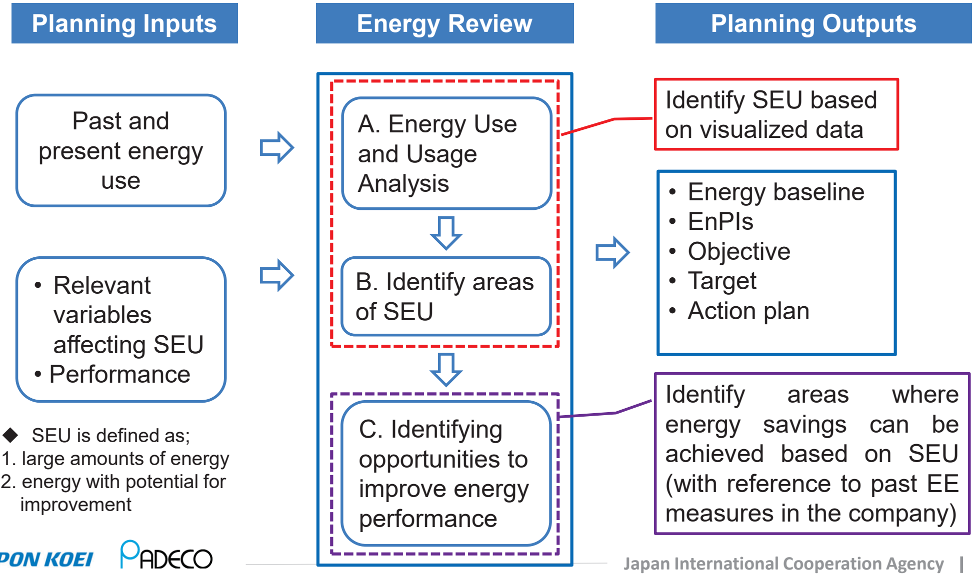
# Case Study of EnMS -ISO 50001-

## 5. Overall Energy Review



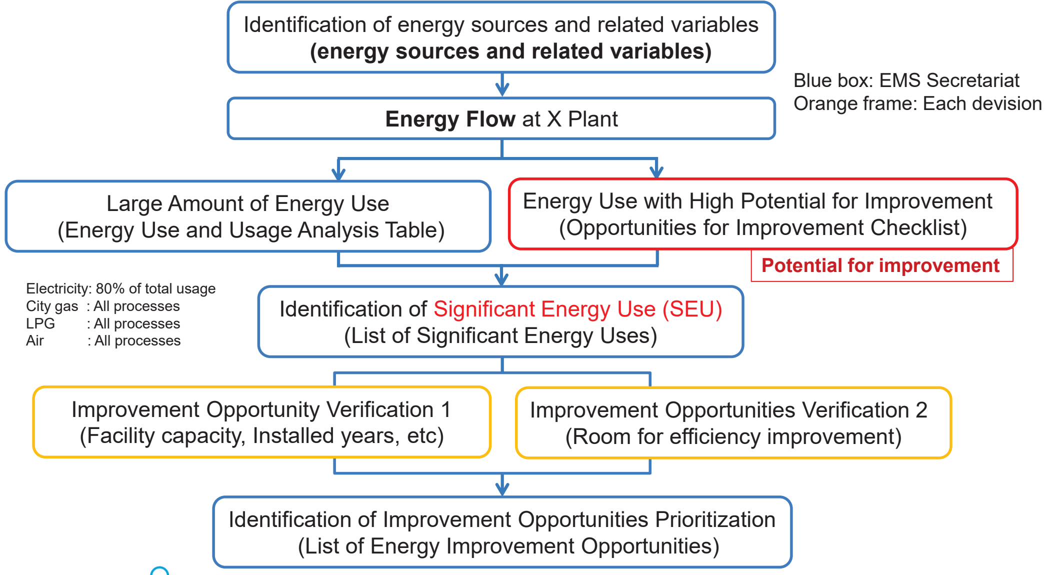
◆ SEU is defined as;

1. large amounts of energy
2. energy with potential for improvement

---

# Case Study of EnMS -ISO 50001-

## 6. Energy Review Flow



Blue box: EMS Secretariat
Orange frame: Each devision

Electricity: 80% of total usage
City gas : All processes
LPG : All processes
Air : All processes

# Case Study of EnMS -ISO 50001-

## 7. Methodology for Setting Energy Baselines and Energy Performance Indicators

- The energy baseline was based on FY 2010, when operations were relatively normal.
- The energy performance indicators (EnPIs) are basic units obtained by dividing the respective energy consumption (total amount) by a more closely related variable.
- The intensity is set more precisely than that used for reporting under the EE Law, so that energy usage can be more clearly understood.

**Energy Baselines and Energy Performance Indicators (EnPIs)**

| | Electricity | City gas | LPG | Air |
|---|---|---|---|---|
| Baseline | FY2010 | FY2010 | FY2010 | FY2012 |
| EnPIs | • Total amount<br>• Intensity (Value added) | • Total amount<br>• Intensity (Production) | • Total amount<br>• Intensity (Average temperature) | • Total amount<br>• Intensity (Value added) |

Note: Parameter of intensity in parentheses

---

# Case Study of EnMS -ISO 50001-

## 8. Energy Objectives and Targets

- Targets were set for a single year (FY2012) and for the medium term (through FY2015).
- In setting the targets, target values were set for each energy source without CO2 conversion or crude oil conversion in order to clarify the effect of energy improvement.

Energy Objectives and Targets (Mid term and FY2012)

| | | Electricity | City gas | LPG | Air |
|---|---|---|---|---|---|
| Intensity | FY2015 | 5% improvement | 5% improvement | Less than FY2012 | 3% improvement |
| | FY2012 | 3% improvement | 3% improvement | Less than FY2012 | 1% improvement |
| Total amount | FY2015 | 30% reduction | 5% reduction | 15% reduction | 3% reduction |
| | FY2012 | 10% reduction | Less than FY2010 | 15% reduction | 1% reduction |

---

# Case Study of EnMS -ISO 50001-

## 9. Preparation of Energy Management System Documents

- The following management system documents were prepared as applicable to the X plant.
  - Energy Management System Manual
  - Energy Review Implementation Procedures
  - Environmental Meeting Procedures
- In addition, several forms mainly related to energy reviews were newly prepared, including an "Efficiency Improvement Feasibility Check Sheet" and an "Energy Review Survey Sheet" that lists;
  - Energy use classification of each process facility
  - Determination of equipment capacity suitability
  - Determination of renewal timing
  - EE improvement items
  - Implementation status of measures.

## 10. Management Review Outputs

The management review included detailed reports on the improvement of energy performance through the efforts of each division. Specific instructions were given to include total energy consumption in an energy performance indicators / targets, and "improving the energy management team's data analysis" and “improvements in implementation capabilities” were suggested.

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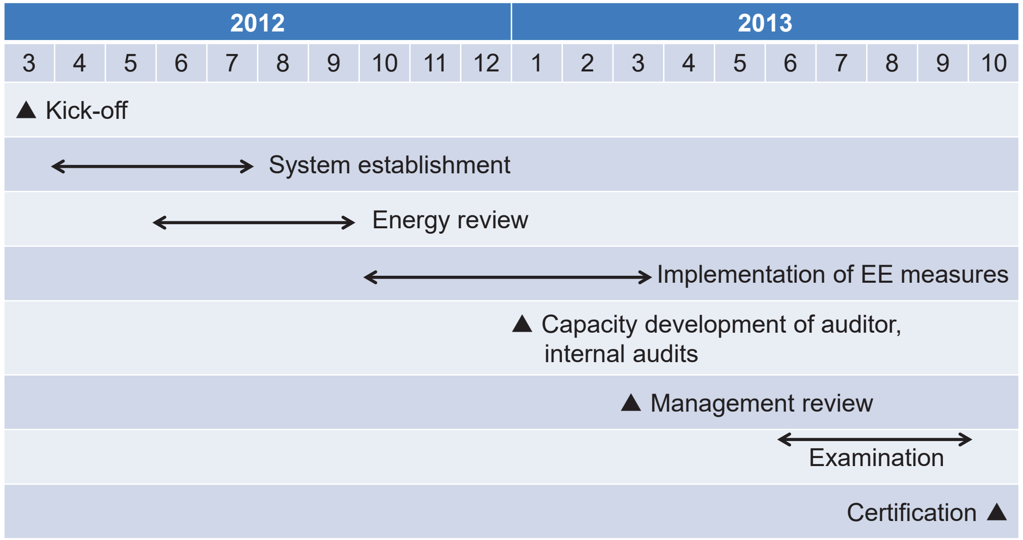
# Case Study of EnMS -ISO 50001-

## 11. Schedule for ISO 50001 – from System Establishment to Certification



2012: 3 4 5 6 7 8 9 10 11 12

2013: 1 2 3 4 5 6 7 8 9 10

▲ Kick-off

System establishment

Energy review

Implementation of EE measures

▲ Capacity development of auditor, internal audits

▲ Management review

Examination

Certification ▲

# Case Study of EnMS -ISO 50001-

## *12. Results of Activities*

Identified specific outcomes of the ISO 50001 are as follows;

- Regrading data collected by the energy management system, the steps formulation (e.g. data analysis, EE measures planning, implementation and effectiveness verification) has been standardized. This will enable permanent and systematic EE&C implementation.
- Persons in charge of implementation in each division improved skills in analyzing energy management data.
- Know-how on EE&C measures has been accumulated.
- Morale / passion for EE&C increased at the plant.
- Improved energy performance.

**Improved Energy Performance Results**

| | | |
|---|---|---|
| Total effect by measures conducted in FY2012 | CO2 reductions (total) | 81.2 t-CO2 |
| | Reduction cost (total) | JPY 2,844,000 |
| Total effect by measures conducted in FY2013 (estimates) | CO2 reductions (total) | 130.3 t-CO2 |
| | Reduction cost (total) | JPY 4,801,000 |

---

# Case Study of EnMS -ISO 50001-

## *13. Potential for Future Improvement*

Future issues for the development of ENMS improvements include the following.

- Further strengthen data analytical capabilities of energy management system as well as implementation capabilities.
- Accumulation of improvement know-how through energy use visualization.
- Support for ISO 50001 certification for overseas subsidiaries as a global mother.

---

# 2. Energy Management Best Practice at District Heating & Cooling (DHC) plant in Japan

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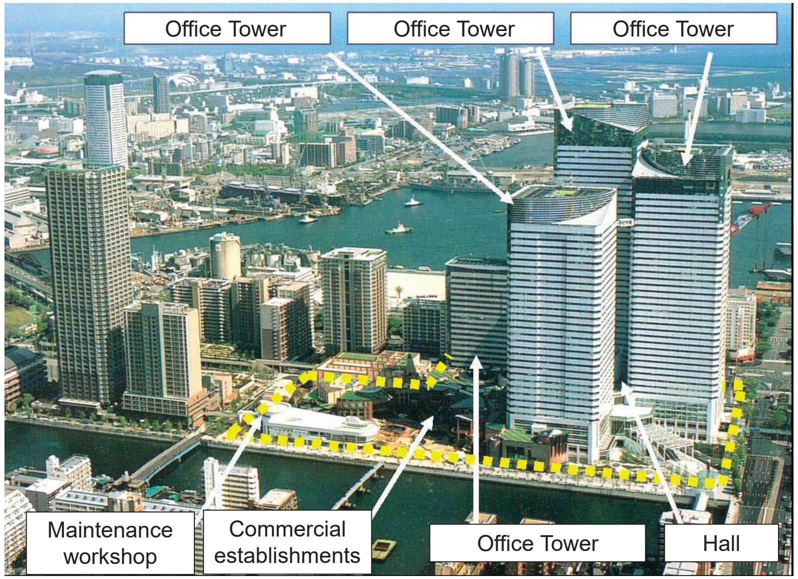
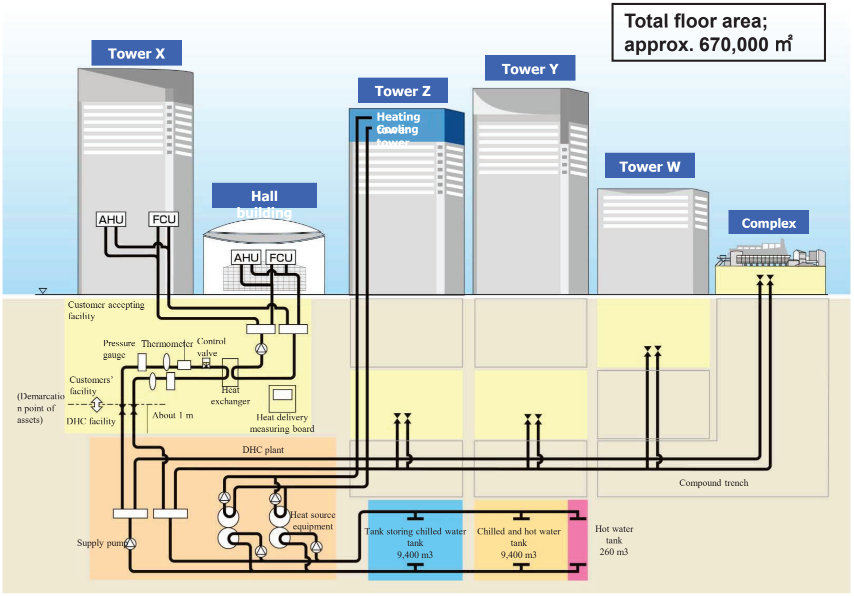
# Outline of District Heating & Cooling System



**Harumi Island District Heating & Cooling, DHC**

# Outline of District Heating & Cooling System

Total floor area;
approx. 670,000 ㎡



Energy flow diagram of chilled and hot water supply

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# Outline of District Heating & Cooling System

- Energy / Environment Management Structure

**Mgmt society for west area**

**Mgmt society for tower X & hall**

**Mgmt society for tower Y**

**Mgmt society for east area**

**Close coordination**

**Integrated management entity**

(Management entity for common area)

■Periodical meeting
(Every other month)
✓ Comprehensive data examination
✓ Each operational improvement
✓ Feedback of the outcome

Record in FY'10

CO2 emissions
= 32,355 t-CO2
(▲10.5% ! )

Base line= Annual average emissions from FY'04 through FY'06

---

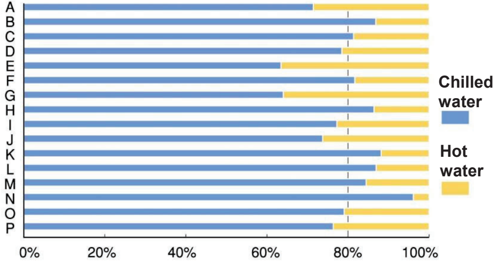
# Key Points 1 for Achieving EEC

## Adoption of the most efficient chiller

Space cooling demand exceeds space heating demand in the offices, etc.
In order to increase the overall system efficiency, it is crucial to adopt the equipment that produces chilled water efficiently.

The most efficient centrifugal chillers at the time of design and construction were adopted.

As for heat demand for air-conditioning in offices, etc., demand for chilled water largely exceeds that for hot water.



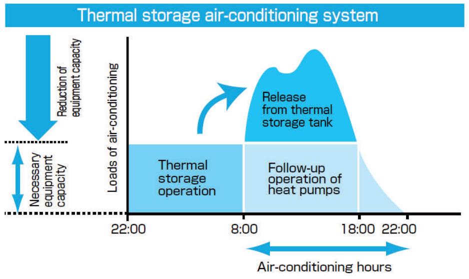
Demand for chilled water and hot water in offices, etc.
(actual data)

---

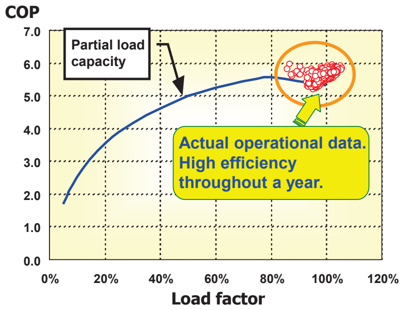
# Key Points 2 for Achieving EEC

## Adoption of Thermal Storage Systems

Heat pumps (chillers) can operate at high load factor where its efficiency is high with thermal storage system. Thus, large-scale thermal storage tank was adopted (19,060 m$^3$).
Note: Thermal storage system has similar effects with inverter in terms of improving operational efficiency.



Operation of thermal storage air-conditioning system

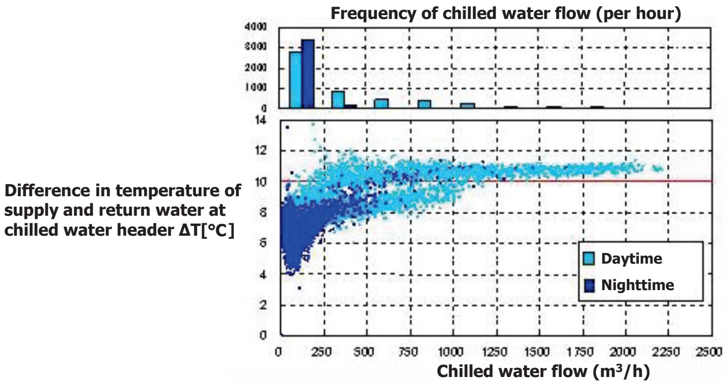


Operational records of chiller

# Key Points 3 for Achieving EEC

## Adoption of large temperature difference water

To reduce the power consumption by pumps, the temperature difference of supply and return water was designed at 10 degrees, while the standard is typically 7 degrees.



Weighted average ΔT
Daytime : 9.9°C
Nighttime : 7.5°C

**Annual Results of difference in temperature of coming and going water**

---

# Key Points 4 for Achieving EEC

## Adoption of heat recovery heat pumps

Heat recovery heat pumps save energy drastically by recycling waste heat from cooling operation. Most of the waste heat is recovered and utilized as heat for space heating.

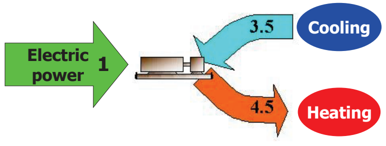
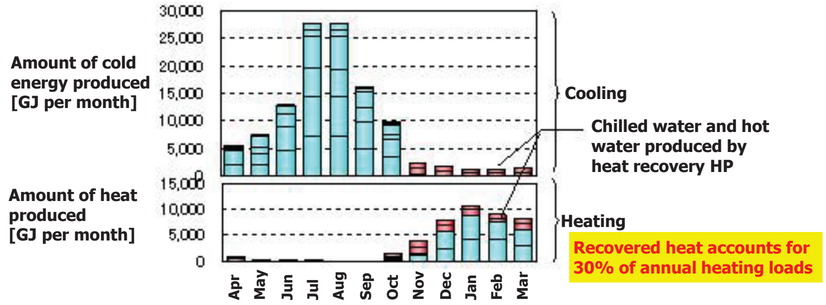


**Image of heat recovery heat pump (COP=8)**



**Data of waste heat recovery through a year**

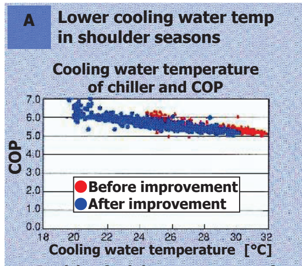
---

# Key Points 5 for Achieving EEC

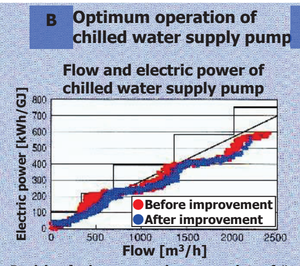
## Implementation of continuous commissioning

Creation of "performance evaluation and review committee" including people of academic standing, designer and constructor. It lasted 3 years after completion of construction.

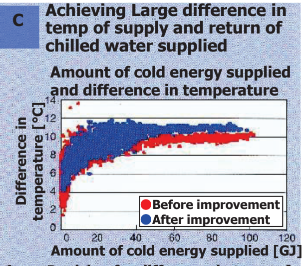
- Understanding situation of operation through close and careful measurements and analyses.
- Evaluation of performance and identification of issues.
- Implementation of measures toward better performance and review of the effects thereof.



Devising for inlet temperature of cooling water of centrifugal chiller



Devising for increase or decrease points of # of units in operation for chilled water supply pump



Devising for difference in temp of supply & return of chilled water

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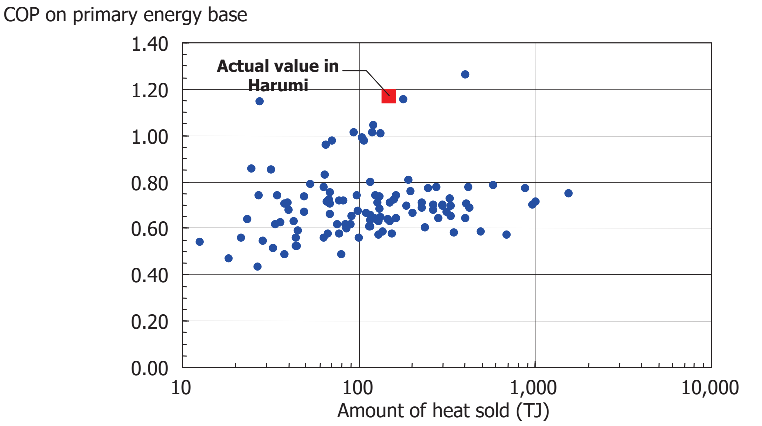
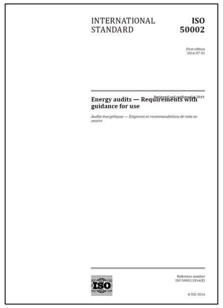
# Achieved Top Energy Efficiency Rating

- ✓ Among high-efficiency DHC systems, Harumi DHC achieved a top energy efficiency rating in Japan.



**COP on the primary energy basis for DHC in Japan**

# 3. Energy Audits, ISO 50002, and its Case Study



INTERNATIONAL STANDARD

ISO 50002

First edition
2014-07-01

Reviewed and confirmed in 2019

**Energy audits — Requirements with guidance for use**

*Audits énergétiques — Exigences et recommandations de mise en oeuvre*

Reference number
ISO 50002:2014(E)

© ISO 2014

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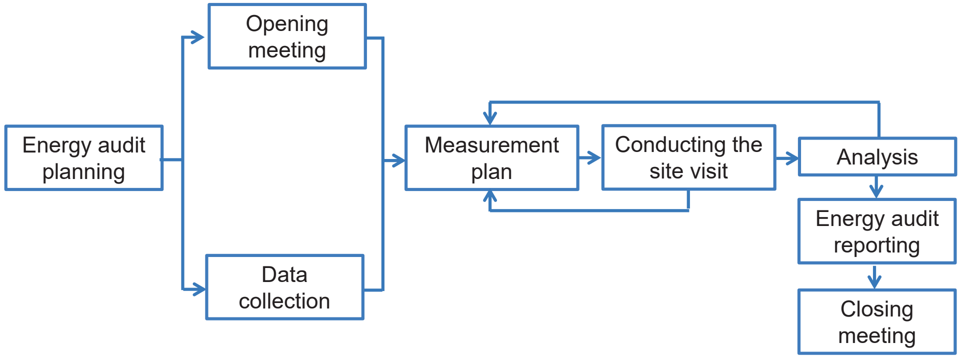
# Key Points of ISO 50002 (Energy audits)

## *Energy Audit Process Flow*

- ISO 50002 stipulates the energy audit process consists of the following stages.



**Energy Audit Process Flow Diagram**

---

# Key Points of ISO 50002 (Energy audits)

## *Data Collection*

Where available, the energy auditor shall collect, collate and record the appropriate energy data that support the audit objectives. This includes the following information:

A) a list of energy consuming systems, processes and equipment;

B) detailed characteristics of the energy uses within the defined energy audit scope, including relevant variables and how the organization believes they influence energy performance;

C) historical and current energy performance data, including:

  i. energy consumption, relevant variables, relevant related measurements (e.g. power factor measurements; results from a thermographic or compressed air survey);

  ii. operational history and past events that could have affected energy consumption in the period covered by the data collected;

D) monitoring equipment, configuration and analysis information (e.g. local gauges, distributed control systems, instrumentation types);

E) future plans, design, operation and maintenance documents;

F) energy audits or previous studies related to energy performance;

G) current energy rate schedule(s) (or tariffs) or a reference rate (or tariff) to be used for financial analysis;

---

# Key Points of ISO 50002 (Energy audits)

## *Analysis of Current Energy Performance*

The current energy performance provides the basis for evaluating improvements and shall include:

A) a breakdown of the energy consumption by use and source;

B) energy uses accounting for substantial energy consumption;

C) where available and comparable, comparison with reference values of similar processes;

D) a historical pattern of energy performance;

E) expected improvements for energy performance.

F) where appropriate, relationships between energy performance and relevant variables;

G) an evaluation of the existing energy performance indicator(s) and, if necessary, proposals for (a) new energy performance indicator(s).

# Key Points of ISO 50002 (Energy audits)

## *Identification of Improvement Opportunities*

The energy auditor shall identify energy performance improvement opportunities based on analysis and the following:

A) their own competency and expertise;

B) evaluation of the design and configuration options to address the system needs;

C) the operating lifetime, condition, operation and level of maintenance of the audited objects;

D) the technology of existing energy uses in comparison to the most efficient on the market;

E) best practices, including operational controls and behaviours;

F) future energy use and changes in operation.

---

# Key Points of ISO 50002 (Energy audit)

## *Evaluation of Improvement Opportunities*

The energy auditor shall evaluate the impact of each opportunity on the current energy performance based on the following:

A) energy savings over an agreed time period or expected operating lifetime; (e.g. Energy savings, improvements in specific energy consumption).

B) financial savings anticipated from each improvement opportunity;

C) necessary investments;

D) agreed economic and other criteria identified in the energy audit planning;

E) other non-energy gains (such as productivity or maintenance);

F) the ranking of energy performance opportunities;

G) potential interactions between various opportunities.

---

# Key Points of ISO 50002 (Energy audits)

## *Energy Audit Report Contents*

The energy audit report shall include the following topics:

**A) Executive summary:**

i. summary of energy use and consumption;

ii. ranking of opportunities for improving energy performance;

iii. suggested implementation programme;

**B) Background:**

i. general information on the organization, energy auditor and energy audit methods;

ii. relevant legal and other requirements applicable to the energy audit;

iii. statement of confidentiality;

iv. context of the energy audit;

v. energy audit description, defined scope and boundaries, audited objective(s) and timeframe;

---

# Key Points of ISO 50002 (Energy audits)

**C) Energy audit details**

i. information on data collection:

ii. analysis of energy performance and any energy performance indicator(s);

iii. basis for calculations, estimates and assumptions and the resulting accuracy;

iv. criteria for ranking opportunities for improving energy performance.

**D) Opportunities for improving energy performance**

i. recommendations and the suggested implementation programme;

ii. assumptions and methods used in calculating energy savings, and the resulting accuracy of calculated energy savings and benefits;

iii. assumptions used in calculating costs of implementation, and the resulting accuracy;

iv. appropriate economic analysis, including known financial incentives and any non-energy gains;

v. potential interactions with other proposed recommendations;

vi. measurement and verification methods recommended for use in post-implementation assessment of the recommended opportunities;

**E) Conclusions and recommendations.**

# Key Points of ISO 50002 (Energy audits)

## < Reference> Energy Audit Principles

The energy audit shall be conducted according to the following principles:

A) the audit is consistent with the agreed energy audit scope, boundary and audit objective(s);

B) the measurements and observations are appropriate to the energy uses and consumption;

C) the collected energy performance data are representative of the activities, processes, equipment and systems;

D) the used data for quantifying energy performance and identifying improvement opportunities are consistent and unique;

E) the process of collecting, validating and analysing data is traceable;

F) the energy audit report provides energy performance improvement opportunities based on appropriate technical and economic analysis.

---

# Case Study of Energy Audits (1)

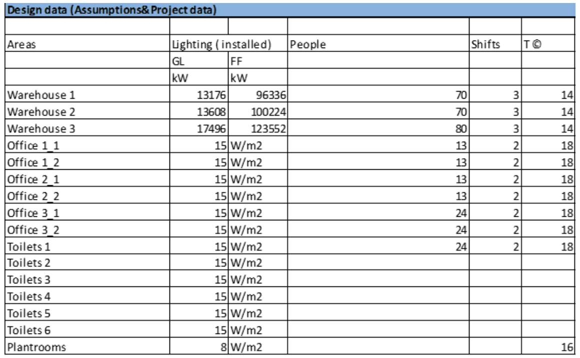
## Logistics Center Project (2 large warehouses + offices)

---

# Case Study of Energy Audits (1)

## Energy Dynamic Simulation

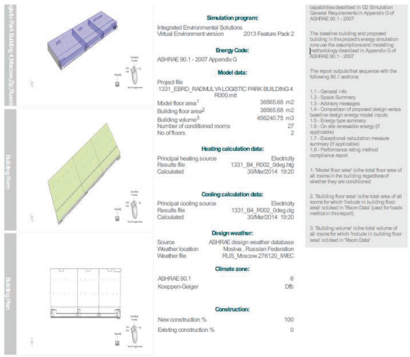
### Part of Building Design Data (Project Data)



Design data (Assumptions& Project data)

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| Areas | Lighting ( installed) | | People | Shifts | T © |
| | GL | FF | | | |
| | kW | kW | | | |
| Warehouse 1 | 13176 | 96336 | 70 | 3 | 14 |
| Warehouse 2 | 13608 | 100224 | 70 | 3 | 14 |
| Warehouse 3 | 17496 | 123552 | 80 | 3 | 14 |
| Office 1_1 | 15 | W/m2 | 13 | 2 | 18 |
| Office 1_2 | 15 | W/m2 | 13 | 2 | 18 |
| Office 2_1 | 15 | W/m2 | 13 | 2 | 18 |
| Office 2_2 | 15 | W/m2 | 13 | 2 | 18 |
| Office 3_1 | 15 | W/m2 | 24 | 2 | 18 |
| Office 3_2 | 15 | W/m2 | 24 | 2 | 18 |
| Toilets 1 | 15 | W/m2 | 24 | 2 | 18 |
| Toilets 2 | 15 | W/m2 | | | |
| Toilets 3 | 15 | W/m2 | | | |
| Toilets 4 | 15 | W/m2 | | | |
| Toilets 5 | 15 | W/m2 | | | |
| Toilets 6 | 15 | W/m2 | | | |
| Plantrooms | 8 | W/m2 | | | 16 |

### Screen of General Information of Dynamic Energy Calculation



**Simulation program:**

Integrated Environmental Solutions
Virtual Environment version 2013 Feature Pack 2

**Energy Code:**

ASHRAE 90.1 - 2007 Appendix G

**Model data:**

Project file
1331_EBRD_RADMULYA LOGISTIC PARK BUILDING 4 R000.mit

| | |
|---|---|
| Model floor area[1] | 36565.68 m2 |
| Building floor area[2] | 36565.68 m2 |
| Building volume[3] | 456240.75 m3 |
| Number of conditioned rooms | 27 |
| No of floors | 2 |

**Heating calculation data:**

| | |
|---|---|
| Principal heating source | Electricity |
| Results file | 1331_B4_R002_0deg.htg |
| Calculated | 30/Mar/2014 19:20 |

**Cooling calculation data:**

| | |
|---|---|
| Principal cooling source | Electricity |
| Results file | 1331_B4_R002_0deg.clg |
| Calculated | 30/Mar/2014 19:20 |

**Design weather:**

| | |
|---|---|
| Source | ASHRAE design weather database |
| Weather location | Moskva , Russian Federation |
| Weather file | RUS_Moscow.276120_IWEC |

**Climate zone:**

| | |
|---|---|
| ASHRAE 90.1 | 6 |
| Koeppen-Geiger | Dfb |

**Construction:**

| | |
|---|---|
| New construction % | 100 |
| Existing construction % | 0 |

capabilities described in G2 Simulation General Requirements in Appendix G of ASHRAE 90.1 - 2007

The baseline building and proposed building in this project's energy simulation runs use the assumptions and modelling methodology described in Appendix G of ASHRAE 90.1 - 2007

The report outputs that sequence with the following 90.1 sections

1.1 - General info
1.2 - Space Summary
1.3 - Advisory messages
1.4 - Comparison of proposed design versus baseline design energy model inputs
1.5 - Energy type summary
1.6 - On site renewable energy (if applicable)
1.7 - Exceptional calculation measure summary (if applicable)
1.8 - Performance rating method compliance report

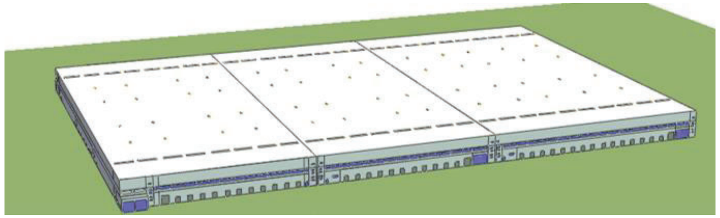
1. 'Model floor area' is the total floor area of all rooms in the building regardless of whether they are conditioned

2. 'Building floor area' is the total area of all rooms for which 'Include in building floor area' is ticked in 'Room Data' (used for loads metrics in this report)

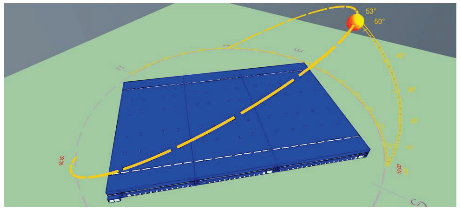
3. 'Building volume' is the total volume of all rooms for which 'Include in building floor area' is ticked in 'Room Data'

---

# Case Study of Energy Audits (1)



Facade and Roof of Warehouse



Sun Trajectory

# Case Study of Energy Audits (1)

### Summary of Dynamic Energy Calculation of the Building for BREEAM Assessment

| Indicator | Baseline | The Project |
|---|---|---|
| **Overall final energy performance (electricity + fuel) (kWh/m²/year)** | 215 | 95 |
| **Overall final energy consumption (electricity + fuel) (MWh/year)** | 7,856 | 3,474 |
| **Energy savings of electricity (kWh/m²/year)** | - | 31 |
| **Energy savings of electricity (MWh/year)** | - | 1,132 |
| **Energy savings of heat and fuel (kWh/m²/year)** | - | 89 |
| **Energy savings of heat and fuel (MWh/year)** | - | 3,250 |
| **Primary energy savings (KJ/m²/year)** | - | 2,754 |
| **Primary energy savings (MJ/year)** | - | 100,697 |

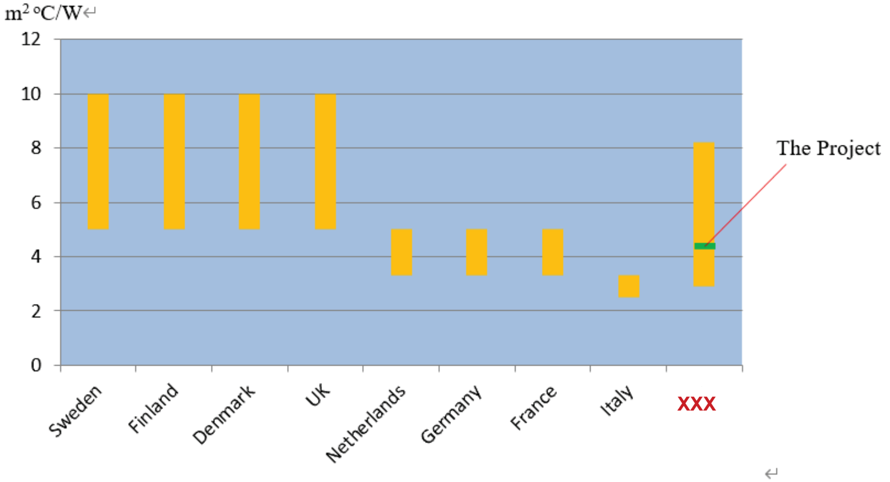
# Case Study of Energy Audits (1)

## *Examined EE&C Technologies (additional study)*

| Examined technologies | Examination / Evaluation | Financial Analysis |
|---|---|---|
| Combined Heat & Power (co-generation) | Proposed | • Investment cost<br>• Cash-flow<br>• Pay back period<br>• IRR<br>• NPV |
| Variable speed control units (inverters) | Proposed | |
| Efficient transformer | Proposed | |
| Renewable energy | Already included | - |
| Peak shaving | Not necessary (high load factor) | - |
| Building envelope performance | Good (see next slide) | - |

# Case Study of Energy Audits (1)

### Evaluation of Building Thermal Properties



# Case Study of Energy Audits (2)

## *Mining Plant Project*

**Complete view of the existing crushing plant**

# Case Study of Energy Audits (2)

## *Examined EE&C Technologies*

| Examined technologies | Examination / Evaluation | Financial Analysis |
|---|---|---|
| Efficient motors | Proposed | Investment cost<br>Cash-flow<br>Pay back period<br>IRR<br>NPV |
| PV system | Proposed | |
| PV system with financial incentives | Proposed | |
| Inverter to motors | Already included | - |
| Improvement of power factor of receiving ends | Analyzed high enough | - |
| Inverter to compressors | Recommended | - |
| Efficient transformers | Recommended | - |
| Efficient lighting | Recommended | - |
| Electrically-driven dump trucks for a mine | Recommended | - |
| Trolley dump trucks for a mine | Recommended | - |

---

# Case Study of Energy Audits (2)

Source Energy Conservation Centre of Japan

**Electrically-driven dump trucks for a mine**

Source Energy Conservation Centre of Japan

**Electrically-driven dump trucks for a mine**

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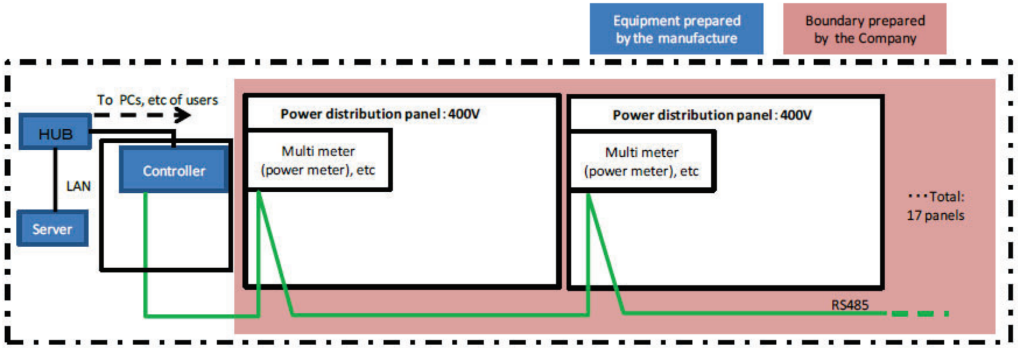
# Case Study of Energy Audits (2)



**Structure of EMS for 17 Power Distribution Panels**

**Estimates for the introduction of EMS**

| Item | Cost (USD) |
|---|---|
| The cost of the hardware and software | XXXXX |
| The cost of design, installation and construction | XXXXX |
| The total cost of introduction of EMS | XXXXX |

---

# Case Study of Energy Audits (2)

## Representative Monitoring Items and Functions with the EMS

| Monitoring items and functions | Comments |
|---|---|
| Peak demand of electric power | Alarm function included. ( in case of exceeding threshold value) |
| Demand history of electric power | Displaying the power demand history. |
| Power consumption history by the distribution panel | Displaying the power demand history by the equipment groups. |
| Analysis by the output level (e.g. in manufacturing) and energy management (targets/actual results) | Analysis by the output level and equipment groups.<br>The following targets and actual results to be displayed in the tables and the graphs on monthly basis.<br>a. Electric power consumption<br>b. Primary energy consumption<br>c. $CO_2$ emissions<br>d. Costs |
| Creation of the reports | Creation of the reports on daily, monthly and yearly basis regarding energy consumption. |
| Creation of the reports required by the government | Creation of the reports to be submitted to the government. |

# 4. Energy Audit Best Practice at Aquarium & Amusement Park in Japan

---

## Outline of the Aquarium & Amusement Park

- ✓ The company was Established in 1990.
- ✓ The amusement park was opened in 1993.
- ✓ Annual number of visitors; 4 to 5 million (Top 5 in Japan).
- ✓ The park is type-1 designated energy management factory under "the law concerning the Rational Use of Energy".

◆ Three-story aquarium with thousands of fish which is one of the largest in Japan.
⇒ A lot of cold energy & heat (chilled & hot water) are necessary to maintain water temperature in water tanks constant all year around as well as space heating & cooling for visitors.

◆ Other attractions

- ➢ Vertical fall amusement (BLUE FALL) with 107 meters high.
- ➢ Japan's first roller coaster that swings out over the ocean.
- ➢ World famous Merry-Go-Round with thousands of lights glittering.

---

## Outline of the Aquarium & Amusement Park

---

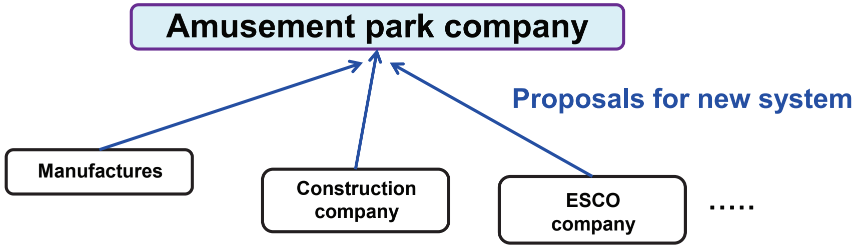
## 4 WANTS in the Company

1. Cut energy cost
2. Improve the efficiency of maintenance and operation of facilities
3. Promote further energy savings and environmental measures
4. Asset-light business operation by reducing investments

**Two major backgrounds in Japan**

- ✓ Increasing interests in energy savings by the law concerning the Rational Use of Energy.
- ✓ Increasing interests in $CO_2$ emissions reduction.

# Toward the Realization of 4 WANTS



- Several companies proposed new system.
- Amusement park company itself analyzed and examined each proposal for more than a year.
- In the process of examination, the responsible person was appointed by the company played an important role on;
  - ➢ Providing suggestion to management from technical angle.
  - ➢ Verification of various figures indicated in proposals such as consumption of electric power, city gas, water.

---

# Key Point 1 for Realization of 4 WANTS

1. Reduction of maintenance fee for co-generation
2. High efficiency system which contributes to energy savings and $CO_2$ reductions
3. Simple system toward the realization of efficient operation

⬇

**Stop operation of co-gen (2 units) and introduction of high efficiency air-source heat pumps** instead.

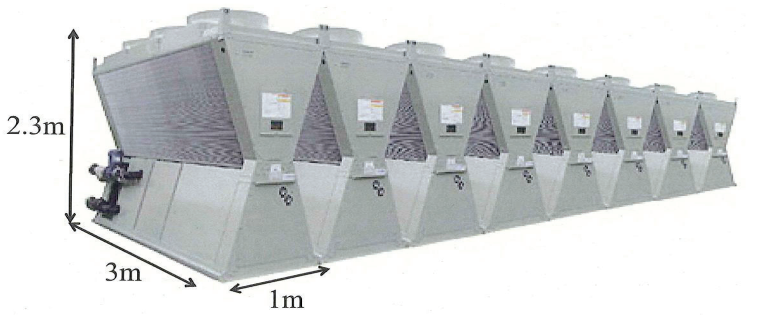
- ➢ In case of air-source HPs, cooling water necessary in the existing system will not become necessary by air-source HPs.

---

# Key Point 2 for Realization of 4 WANTS

## Adoption of high efficiency heat pumps

- ➢ The industry's first large-scale heat pumps with high efficiency.
- ➢ This heat pump won the Minister of Economy, Trade and Industry Prize at the Energy Conservation Awards.



Picture of high efficiency heat pumps

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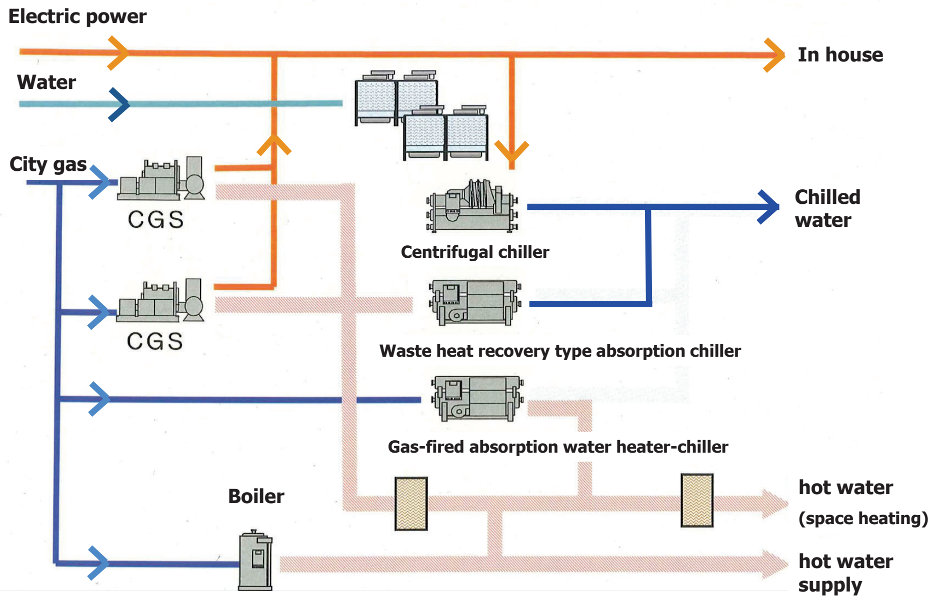
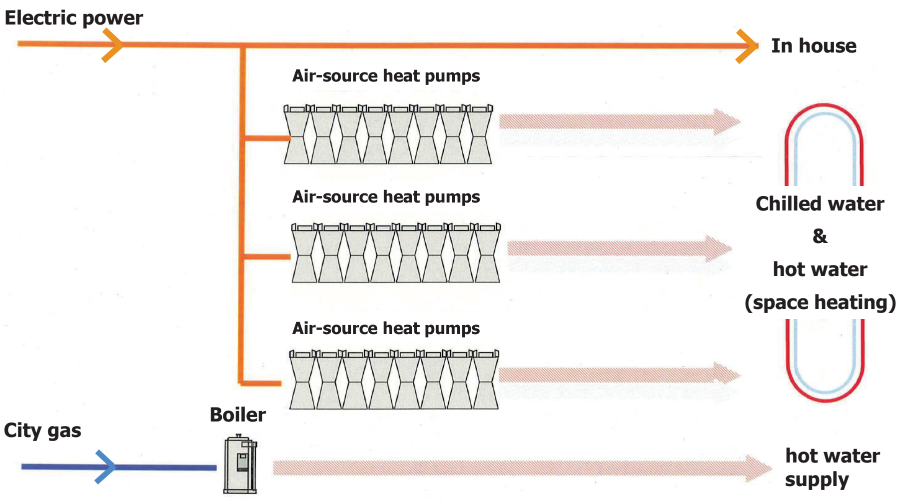
# System Comparison – existing system -



# System Comparison – renewed system -



New system is more simple.
⇒ Needs no water and less space.

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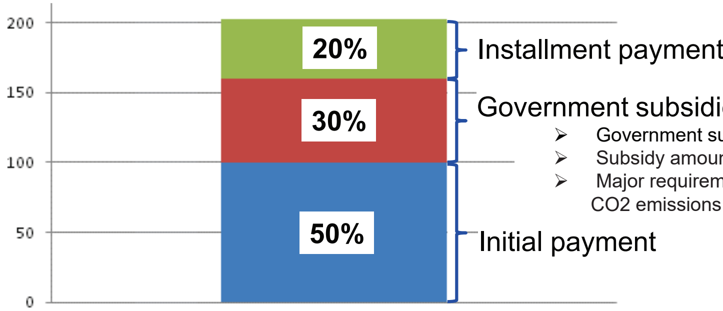
# Construction Cost



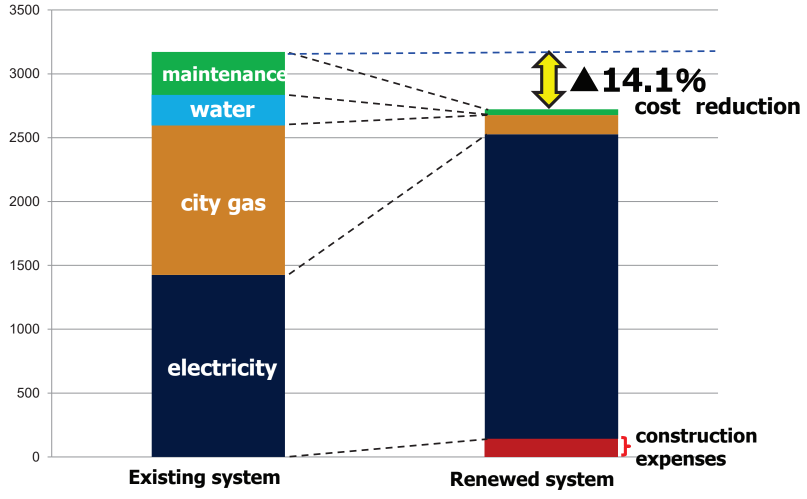
- Government subsidy; Ministry of the Environment
- Subsidy amount; 1/3 (up to 1.4 million USD)
- Major requirements; 300 t-CO2/year reductions of CO2 emissions.

**Composition on payment for construction cost**

- 10% out of total cost are interests.
- Term of installment payment is 15 yrs.

---

# Comparison of Life Cycle Cost



**Comparison of LCC (15yrs)**

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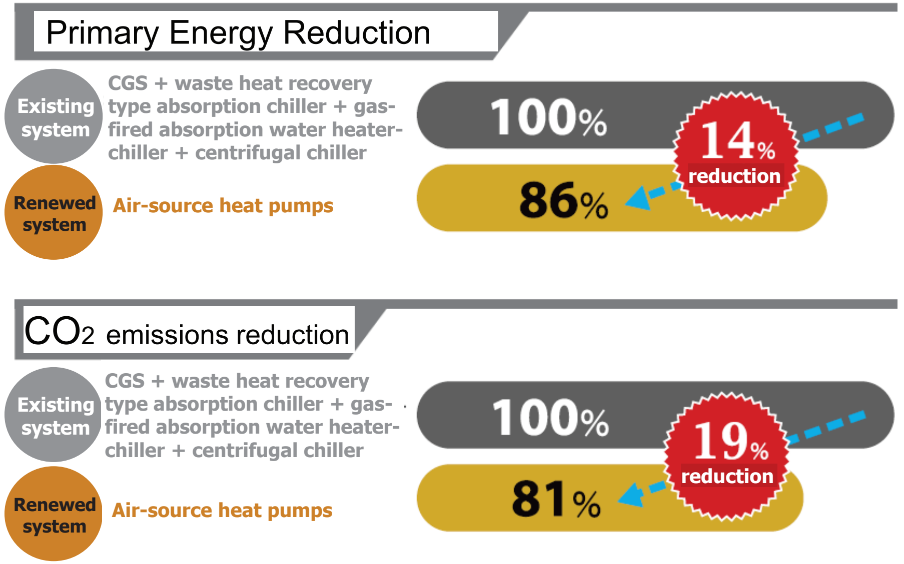
# Primary Energy & $CO_2$ Emissions Reduction



## Primary Energy Reduction

**Existing system** CGS + waste heat recovery type absorption chiller + gas-fired absorption water heater-chiller + centrifugal chiller

**Renewed system** Air-source heat pumps

## $CO_2$ emissions reduction

**Existing system** CGS + waste heat recovery type absorption chiller + gas-fired absorption water heater-chiller + centrifugal chiller

**Renewed system** Air-source heat pumps

# Through 2 Years Operation

- ■ **Operational cost reduction**

➡ **Approx. 70 million JPY (0.5 million USD) was reduced annually.**

⬇

**Construction cost was already recovered within 2 years.**

- ■ **$CO_2$ emissions reductions**

  - ➢ **Obligated amounts of reductions by MOE**
  **= Approx. 600 t-$CO_2$/year**

➡ **Approx. 1,800 t-$CO_2$ was reduced within 2 years.**

⬇

**$CO_2$ emissions clears the designated level by MOE.**

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**Thank you very much for your kind attention !**

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The Technical Cooperation Project to Promote Energy Efficiency in Caribbean Countries

# Market Study of EV

February 2023

Nippon Koei Co., Ltd.
PADECO Co., Ltd.

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# Today's Agenda

- ✓ Market analysis of EVs
- ✓ Market analysis of storage batteries
- ✓ Introduction of new technologies

# 1. Different Types of EVs

---

## Different Types of EVs

- Different types of EVs

| | Automobile |
|---|---|
| With battery for drive | **BEV: Battery-powered vehicle**<br>HV: Hybrid vehicle<br>PHEV: Plug-in hybrid vehicle |
| No battery for drive | FCV: Fuel-cell vehicle (hydrogen vehicle)<br>Solar car<br>Trolley bus |

Ref. UZABASE

**ICV:** Internal Combustion Engine Vehicle

---

## Different Types of EVs

- Pros & Cons of EVs

ICV: Internal Combustion Engine Vehicle
BEV: Battery-powered vehicle
PHEV: Plug-in hybrid vehicle
FCV: Fuel-cell vehicle (hydrogen vehicle)

| | Pros | Cons |
|---|---|---|
| ICV  | • Cheaper to buy<br>• Longer driving range<br>• Wider cabin space<br>• Good infrastructure (many gas stations)<br>• Short refueling time | • Higher CO2 emission<br>• Higher running cost |
| BEV  | • No CO2 emission<br>• Cheap running cost<br>• Can be charged at home | • More expensive than ICV<br>• Shorter driving range<br>• Limited cabin space<br>• Limited number of charging stations<br>• Longer charging time (rapid charge takes 30 mins) |

Ref. UZABASE

---

## Different Types of EVs

- Pros & Cons of EV

ICV: Internal Combustion Engine Vehicle
BEV: Battery-powered vehicle
PHEV: Plug-in hybrid vehicle
FCV: Fuel-cell vehicle (hydrogen vehicle)

| | Pros | Cons |
|---|---|---|
| HV/PHEV  | • Longer driving range<br>• Lower CO2 emission<br>• Cheaper running cost than ICV<br>• Good infrastructure (many gas stations)<br>• Short refueling time<br>• PHEV can be recharged at home | • More expensive to buy (because there are 2 driving systems of ICV and BEV)<br>• Limited cabin space |
| FCV  | • Longer driving range<br>• No CO2 emission<br>• Wider cabin space<br>• Short filling time (takes 5 mins) | • Limited number of hydrogen filling stations<br>• Limited car models |

Ref. UZABASE, ENEOS

# 2. Market Analysis of EVs & Storage Batteries

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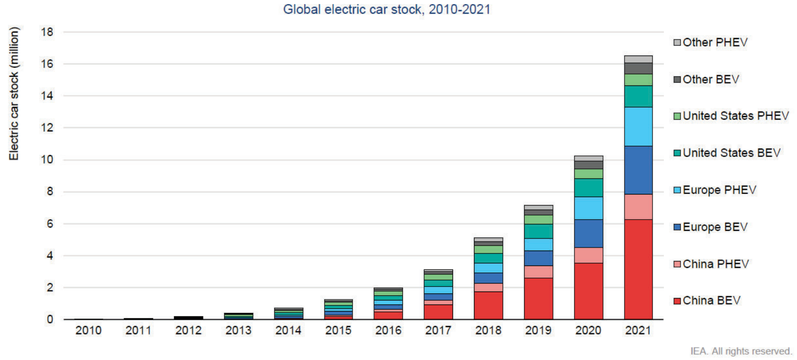
# Market Analysis of EVs

- Market size of EVs

The EV market is rapidly growing, and sales of EVs were 6.6 million units in the world in 2021. There were over 16.5 million EVs on the road. EVs are 10% of all vehicles.



Notes: BEV = battery electric vehicle; PHEV = plug-in hybrid electric vehicle. Electric car stock in this figure refers to passenger light-duty vehicles. "Other" includes Australia, Brazil, Canada, Chile, India, Japan, Korea, Malaysia, Mexico, New Zealand, South Africa and Thailand. Europe in this figure includes the EU27, Norway, Iceland, Switzerland and United Kingdom.
Sources: IEA analysis based on country submissions, complemented by ACEA; CAAM; EAFO; EV Volumes; Marklines.

Ref. Global EV Outlook 2022, IEA

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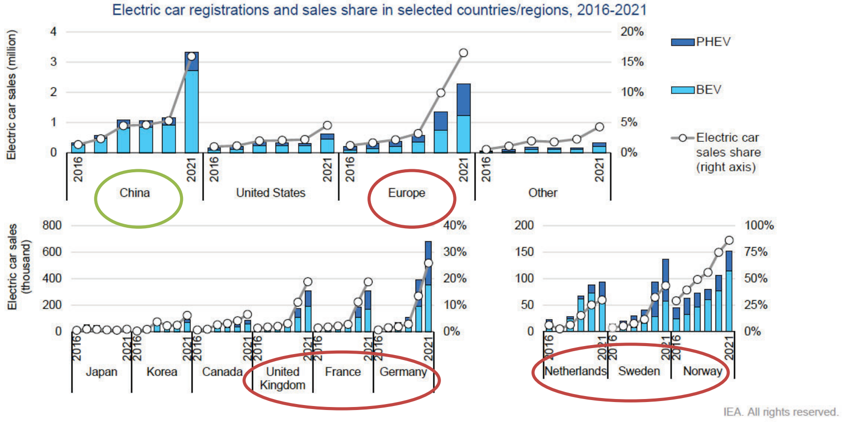
# Market Analysis of EVs

- Market size by countries/regions

China and Europe are the top 2 growing markets of EV sales.



Notes: The countries/regions shown are the world's largest EV markets and are ordered by size of the total car market (i.e. all powertrains) in the upper half of the figure and by sales share of electric cars in the lower charts. Acronyms and geographic groupings are defined in the Notes of the previous figure. Regional EV registration data can be interactively explored via the Global EV Data Explorer.
Sources: IEA analysis based on country submissions, complemented by ACEA; CAAM; EAFO; EV Volumes; Marklines.

Ref. Global EV Outlook 2022, IEA

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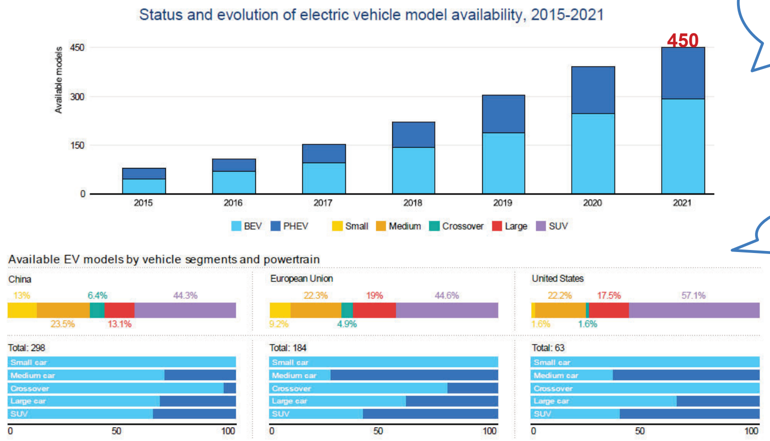
# Market Analysis of EVs

- Increase of EV models



70% was BEV, 30% was PHEV in the road in 2021

SUVs were the most popular

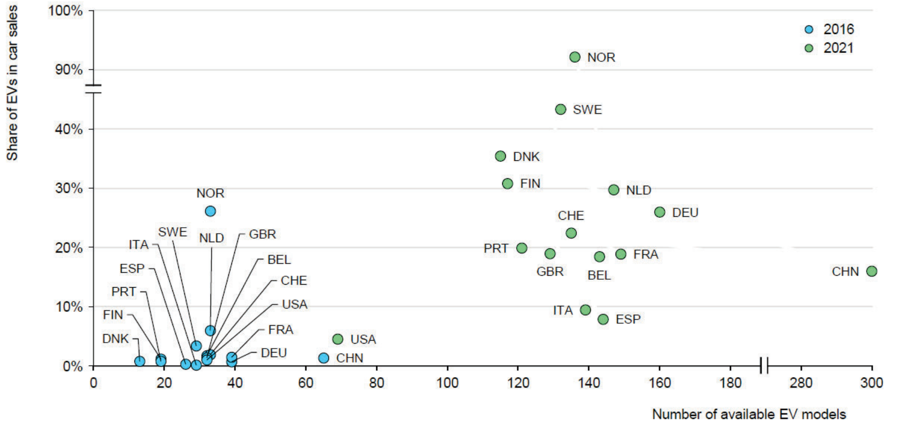
Notes: BEV = battery electric vehicle; PHEV = plug-in hybrid vehicle. Small cars include A and B segments. Medium cars include C and D segments. Crossovers are a type of sports utility vehicle (SUV) built on a passenger car platform. Large cars include E and F segments and multi-purpose vehicles. Vehicle models do not include the various trim levels.
Sources: IEA analysis based on EV Volumes and Marklines.

Ref. Global EV Outlook 2022, IEA

# Market Analysis of EVs

- Increase of EV models and sales

Number of available EV models relative to EV sales share in selected countries, 2016 and 2021



IEA. All rights reserved.

Notes: EVs = BEVs and PHEVs. Vehicle models do not include the various trim levels.
Sources: IEA analysis based on EV Volumes.

Ref. Global EV Outlook 2022, IEA

---

# Market Analysis of EVs

- Future EV market size

- The total sales of EVs is expected to be 18 million units in 2025 and over 30 millions in 2030.
- ICV will be 13% of new car sales in 2025, and over 20% in 2030. EV will be the main passenger car in the world.

| | 2021 | 2025 | 2030 |
|---|---|---|---|
| EV | 16.5 mil units | 18 mil units | 30 mil units |

Ref. Global EV Outlook 2022, IEA

---

# Market Analysis of EVs

- Policy and Regulation

Automobile regulation of each country, subsidy and policy for EVs

| Country | Regulation | EV Subsidy & Policy |
|---|---|---|
| China | Introduce NEV regulation to produce and import 10% of NEV (EV, PHEV, FCV) out of 30,000 units of yearly production and import vehicle. | Subsidy for BEV, PHEV<br>No tax for purchasing BEV, PHEV<br>Mitigation measure of issuing number plate of BEV<br>Increase number of NEV sales to 20% by 2025. |
| EU | The "Green Deal Policy" launched by the European Union in 2019 aims to reduce carbon emissions by at least 50% by 2030 and achieve carbon neutrality targets by 2050.<br>● Germany<br>Stop selling ICV (Internal Combustion Engine Vehicle) by 2030.<br>● France<br>Stop selling ICV (Internal Combustion Engine Vehicle) by 2040. | ● Germany<br>Subsidy for BEV, PHEV<br>10yrs preferential treatment of car tax (5yrs no tax and 5yrs 50% tax reduction)<br>● France<br>Subsidy for BEV, PHEV<br>Penalty in case CO2 emission is over 120g/km |
| US | Introduced ZEV regulation to promote sales of new generation vehicle to reduce CO2 emission | Subsidy for BEV, PHEV |
| Japan | Reach 30% of EV sales by 2030<br>Set goal of fuel consumption of new car to 25.4km/l by 2030 (19.2km/l in 2016). | Subsidy for BEV, PHEV<br>No tax for purchasing BEV<br>Preferential treatment of car tax by regional government |

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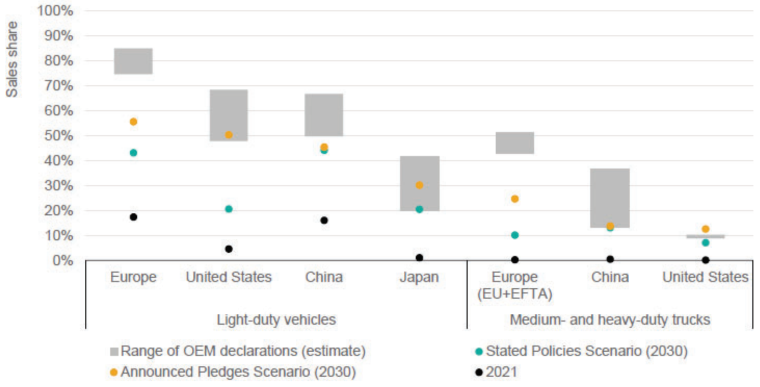
# Market Analysis of EVs

- Policy and Regulation

**Zero emissions vehicle announcements by automakers are more ambitious than policy targets**

OEM targets and registrations in the Stated Policies and Announced Pledges scenarios, 2030



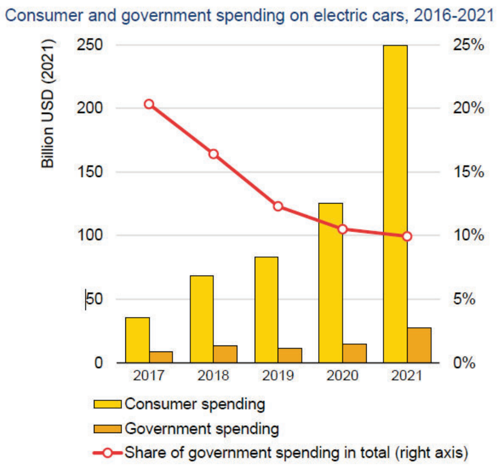
IEA. All rights reserved.

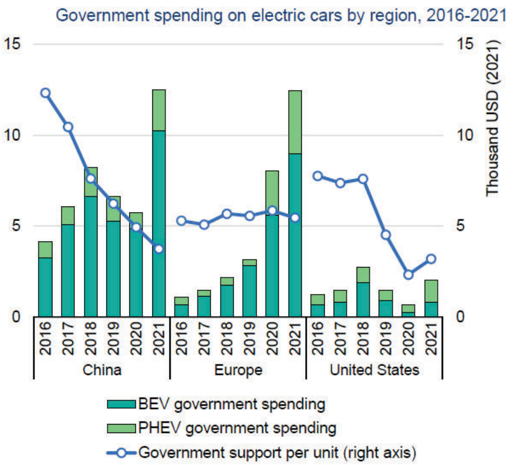
Ref. Global EV Outlook 2022, IEA

# Market Analysis of EVs

- Subsidies

Chinese and European governments spent more money on EVs.
Sales price of EVs remain cheaper in China.


Consumer and government spending on electric cars, 2016-2021


Government spending on electric cars by region, 2016-2021

IEA. All rights reserved.

Ref. Global EV Outlook 2022, IEA

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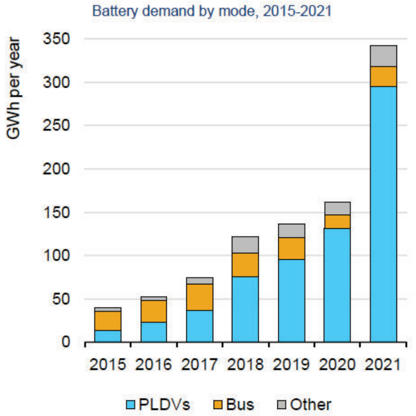
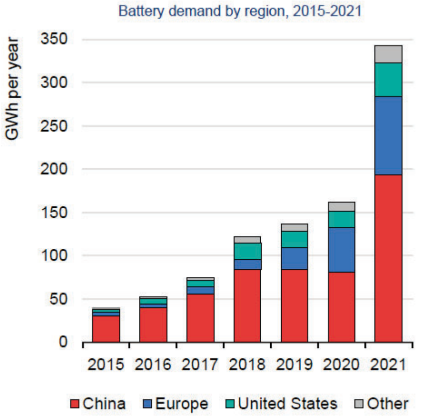
# Market Analysis of EV Batteries

- Increase market demand of EV batteries


Battery demand by mode, 2015-2021


Battery demand by region, 2015-2021

IEA. All rights reserved.

Notes: GWh = gigawatt-hours; PLDVs = passenger light-duty vehicles; other includes medium- and heavy-duty trucks and two/three-wheelers. This analysis does not include conventional hybrid vehicles.
Sources: IEA analysis based on EV Volumes.

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# Market Analysis of EV Batteries

- Market size of EV batteries

- The EV battery market is expected to be worth 218.47 billion USD by 2027, from 34.08 billion USD in 2020 (CAGR of 31.56%).
- The lithium-ion battery segment is expected to dominate the market.
- There are technological advancements of the lithium-ion battery market and reduced the overall cost of lithium-ion battery production.
- Asia Pacific is expected significant growth in the EV battery market due to increasing demand from China, India, Japan, and other countries.
- The increasing share of EVs and rising sales volumes are also driving demand for lithium-ion battery in the U.S. and Europe("Green Deal Policy").

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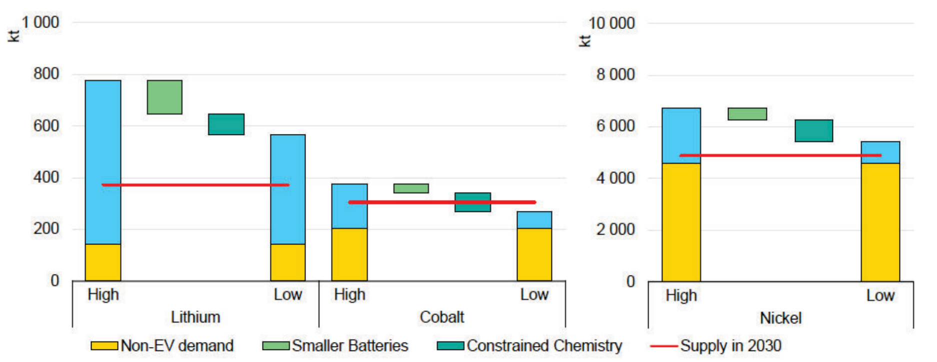
# Market Analysis of EV Batteries

- Increase market demand of EV batteries

**Demand side measures such as limiting the growth of battery size can help bridge the gap**

Measures to lower metal demand in 2030 in the Net Zero Scenario



IEA. All rights reserved.

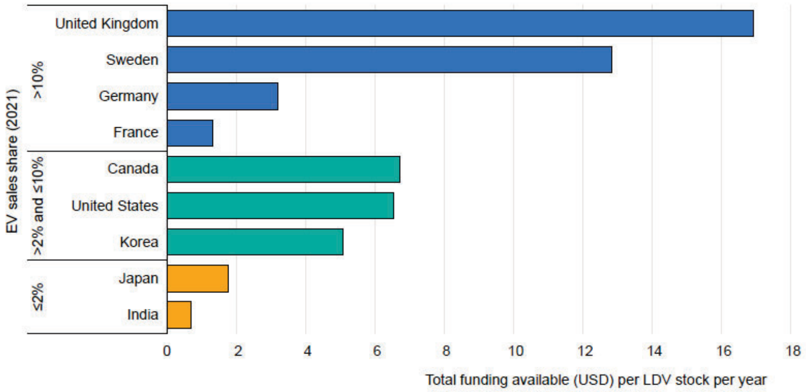
Notes: NZE = Net Zero Emissions by 2050 Scenario; STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario.
Sources: IEA analysis based on Benchmark Mineral Intelligence for supply capacity.

# Charging Infrastructure

- Increase number of EV charging stations

China and Europe boast the largest EV charging networks in the world. Governments provide subsidies for installation of charging stations.

Government funding for publicly available charging infastructure normalised by LDV stock and funding period, 2021



IEA. All rights reserved.

Ref. Global EV Outlook 2022, IEA

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## 3. Analysis of EV Markers

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# Analysis of EV Markers

- EV auto makers

Ref) UZABASE

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# Analysis of EV Markers

- EV auto makers

Companies included in the EV, battery and top-ten automaker indices

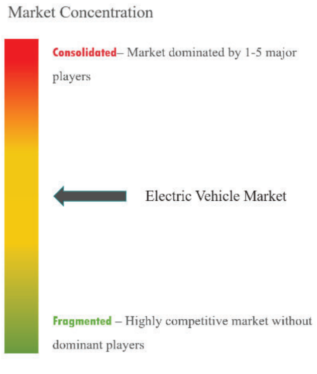
| EV index | Battery index | Top-ten automaker index |
|---|---|---|
| • Tesla<br>• Lucid Group<br>• Rivian Automotive<br>• NIO<br>• Li Auto<br>• XPeng<br>• Fisker<br>• Nikola<br>• Arrival<br>• Proterra<br>• Lion Electric<br>• Hyzon Motors<br>• Canoo<br>• Hyliion Holdings Corp | • LG Energy Solution<br>• BYD<br>• Contemporary Amperex Technology Ltd<br>• Samsung SDI<br>• Gotion High-Tech<br>• Eve Energy Co<br>• Farasis Energy Gan Zhou | • Toyota Motor<br>• Volkswagen<br>• Kia<br>• General Motors<br>• Ford Motor<br>• Nissan Motor<br>• Stellantis<br>• Renault<br>• Hyundai Motor<br>• Mercedes-Benz Group |

# Analysis of EV Markers

- Main players of EV makers

Main players

1. Tesla
2. BYD Company Ltd
3. Mercedes-Benz Group
4. Volkswagen
5. Toyota



Source: Mordor Intelligence

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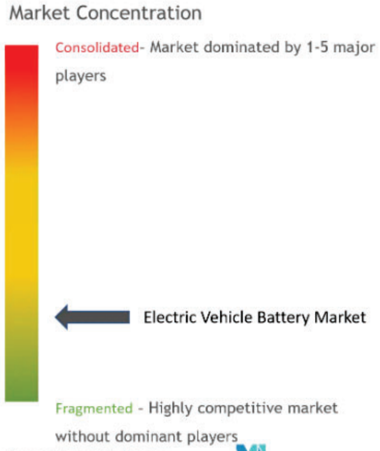
# Analysis of EV Maker

- EV storage battery makers

Main players

1. Panasonic Corporation
2. Contemporary Amperex Technology Co Ltd
3. Samsung SDI Co. Ltd.
4. BYD Company Limited
5. LG Energy Solution Ltd



Source: Mordor Intelligence

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## 4. Case Study

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# Case Study (Japan)

- Cost analysis of each vehicles in Japan

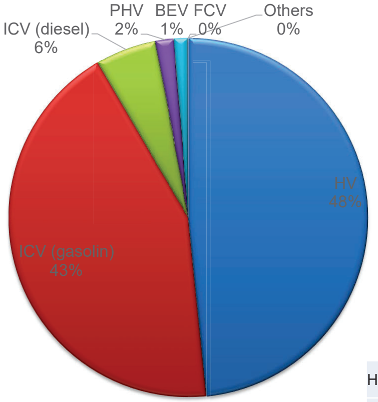
BEV is the lowest running cost. Shorter driving range and longer charging time are challenges.

| | Car Type | Sales Price | Pay on a spot | Driving range | Distance that can be traveled for 1,000 yen |
|---|---|---|---|---|---|
| BEV | Tesla Model S  | 12,000,000 yen | 600 yen | 650 km | 923km |
| PHEV | Toyota SIENTA (PHEV)  | 2,910,000 yen | 6,720 yen | 1,142 km | 169 km |
| ICV | Toyota SIENTA (ICV) | 2,560,000 yen | 6,560 yen | 850 km | 129 km |
| FCV | Toyota MIRAI  | 7,100,000 yen | 6,720 yen | 850 km | 126 km |

Ref. Tesla Japan, Toyota,
https://car.rakuten.co.jp/magazine/articles/2022/carlife05/

# Case Study (Japan)

- Car Sales by Fuel Type in Japan (January to October 2022)



| HV | ICV (gasolin) | ICV (diesel) | PHV | BEV | FCV | Others | Total |
|---|---|---|---|---|---|---|---|
| 883432 | 786897 | 100418 | 29738 | 22861 | 810 | 68 | 1824224 |
| 48.43% | 43.14% | 5.50% | 1.63% | 1.25% | 0.04% | 0% | 100% |

Ref: Japan Automobile Dealer Association

---

# Case Study (Japan)

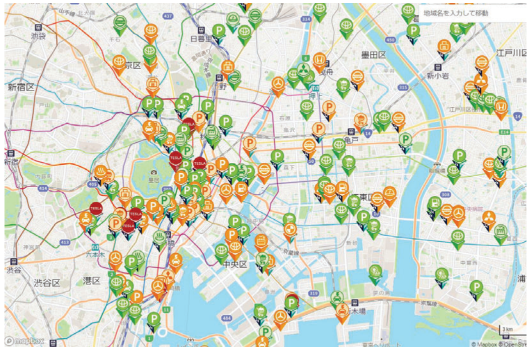
- Comparison of infrastructure in Japan

| | |
|---|---|
| **Fuel stations:** | **28,500** |
| **EV charging stations:** | **21,000** |
| **FCV hydrogen filling stations:** | **161** |

**(as of Nov. 2022)**

| | |
|---|---|
| ICV: | Internal Combustion Engine Vehicle |
| BEV: | Battery-powered vehicle |
| FCV: | Fuel-cell vehicle (hydrogen vehicle) |

- Increase no. of EV charging stations



Location of EV charging stations in central Tokyo

- Limited no. of hydrogen filling stations

Location of FCV hydrogen stations in central Tokyo (5 stations only)

Ref. GoGoEV, NeV, ENEOS, Toyota Mirai

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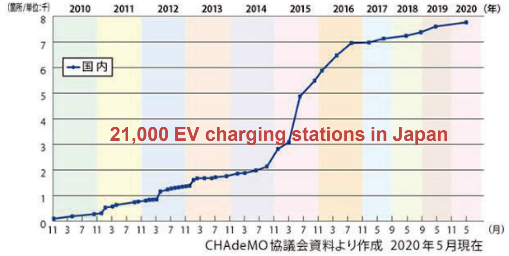
# Case Study (Japan)

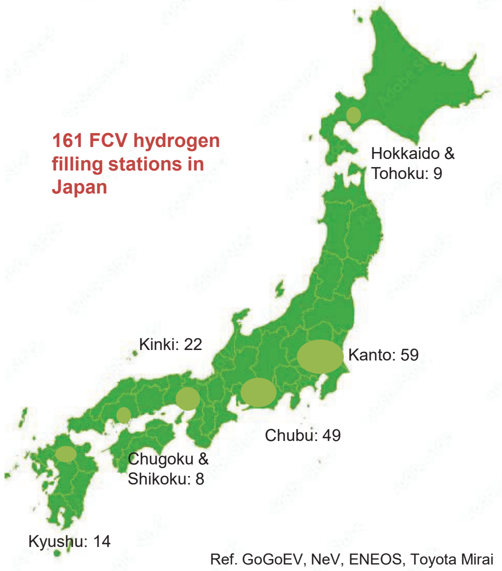
- Increase no. of EV charging stations in Japan



**21,000 EV charging stations in Japan**

- Limited no. of hydrogen filling stations in Japan

**161 FCV hydrogen filling stations in Japan**



Ref. GoGoEV, NeV, ENEOS, Toyota Mirai

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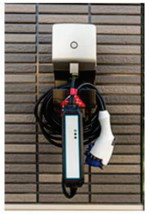
# Case Study (Japan)

- Different types of EV stations



- Cost of installation of charging station in Japan

Rapid charging station: 21,500-36,000USD
Normal charging station: 1,500 -2,900USD

- Plan of EV stations for general customers in Japan

| Plan to use EV charging station | Rapid charge plan | Normal Charge plan | Combine plan |
|---|---|---|---|
| Charging machine | Rapid charger | Normal charger | Both |
| Monthly plan | 28.5 USD/mo | 10 USD/mo | 31.5 USD/mo |
| Pay on a spot | 0.1 USD/min | 0.02 USD/min | 0.1 USD/min<br>0.02 USD/min |
| Registration charge | | 10 USD | |

Ref. Guliver, GoGoEV, NeV, ENEOS

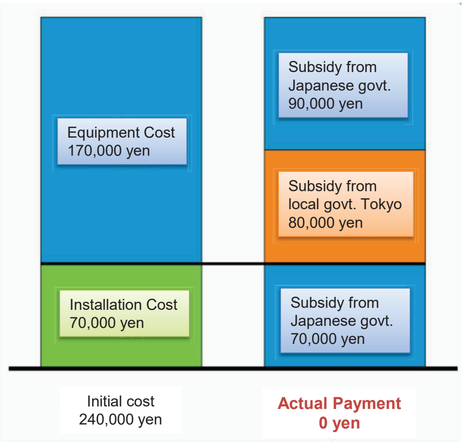
# Case Study (Japan)

- Household EV charger

◆ Installation of household charging plugs:
JPY 40,000-120,000 (USD 270-820)

◆ Running cost: EV < ICV
*When you drive 10,000km with EV (Nissan Leaf) and ICV (Toyota Prius), running cost of Nissan Leaf is JPY 30,000 (USD 200) cheaper than Toyota Prius.*

- Subsidy in Japan
Details can be access from
http://www.cev-pc.or.jp/english/cev-subsidy.html



**Example of subsidies for household EV charger**

Ref. ENECHANGE

---

# Case Study (Japan)

- Different types of FCV hydrogen filling stations

Consumer price: 8-8.7 USD/Litter

@Hydrogen filling station

@ Convenience store

@ Gas station

@ Compressed Natural gas station

@ Liquefied petroleum gas station

@ Airport

- Cost of installation of hydrogen filling station in Japan

| | |
|---|---|
| Installation : | 500 million yen (3.6 million USD) |
| Subsidy of govt : | 350 million yen (2.5 million USD) |
| Initial cost: | 150 million yen (1.1 million USD) |

Ref.
https://www.jhym.co.jp/station/
https://www.etic.co.jp/feature/hydrogen-station1118//

---

# Case Study (Japan)

- Japanese EV makers analysis

| Name | Area | Analysis |
|---|---|---|
| Toyota | Automobile | • Focused on PHEV, FCV & BEV. By 2025, Toyota will introduce EV (PHEV, BEV, FCV) in all models.<br>• BEV for personal mobility (car for 1-2 passenger use), connected EV & MaaS (Mobility as a Service).<br>• Creating EV platform called 'e-TNGA' with Subaru for efficiency of EV development. |
| Nissan | Automobile | • Nissan set goal of EV & e-POWER sales ratio as 30% by 2022.<br>• Nissan developed a simple Hybrid system called 'e-POWER', which uses engine only for power creation. E-POWER can realize shorter charging time and cheap selling price.<br>• Nissan also develops small EVs. |
| Panasonic | Electronics | • Operating EV battery factory 'GIGA factory' with Tesla.<br>• In April 2022, Panasonic established 'Prime Planet Energy & Solutions' with Toyota to produce EV battery.<br>• Panasonic launched EV with self-driving system called Spacy. |
| Prime Earth EV energy | Battery | • Toyota and Panasonic established together in 1996 to produce EV battery.<br>• Increasing production capacity based on Toyota's plan.<br>• A factory for HEV battery (nickel metal hydride battery) was established in 2021. |

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# Case Study (Japan)

- Each Japanese makers analysis

| Name | Area | Analysis |
|---|---|---|
| Prime Planet Energy & Solutions | Battery | • EV battery maker for Lithium-ion battery funded by Toyota (51%) and Panasonic (49%).<br>• Developed EV battery for all-solid battery and started operation in April 2020.<br>• Provide batteries not only for Toyota but also for other makers. |
| Denso | Electronic parts for automobile | • Toyota was agreed to business transfer and Denso of main electronic parts business (such as inverter, motor, semiconductor) to increase competitive advantage.<br>• To develop auto driving car, Denso strength cooperation with Toyota. |
| Aishin Seiki | Powertrain | • For development of auto driving car, management integration with subsidiary named Aishin AW in April 2021, and changed company name to Aishin. Mass production of EV motor parts started in 2020 and supply the parts to Toyota EV production in China. |
| Hitachi Automotive Systems | Electronic parts for automobile | • Provide EV motor to GM (General Motors), Inverter to GM, Ford Motors, Mercedes, BMW etc.<br>• In October 2019, management integration with Honda suppliers (Kehin, Nisshin Kogyo, and Showa) in purpose to become a maga player in the field of auto powertrain, chassis, self-drive, and ADAS (Advanced driver-assistance systems). |

# Case Study (Japan)

- Each Japanese makers analysis

| Name | Area | Analysis |
|---|---|---|
| Meidensha | Heavy power (Power equipment) | • Provide EV motor and inverter to Mitsubishi auto factory.<br>• Invested 7 billion yen to equipment facility at 3 factories in 2018.<br>• Invested to subsidiary Meidensha for EV production in China in 2019.<br>• Established new factory development for motor and invertor with investment of 5 billion yen in Feb 2020. |
| NiDec | Motor | • Produce EV motor, and parts of together with motor and inverter.<br>• Order of EV motor was rapidly increased by 2023, decided to expand production lines in Poland and Mexico in addition to a current factory in China. |
| Mitsubishi Electric | Electronics | • Provide inverter to Honda, Suzuki and Daimler.<br>• Develop V2H (Vehicle to Home) system, that utilize EV battery for household power supply. |
| TDK Automotive Technologies | Inverter | • EV inverter maker funded by TDK (75%) and Toshiba (25%).<br>• Provide inverter to Volkswagen and Ford Motors etc. |

Ref. SPEEDA

---

# Case Study (Barbados)

- EV Dealers in Barbados

- Megapower Barbados
https://www.megapower365.com/

- Private vehicles
MG
NISSAN
JAGUAR

- Commercial vehicles
BYD (bus, van, trucks etc.)

- Courtesy Garage Barbados
https://www.courtesygarage.com/showroom/

- Private vehicles
Hyundai (EV and HV)

NISSAN ARIYA (BEV)
@Megapower
150,000 BBD

NISSAN X-TRAIL (ICV)
@COURTESY
117,995 BBD

NISSAN JUKE 2015 (ICV)
@qv motors
55,900 BBD

---

# Case Study (Barbados)

- Cost of charging station

- 0.15 kWh/km to 0.2 kWh/km
- About 2,200 to 2,900 kWh of electricity per year
- About $1,300 to $1,700 per year in electricity based on our residential tariff

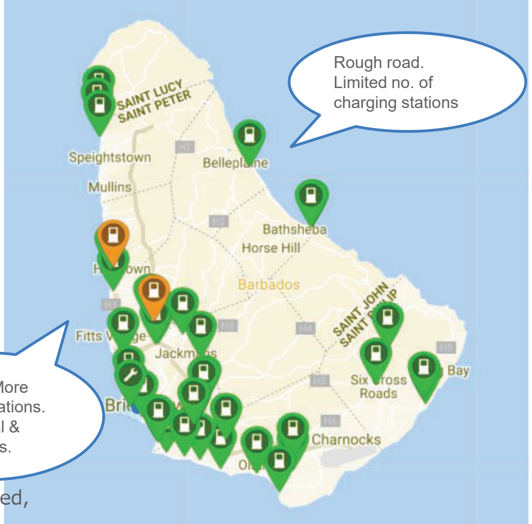
- Megapower rate

| | |
|---|---|
| Top-up charger (Garo) | $1.5/kWh |
| Medium & fast chargers (DBT) | $1.75/kWh |
| All you can charge | $600/month |
| All you can charge (non-megapower Evs) | $1,000/month |

- Charging speed
Ultra charger 100kW: 30-45 mins
Rapid charger 25kW: 2-3 hours
Fast charger 7.2kW 10-16 hours

Ref) The Barbados Light & Power Company Limited, Megapower

- Map of EV Charging Station



Rough road. Limited no. of charging stations

Flat road. More charging stations. Commercial & tourist areas.

---

# Case Study (Barbados)

- New Incentives of the Barbados Government

- Government workers who can borrow up to $100,000 interest-free for purchase an electric or hybrid vehicle (it was $50 000 for vehicle purchase)
- Tax and VAT holiday on electric vehicles for 24 from April 1, 2022. Also, 10% import duty for the next two years on the purchase of electric vehicles".

Ref) Electric cars tax breaks, but new alternate levy
https://barbadostoday.bb/2022/03/15/electric-cars-tax-breaks-but-new-alternate-levy/

# 5. Introduction of New Technology

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# Introduction of New Technology

■Toyota's Woven City: a Prototype City of the Future

YouTube Video:
https://www.youtube.com/watch?v=ng3X39lenvg

Toyota has revealed plans to build a prototype "city" of the future on a 175-acre site at the base of Mt. Fuji in Japan.

Called the Woven City, it will be a full connected ecosystem powered by hydrogen fuel cells. Envisioned as a "living laboratory," the Woven City will serve as a home to full-time residents and researchers who will be able to test and develop technologies such as autonomy, robotics, personal mobility, smart homes and artificial ntelligence in a real-world environment.

Read more about Toyota's Woven C
https://blog.toyota.co.uk/toyota-wove...

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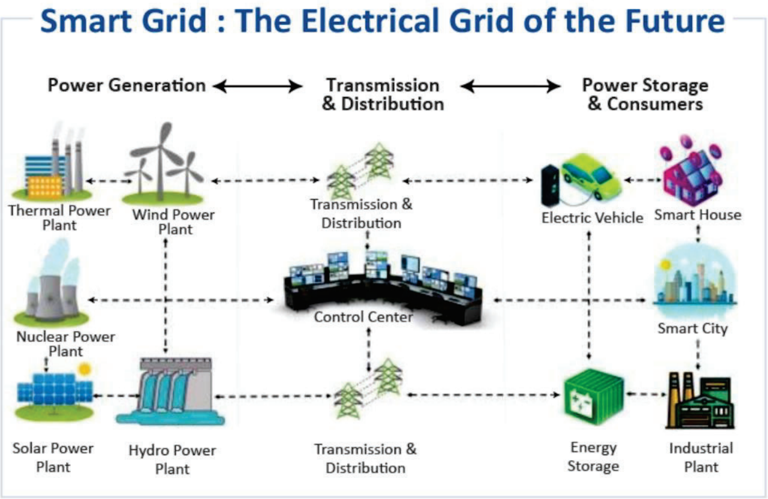
# Introduction of New Technology

Smart Grid is the integration of our existing Electrical Grid with **2-way communication** and **digital sensing technology** in order to enhance the capabilities of the current grid and make it more secure, reliable, efficient, and self-sufficient.



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# Introduction of New Technology

■Wireless Transmission

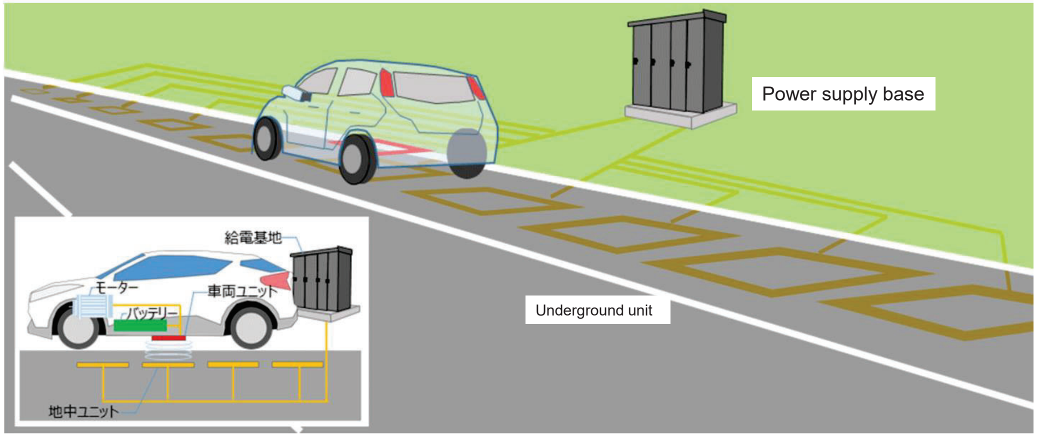


Image of wireless charging of EV

Ref) https://www.toyota.co.jp/jpn/tech/partner_robot/news/202112_01.html

# Introduction of New Technology

Experiment of PV and wireless charging system

https://media.dglab.com/2022/05/02-dwpt-01/

---

# Introduction of New Technology

■Wireless Transmission

Image of wireless transmission to a large flying object for use in a communication network

Image of wireless transmission to remote islands
*There is a plan to build a PV generation facility in space for wireless transmission.

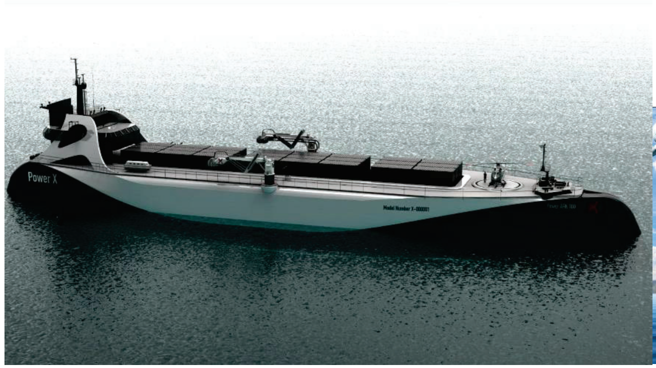
Ref. https://www.ieice.org/~cs-edit/magazine/ieice/spsec/Bplus57_sp.pdf

---

# Introduction of New Technology

- Electric carrier ship

Power X is an electric carrier ship that stores electricity generated from the ocean in batteries and transports it. Power X Inc. manufactures and operates large storage batteries and deliver clean power generated by offshore wind power stations to around the world.
Conventional power transmission systems using submarine cables are problematic in terms of installation costs (e.g., drilling of the seabed) and environmental impact, but Power X does not require large-scale construction work and has minimal environmental impact.



Ref. Power X, PowerX, Inc. (power-x.jp)

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# Thank you!

Anna Miyaura (Ms.)
JICA Expert of Human Resources Development/Monitoring
Project Consultant @PADECO
[redacted]

# Battery VS Hydrogen Storage

Feb-9, 2023
JET (JICA Expert Team)
Nippon Koei Co., Ltd.
PADECO Co., Ltd.

---

## Contents

- Battery VS Hydrogen Storage
- Characteristics and Cost of Batteries
- Hydrogen Storage Applications and Introduction Example
- An example of the cost of producing electricity with green hydrogen

---

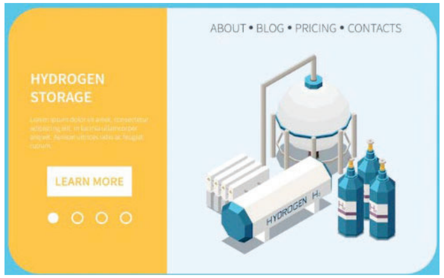
## Prerequisites of contents

**Battery**

Source: Solar Thermal Energy Promotion Inc.

**VS**

**Hydrogen**



Source: Macrovector / Freepik

Please note …

- Technologies related to batteries and hydrogen storage are still developing.
- Presentation material include examples of a sort of study.

---

## Battery VS Hydrogen Storage (1)

What are the strengths of Battey and Hydrogen storage?

| | Power to Gas (Hydrogen) | Lead battery | Lithium-ion battery | NAS battery | Redox flow battery |
|---|---|---|---|---|---|
| Energy Density | 1,290 Wh/L *1 | 40 – 80 Wh/L | 200 – 300 Wh/L | 140 Wh/L | 10 Wh/L |
| Energy Conversion Efficiency | 75 – 80% *2 | 75 – 85% | 95% | 90% | 70% |
| Response Time | 10 seconds *3 | Max. tens of milliseconds | Max. tens of milliseconds | Max. tens of milliseconds | Max. tens of milliseconds |

*1 In case of 70 MPa Compressed H2
*2 Efficiency of water electrolyzer
*3 Response time of water electrolyzer

Source: JET created this table based on the report of CO2 Free Hydrogen Working Group, Ministry of Economic, Technology and Industry, Japan, 2017

# Battery VS Hydrogen Storage (2)

What are the strengths of Battey and Hydrogen storage?

1. Battery

Fast response speed

⇒ Superior ability to follow output fluctuations of renewable energy

2. Hydrogen Storage

High energy density

⇒ Suitable for large-volume and long-term energy storage

Before discussing costs, let’s first look at the different characteristics of each

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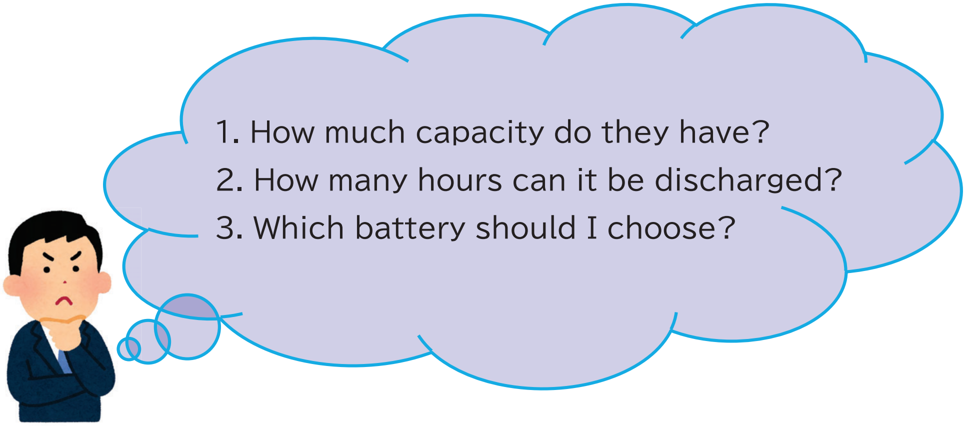
# Batteries Energy Storage System

1. Battery

Fast response speed

⇒ Superior ability to follow output fluctuations of renewable energy



1. How much capacity do they have?
2. How many hours can it be discharged?
3. Which battery should I choose?

---

# Characteristics of Batteries (1)

The characteristics of each typical battery are shown below.

| | Advantage | Disadvantage |
|---|---|---|
| Lead-Acid battery | ➢ Low manufacturing costs result in lower unit power costs<br>➢ Easy maintenance | ☐ Faster deterioration as the number of charge/discharge cycles increases<br>☐ Physically large |
| Lithium-Ion battery | ➢ Compact size and large capacity<br>➢ High-current charging and discharging | ☐ Fire hazard<br>☐ Extreme degradation after around 500 charge-discharge cycles |
| NaS battery | ➢ Durability<br>➢ High energy density<br>➢ Low cost | ☐ Requires about 300 Celsius degrees to operate<br>☐ Handling and disposal of hazardous materials such as sodium and sulfur |
| Redox-flow battery | ➢ Easy to scale up and suitable for large-capacity facilities<br>➢ Long cycle life, can be used for more than 10 years | ☐ Relatively low energy density<br>☐ Long installation period for large facilities<br>☐ Requires a large site |

Source: JET created this table based on the report of CO2 Free Hydrogen Working Group, Ministry of Economic, Technology and Industry, Japan, 2017

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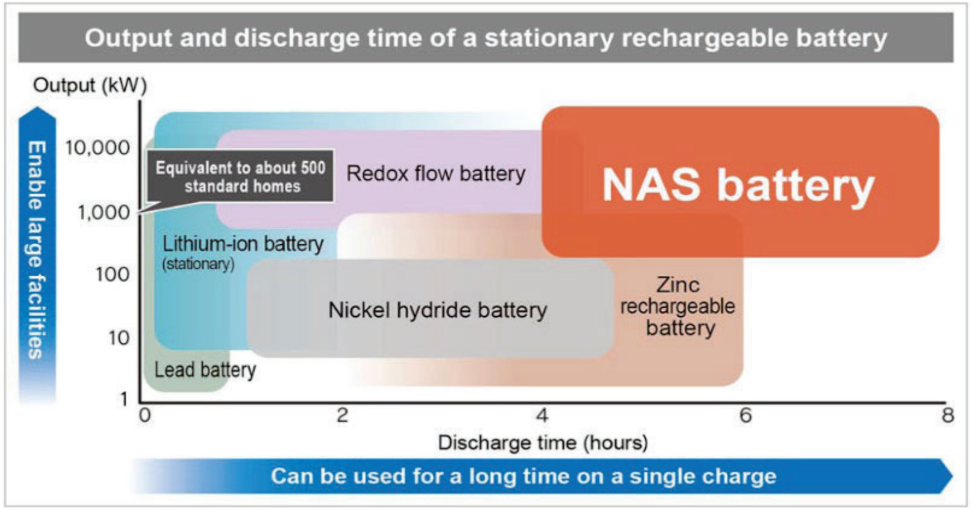
# Characteristics of Batteries (2)

Storage batteries depend on capacity and discharge time.



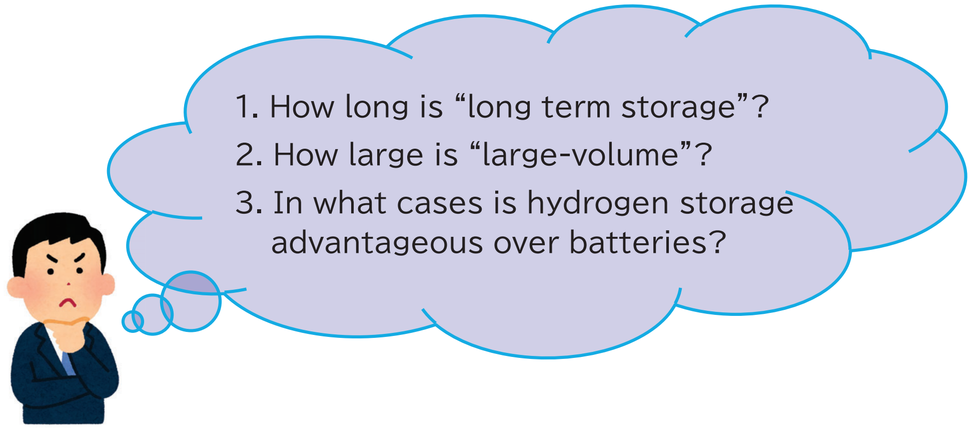
Source: https://www.mynewsdesk.com/ngk-insulators/news/sodium-sulfur-battery-technology-nas-battery-enables-megawatt-hour-energy-storage-realizes-a-stable-supply-of-renewable-energy-410813

# Hydrogen Storage(1)

## 2. Hydrogen Storage

High energy density

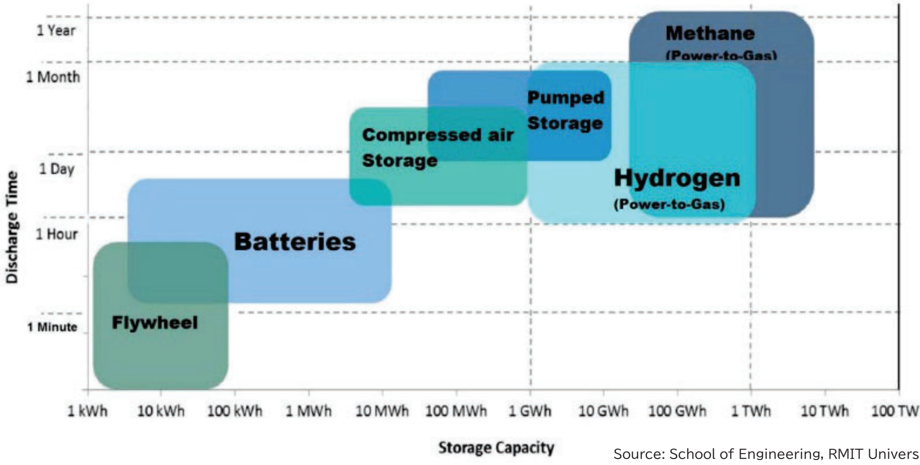
⇒ Suitable for large-volume and long-term energy storage



1. How long is “long term storage”?
2. How large is “large-volume”?
3. In what cases is hydrogen storage advantageous over batteries?

---

# Hydrogen Storage(2)



Source: School of Engineering, RMIT University (2015)

It is difficult to compare the cost of hydrogen with that of batteries. The areas of expertise are totally different.

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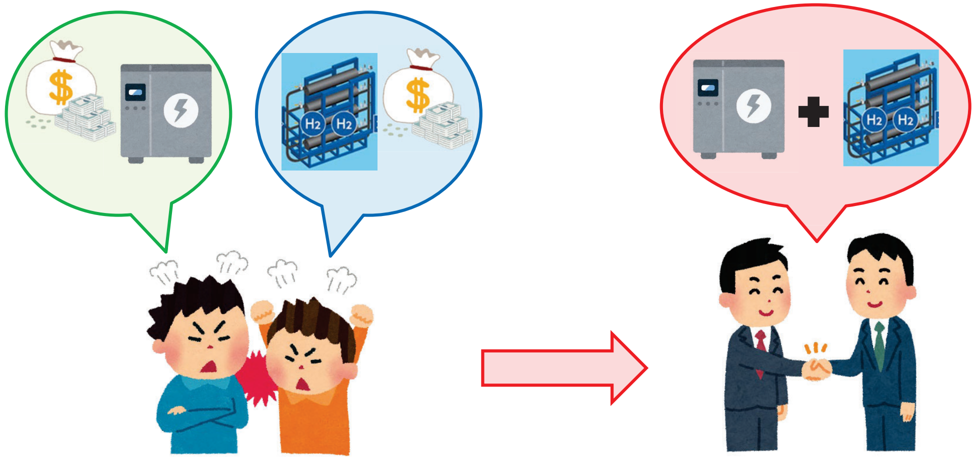
# Battery VS Hydrogen Storage (3)



A combination of batteries and hydrogen storage is effective.

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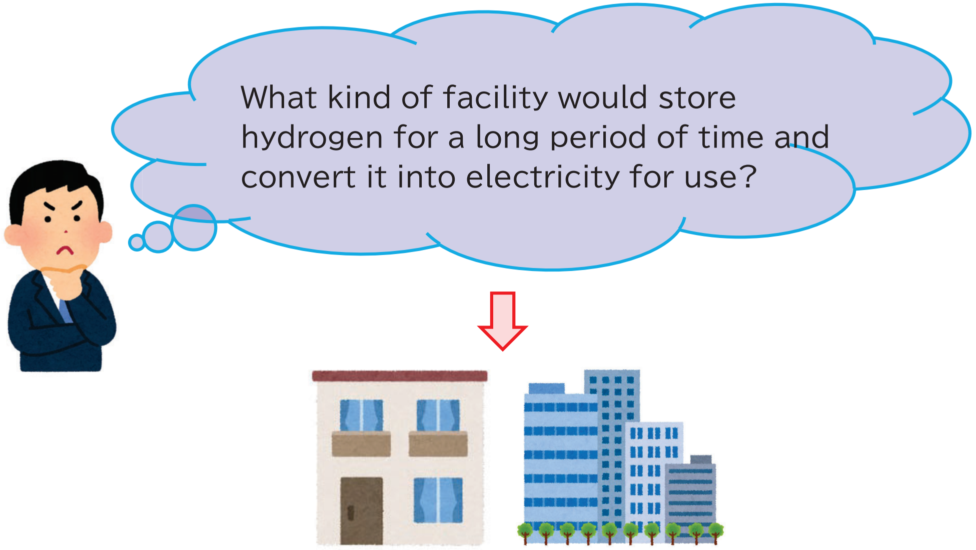
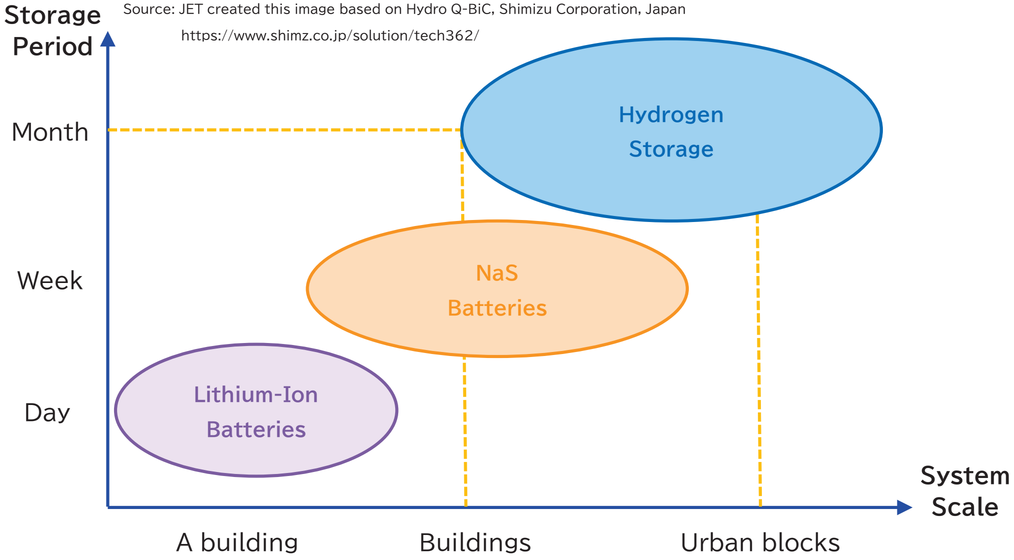
# Case Studies in Japan (1)



What kind of facility would store hydrogen for a long period of time and convert it into electricity for use?

Could be used in a house or building as an example.

# Case Studies in Japan (2)



Source: JET created this image based on Hydro Q-BiC, Shimizu Corporation, Japan
https://www.shimz.co.jp/solution/tech362/

⇨ See a case study of hydrogen storage.

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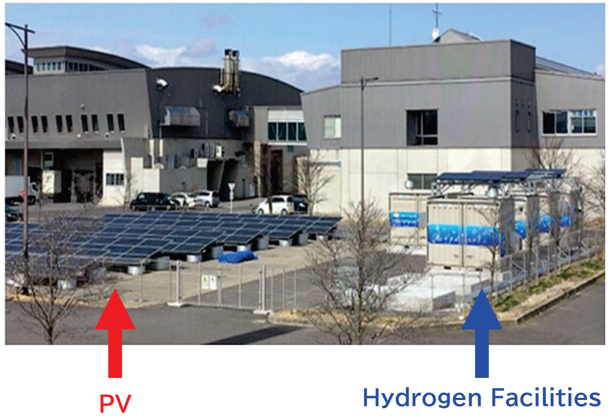
# Case Studies in Japan (3)

**Buildings of wholesales market**



| Specifications | |
|---|---|
| Location | Wholesales Market |
| Power Demand | 100 kW |
| PV | 64 kW |
| Water Electrolyzer | 5 Nm3/h |
| Hydrogen absorbing alloy tank | (1) 80 Nm3<br>(2) 100 Nm3 |
| Fuel cell | 14 kW |
| Batteries | 20 kW – 20 kWh<br>Lithium-Ion |

Source: Hydro Q-BiC, Shimizu Corporation, Japan, https://www.shimz.co.jp/solution/tech362/

---

# Case Studies in Japan (4)

**Office Building (Zero Emission Building)**

| Specifications | |
|---|---|
| Location | Office building |
| PV | 140 kW |
| Hydrogen absorbing alloy tank | 2,000 kWh |

**Hydrogen Facilities** Basement

- Various energy-saving technologies
- PV system
- Hydrogen production and storage with PV surplus power

Source: Hydro Q-BiC, Shimizu Corporation, Japan,
https://www.shimz.co.jp/company/about/news-release/2021/2021006.html

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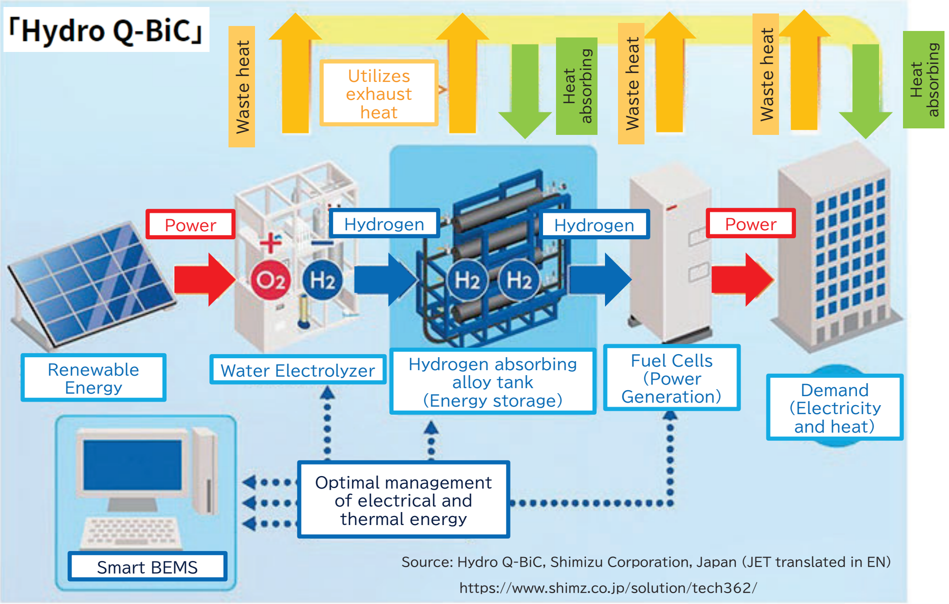
# Hydrogen Storage System

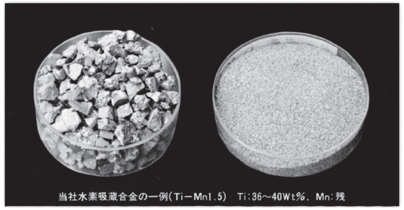


Source: Hydro Q-BiC, Shimizu Corporation, Japan (JET translated in EN)
https://www.shimz.co.jp/solution/tech362/

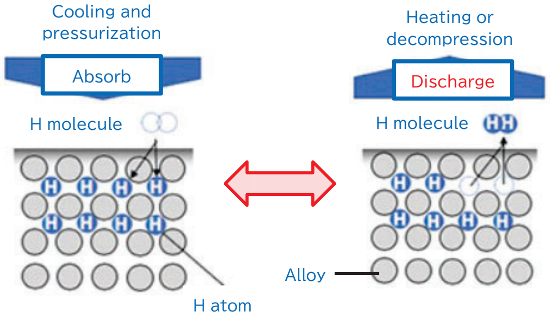
# What is “Hydrogen absorbing alloy”?

Alloy that absorbs hydrogen and releases.

- ➢ Compact storage of large volumes of hydrogen: compressed to about 1/1000th of its original volume
- ➢ Low cylinder pressure reduces the possibility of leakage (Less than 1 MPa)



Source: http://www.daido-100th.com/topics/327/



Source: https://kompas.hosp.keio.ac.jp/sp/contents/medical info/science/201912.html

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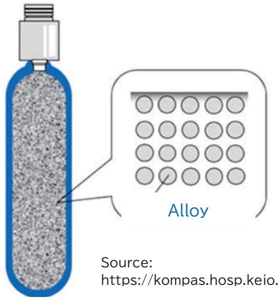
# What is “Hydrogen absorbing alloy”?

The issue with hydrogen storage alloy tanks

- ☐ The tanks will be made of alloy, so they are heavier than cylinders such as compressed hydrogen
- ☐ Alloy prices are expensive as of 2022.



Source: https://kompas.hosp.keio.ac.jp/sp/contents/medical info/science/201912.html

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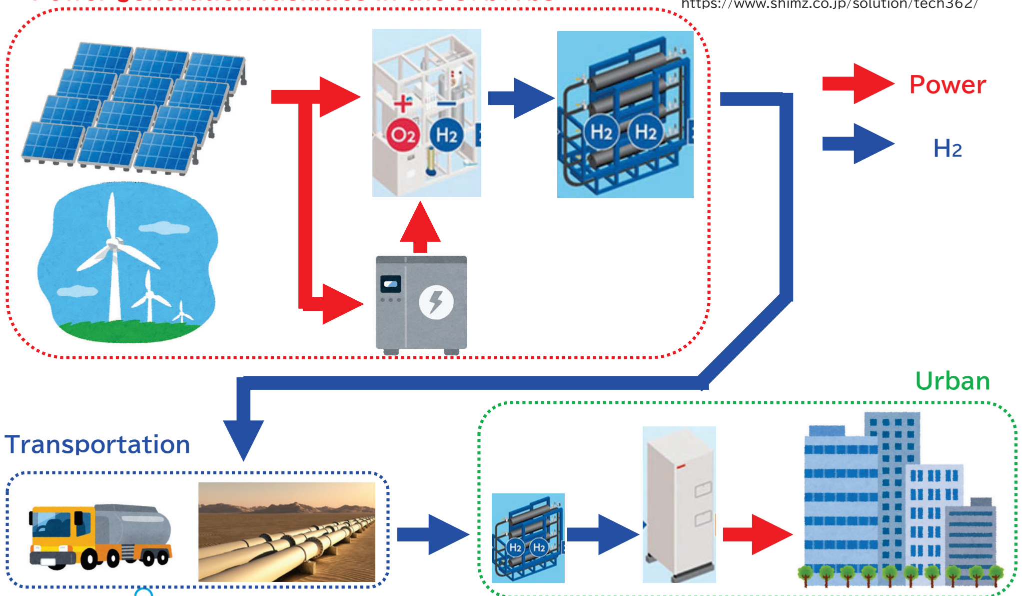
# Image of Hydrogen Utilization

Source: Hydro Q-BiC, Shimizu Corporation, Japan
https://www.shimz.co.jp/solution/tech362/



Power generation facilities in the suburbs

Power

H2

Urban

Transportation

---

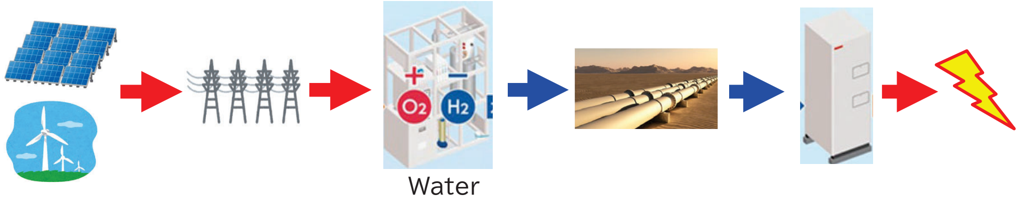
# Cost of Hydrogen Production

Systems using hydrogen storage alloy tanks are not yet at the commercial stage.

⇩

An example calculation of hydrogen production using RE through grid in one study and its generation costs as applied to the CARICOM region is presented below.

**[Equipment configuration]**



RE

Power Grid

Water electrolysis (17.5 MW)

Transportation

Fuel cell

Power

# Cost estimation of $H_2$ Production (1)

This trial calculation based on purchasing electricity produced from renewable energy sources via the grid and using that electricity to produce green hydrogen.

| Cost Estimation | | |
|---|---|---|
| Water electrolyzer rated capacity (Rated input power) | 17.5 | MW |
| Annual hydrogen production (ton) | 2,936 | ton/year |
| Annual hydrogen production (Nm3) | 264,462 | Nm3/year |
| Amount of electricity required per year | 151,620 | MWh/year |
| Variable-OPEX(Water) | 67,714 | USD/year |
| Variable-OPEX(Electricity) | 24,115,195 | USD/year |
| LCOH (price of equalized hydrogen) | 9.89 | USD/kg-H2 |

Source: Created by JET

# Cost estimation of $H_2$ Production (2)

Green hydrogen price in 2022 is 5.5 - 9.5 USD/kg-H2,

＊Depending on location and conditions.

Source: S&P Global Commodity Insights, USA
https://www.spglobal.com/commodityinsights/en/our-methodology/price-assessments/energy-transition/hydrogen-price-assessments

⇨ In the CARICOM region, it is impractical to purchase electricity from renewable energy sources via the grid to produce green hydrogen.

If they can get the electricity needed for water electrolysis from their own renewable energy generation facilities

⇨ The cost of hydrogen production can be reduced.

# Conclusion

◆ **Battery Storage**

Batteries and hydrogen storage have different areas of expertise, so choose based on features, not cost.

◆ **Method of Hydrogen Storage**

In addition to compressed hydrogen and liquefied hydrogen, there are also storage methods using hydrogen storage alloys.

◆ **Cost of Green Hydrogen**

The unit cost of producing green hydrogen is high, but the cost can be reduced to some extent by direct using of renewable energy.

Thank you.

Appendix 3-1-2 Attendant list, and Q&A, of the 1st Energy Efficiency Workshop (Jamaica)

## Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

### Energy Efficiency Workshop
### List of Participants (Jamaica)

**List of Participants for Online Attendance (9 Feb 2023)** **Venue: Zoom**

| No | Name | Agency | Title | Department |
|---|---|---|---|---|
| 1 | Craig Rattary | **Office of Utilities Regulation** | | |
| 2 | Horace Buckley | **MSET** | Director of Projects | Prog. Implementation Div. |
| 3 | Steve Windross | **JPS** | | |

**List of Participants for Online Attendance (10 Feb 2023)** **Venue: Zoom**

| No | Name | Agency | Title | Department |
|---|---|---|---|---|
| 1 | Craig Rattary | **Office of Utilities Regulation** | | |
| 2 | Andre Lindsay | **Office of Utilities Regulation** | Junior Engineer | |
| 3 | Horace Buckley | **MSET** | Director of Projects | Prog. Implementation Div. |

# Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

## 1st EE Workshop: Q&A

| No | Day | Item | Content | Name | Answer |
|---|---|---|---|---|---|
| 1 | 9-Feb | Question | How were the targets determined? Technology vs process/activity. | Craig Rattray | Energy managements needs to be carried out through actual data collection as it is a successful element. |
| 2 | 9-Feb | Question | Does the cost of energy influence the pursued targets and if so, how? | Craig Rattray | The energy cost is very much an important factor particularly in Jamaica as the power rate is increasing and there is a spike in the energy price all over the world as well. Electric power, fuel cost, etc are all increasing and the user will determine the investment by various aspects. Based on experience, the payback period needs to be less than five years. Also, there are some incentives in many countries, Japan for instance gives financial support to invest in efficient technologies and the key point is how many years will it take to recover the investment. Oftentimes efficient technology is very expensive and cannot recover which commonly happens so governmental support is a key factor. |
| 3 | 9-Feb | Question | What is your opinion on the competition between hydrogen fuel cell and technology? Which one do you see becoming predominant on the global scene? | Craig Rattray | It is difficult to decide/answer which will become predominant in the 2020s however possibly the answer will come in the 2030s. |
| 4 | 10-Feb | Question | In your review, did you come across any situation where management had challenges getting persons complying with the requirements of energy efficiency improvements? | Craig Rattray | Yesterday, the standards of energy management was introduced and to implement successful energy management there first needs to be an establishment of an energy management team in the organization in which top management will supervise the team. An energy management manager needs to be appointed and relevant persons from various sections will join the team. The team must consider what will be the energy efficiency policies in their organization and discuss their energy saving targets. The energy management international standards mentions some steps to be taken to implement the successful energy management and to improve energy efficiency. |

# Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

## 1st EE Workshop:  Q&A

| No | Day | Item | Content | Name | Answer |
|---|---|---|---|---|---|
| 5 | 10-Feb | Question | Is the practice of offering incentives or benefits to the employees, was it considered in the approaches you reviewed? | Craig Rattray | There is some award system in Japan. If a very excellent job is carried out by a company/individual, the prize or reward will go to the energy efficiency manufacturers or an individual. This is the overall frame regarding awards as a governmental policy. In the private sector, in the case of Japan, we are a little bit more cautious with energy consumption. Also, two decades ago carbon reduction was very much an important task for Japanese private companies. For instance, Japanese major private sector federations such as electric power and large energy consumption organizations had to develop their plan to reduce carbon emissions about 20 or more years ago. So with this situation, the Japanese showed a lot of interest in carbon emissions and when the persons successfully implemented the cost reduction or energy efficiency improvement, I believe the person or the team is very proud of their achievements. I am not sure if the salary will become more however having been successful, they are proud of it because the people interested in energy efficiency improvement are very much satisfied to be recognized by their achievement in their entity/organization. |
| 6 | 10-Feb | Question | How did they control compatibility issues with the different connectors in Barbados? | Craig Rattray | At the front of your car, you can connect the plug to your car. The connectors operate similar to an electricity plug as there is a convertor plug; the market sells the convertor plug. Because they are only selling the limited types of electric vehicles in Barbados, there have been no issues heard of in relation to the difference of connectors however there can be problems like this and we will try to check about the information. |
| 7 | 10-Feb | Question | With the technology of wireless transmission of power, do you have any idea what frequency is used for long distance? | Craig Rattray | No, actually this is just an introduction of this technology. My background is business administration so I am not really sure about the technical aspects. |

# Appendix 3-2-1 Material for the 2nd Energy Efficiency Workshop (Jamaica)

# Energy Efficiency & Conservation (EEC) Materiel Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

## - Energy Consumption Analysis & EEC Roadmap -

Jamaica, March 2023

Nippon Koei Co., Ltd.
PADECO Co., Ltd.

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## Contents

1. Energy Consumption Analysis from Energy Balance Table
2. EEC Roadmap - Residential Sector -
3. EEC Roadmap - Commercial Sector -
4. Promising Energy Efficient Technologies in non-industrial sectors
5. References

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# 1. Energy Consumption Analysis from Energy Balance Table

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## Energy Consumption Analysis from Energy Balance Table

- **Current situation :Energy consumption outlook by sector and energy source**
  - Transportation is the largest energy consuming sector (40%) followed by non-industrial sector (31%, Residential & Commercial).
  - Oil products is the largest energy source (54%) followed by electricity (33%).

**Energy consumption by sector and energy source on primary energy basis**
**(2021, Thousand Barrels of Oil Equivalent (KBOE))**

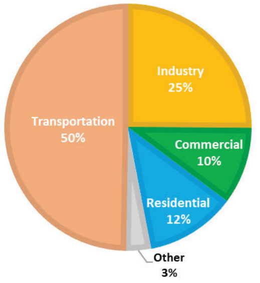
| | Industry | Commercial | Residential | Other | Transportation | Total | |
|---|---|---|---|---|---|---|---|
| Coal | 497 | - | - | - | - | 497 | 3% |
| Natural gas | 518 | - | - | - | - | 518 | 3% |
| Oil products | 1,405 | 346 | 518 | 67 | 6,676 | 9,012 | 54% |
| Bio/RE | 266 | 236 | 387 | 366 | - | 1,255 | 7% |
| Electricity<br>(Primary energy basis) | 1,757 | 1,980 | 1,726 | 32 | - | 5,494 | 33% |
| Total | 4,443 | 2,561 | 2,632 | 465 | 6,676 | 16,777 | 100% |
| | 26% | 15% | 16% | 3% | 40% | 100% | |

Note 1: Primary energy conversion factor of electricity is utilized to evaluate the effect of energy saving by reduction of 1kWh of electricity consumption at demand side.
Note 2: To calculate primary energy consumption of electricity, energy efficiency at end use (39.0%) was used based on the energy balance by Government of Jamaica.
Source: JET with reference to energy balances (2021) by the Government of Jamaica.
https://www.mset.gov.jm/documents/energy-balances/

# Energy Consumption Analysis from Energy Balance Table

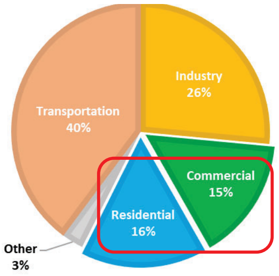
- **National Energy consumption should be evaluated on primary energy basis.**
- **Commercial & residential sectors share 31% of the primary energy consumption.**

### Energy consumption by sector on final consumption basis (2021)



1 kWh consumption corresponds to 2.56 kWh as primary energy supply.
- 1 kWh / 0.39 = 2.56 kWh

### Energy consumption by sector on primary energy basis (2021)



Source: JET with reference to energy balances (2021) by the Government of Jamaica.

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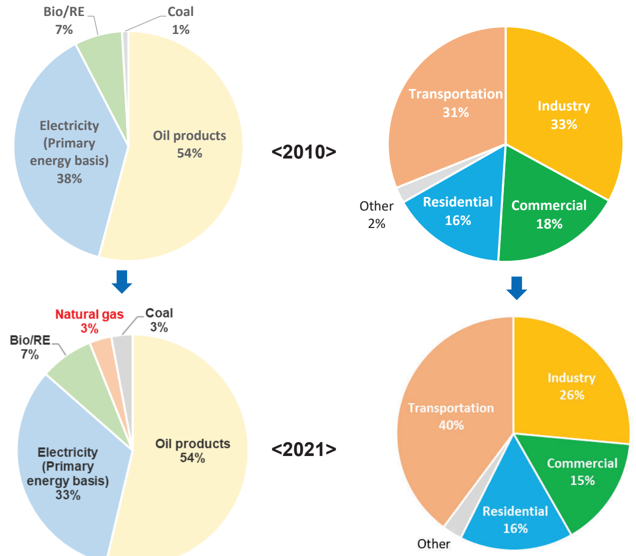
# Energy Consumption Analysis from Energy Balance Table

- **Fuel consumption**
  - ✓Power consumption has been reduced by 5%.
  - ✓Natural gas consumption has been observed.
- **Consumption by sector**
  - ✓Transportation sector has increased by 9% while Industrial & non-industrial sector has been reduced between 2010 and 2021.

Source: JET with reference to energy balances (2010, 2021) by the Government of Jamaica.

### Changes in Energy Consumption Ratio by Fuel (left) and by Sector (right) on Primary Energy Consumption Basis from 2010 (upper) to 2021 (lower)



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# Energy Consumption Analysis from Energy Balance Table

### Energy Consumption by Fuel and by Sector on Final Consumption Basis (2010, KBOE)

| | Industry | Commercial | Residential | Other | Transportation | Total | |
|---|---|---|---|---|---|---|---|
| **Coal** | 159 | - | - | - | - | 159 | 1% |
| **Oil products** | 3,072 | 330 | 327 | 335 | 5,460 | 9,524 | 74% |
| **Bio/RE** | 418 | 533 | 228 | - | - | 1,179 | 9% |
| **Electricity (Final consumption basis)** | 654 | 702 | 675 | 14 | - | 2,045 | **16%** |
| **Total** | 4,303 | 1,565 | 1,230 | 349 | 5,460 | 12,907 | 100% |
| | 33% | 12% | 10% | 3% | 42% | 100% | |

### Energy Consumption by Fuel and by Sector on Primary Energy Basis (2010, KBOE)

| | Industry | Commercial | Residential | Other | Transportation | Total | |
|---|---|---|---|---|---|---|---|
| **Coal** | 159 | - | - | - | - | 159 | 1% |
| **Oil products** | 3,072 | 330 | 327 | 335 | 5,460 | 9,524 | 54% |
| **Bio/RE** | 418 | 533 | 228 | - | - | 1,179 | 7% |
| **Electricity (Primary energy basis)** | 2,148 | 2,306 | 2,217 | 46 | - | 6,718 | **38%** |
| **Total** | 5,797 | 3,169 | 2,772 | 381 | 5,460 | 17,580 | 100% |
| | 33% | 18% | 16% | 2% | 31% | 100% | |

Note: To calculate primary energy consumption of electricity, energy efficiency at end use (30.4%) was used based on the energy balance by Government of Jamaica.

---

# Energy Consumption Analysis from Energy Balance Table

### Energy Consumption by Fuel and by Sector on Final Consumption Basis (2021, KBOE)

| | Industry | Commercial | Residential | Other | Transportation | Total | |
|---|---|---|---|---|---|---|---|
| **Coal** | 497 | - | - | - | - | 497 | 4% |
| **Natural gas** | 518 | - | - | - | - | 518 | 4% |
| **Oil products** | 1,405 | 346 | 518 | 67 | 6,676 | 9,012 | 67% |
| **Bio/RE** | 266 | 236 | 387 | 366 | - | 1,255 | 9% |
| **Electricity (Final consumption basis)** | 686 | 773 | 674 | 12 | - | 2,145 | **16%** |
| **Total** | 3,372 | 1,355 | 1,579 | 445 | 6,676 | 13,428 | 100% |
| | 25% | 10% | 12% | 3% | 50% | 100% | |

### Energy Consumption by Fuel and by Sector on Primary Energy Basis (2021, KBOE)

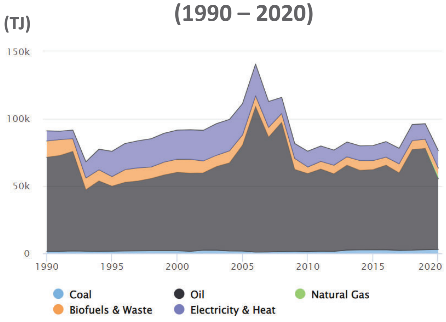
| | Industry | Commercial | Residential | Other | Transportation | Total | |
|---|---|---|---|---|---|---|---|
| **Coal** | 497 | - | - | - | - | 497 | 3% |
| **Natural gas** | 518 | - | - | - | - | 518 | 3% |
| **Oil products** | 1,405 | 346 | 518 | 67 | 6,676 | 9,012 | 54% |
| **Bio/RE** | 266 | 236 | 387 | 366 | - | 1,255 | 7% |
| **Electricity (Primary energy basis)** | 1,757 | 1,980 | 1,726 | 32 | - | 5,494 | **33%** |
| **Total** | 4,443 | 2,561 | 2,632 | 465 | 6,676 | 16,777 | 100% |
| | 26% | 15% | 16% | 3% | 40% | 100% | |

Note: To calculate primary energy consumption of electricity, energy efficiency at end use (39.0%) was used based on the energy balance by Government of Jamaica.

# Energy Consumption Analysis from Energy Balance Table

- In past 10 years, final energy consumption has not changed much with slight increase of AAGR=0.1%
- Regarding fuel type, electricity consumption has increased with AAGR=1.1% while oil consumption has been decreasing.

Final Consumption by Fuel (1990 – 2020)



Trend of Final Consumption by Fuel (2010 – 2020)

(TJ)

| | 2010 | Share | 2020 | Share | AAGR |
|---|---|---|---|---|---|
| Electricity | 11650 | 15% | 12977 | 17% | 1.1% |
| Bio & Waste | 4944 | 7% | 5676 | 7% | 1.4% |
| Natural Gas | - | - | 2225 | 3% | |
| Oil | 58012 | 77% | 52590 | 69% | -1.0% |
| Coal | 1187 | 2% | 2831 | 4% | 9.1% |
| Total | 75793 | 100% | 76299 | 100% | 0.1% |

Source: United Nations Statistics Division.

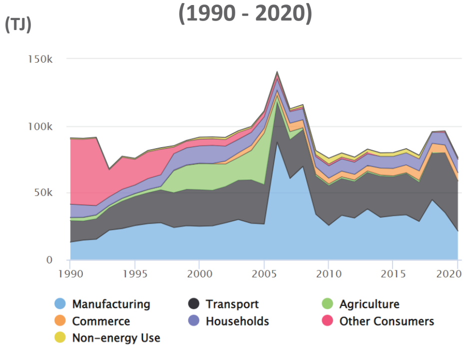
Note: AAGR = Annual Average Growth Rate

---

# Energy Consumption Analysis from Energy Balance Table

- In past 10 years from 2010 to 2020, commercial, transport and residential sectors have been increasing its final consumption while reduction has been observed in industrial sector.

Final Consumption by Sector (1990 - 2020)



Trend of Final Consumption by Sector (2010 – 2020)

(TJ)

| | 2010 | Share | 2020 | Share | AAGR |
|---|---|---|---|---|---|
| Transport | 29839 | 39% | 37493 | 49% | 2.3% |
| Commerce | 4328 | 6% | 6188 | 8% | 3.6% |
| Households | 9200 | 12% | 9904 | 13% | 0.7% |
| Industry | 25598 | 34% | 21400 | 28% | -1.8% |
| Other | 1424 | 2% | 818 | 1% | -5.4% |
| Non-energy Use | 4232 | 6% | 494 | 1% | -19.3% |
| Agriculture | 1172 | 2% | - | - | - |
| Total | 75793 | 100% | 76297 | 100% | 0.1% |

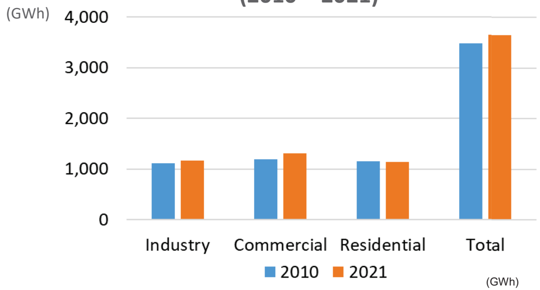
Source: United Nations Statistics Division.

---

# Energy Consumption Analysis from Energy Balance Table

- Energy efficiency efforts at demand side should be evaluated by final consumption basis when efficiency at supply side changes significantly.
- Non-industrial sector shares 67% of annual electricity consumption.
- AAGR between 2010 – 2021 was 100.4% (very slight increase).

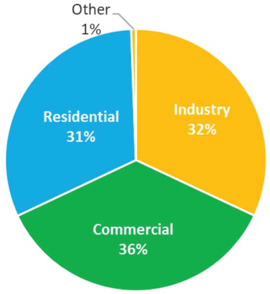
Trend of Power Consumption by Final Consumption Basis (2010 – 2021)



(GWh)

| | Industry | Commercial | Residential | Other | Total |
|---|---|---|---|---|---|
| 2010 | 1,111 | 1,193 | 1,147 | 24 | 3,475 |
| 2021 | 1,166 | 1,314 | 1,145 | 21 | 3,646 |
| AAGR | 100.4% | 100.9% | 100.0% | 98.9% | 100.4% |

Ratio of Power Consumption by Sector in 2021



Source: JET with reference to energy balances (2021) by the Government of Jamaica.

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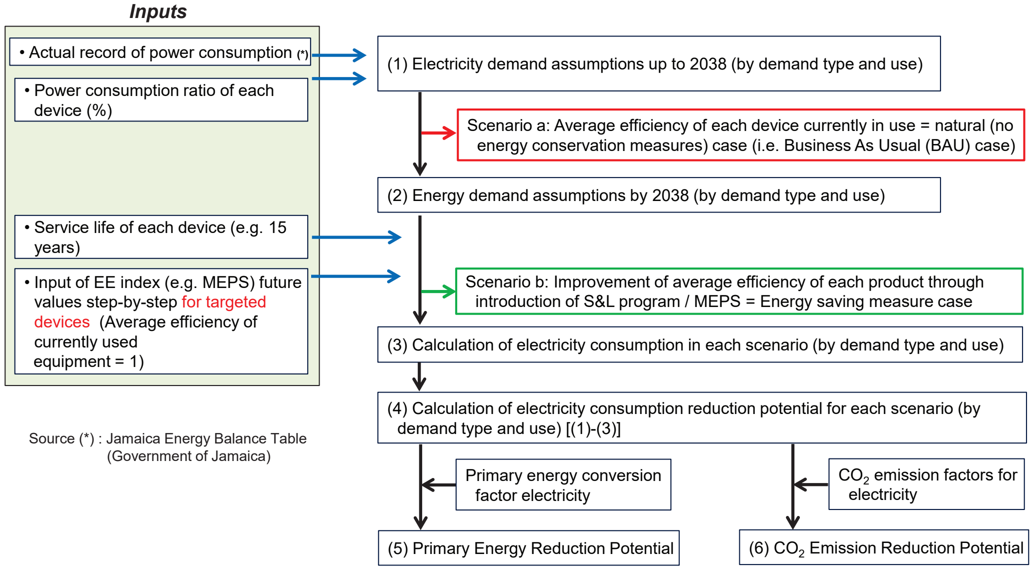
# 2. Energy Efficiency & Conservation (EEC) Roadmap - Residential Sector -

# Method of EEC Roadmap Development



***Inputs***

- Actual record of power consumption (*)
- Power consumption ratio of each device (%)
- Service life of each device (e.g. 15 years)
- Input of EE index (e.g. MEPS) future values step-by-step for targeted devices (Average efficiency of currently used equipment = 1)

(1) Electricity demand assumptions up to 2038 (by demand type and use)

Scenario a: Average efficiency of each device currently in use = natural (no energy conservation measures) case (i.e. Business As Usual (BAU) case)

(2) Energy demand assumptions by 2038 (by demand type and use)

Scenario b: Improvement of average efficiency of each product through introduction of S&L program / MEPS = Energy saving measure case

(3) Calculation of electricity consumption in each scenario (by demand type and use)

(4) Calculation of electricity consumption reduction potential for each scenario (by demand type and use) [(1)-(3)]

Primary energy conversion factor electricity

$CO_2$ emission factors for electricity

(5) Primary Energy Reduction Potential

(6) $CO_2$ Emission Reduction Potential

Source (*) : Jamaica Energy Balance Table (Government of Jamaica)

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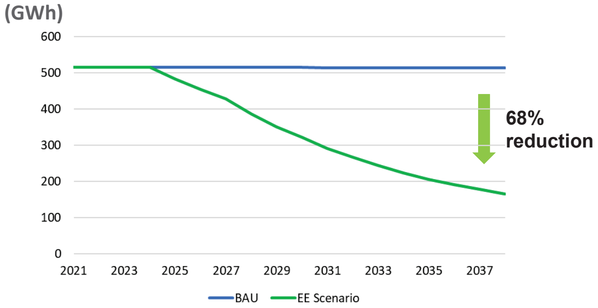
# Energy Efficiency & Conservation (EEC) Roadmap

- **Electric power consumption of refrigerator has been estimated to be reduced by 68% with EE Scenario compared with BAU Scenario in 2038.**
- **Energy efficiency of refrigerator in use at households will be 3.1 times more efficient compared with that of currently used in 2038 in EE Scenario with Introduction of MEPS.**

**Electric Power Consumption by Refrigerator up to 2038 (BAU and EE Scenario)**



**Assumed MEPS (EE Index) introduction for refrigerator in EE Scenario**

| EE index | |
|---|---|
| Present | 1 |
| 2025 | 2 |
| 2028 | 3 |
| 2031 | 3.5 |
| 2034 | 4 |

Average EE index currently used at all households

Assumed stepwise introduction of MEPS

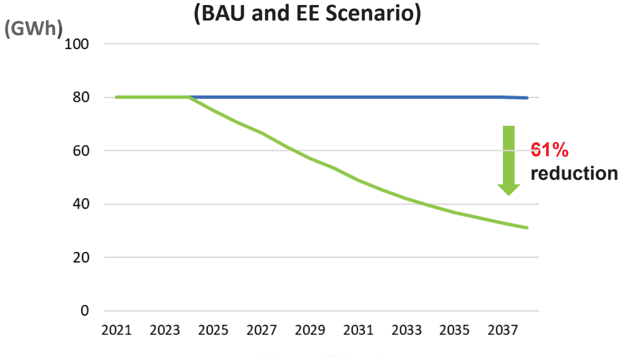
**Average EE index will be 3.1 in 2038 used at all households**

---

# Energy Efficiency & Conservation (EEC) Roadmap

- **Electric power consumption of air conditioner has been estimated to be reduced by 61% with EE Scenario compared with BAU Scenario in 2038.**
- **Energy efficiency of air conditioner in use at households will be 2.6 times more efficient compared with that of currently used in 2038 in EE Scenario with Introduction of MEPS.**

**Electric Power Consumption by Air Conditioner up to 2038 (BAU and EE Scenario)**



**Assumed MEPS (EE Index) introduction for air conditioner in EE Scenario**

| EE index | |
|---|---|
| Present | 1 |
| 2025 | 2 |
| 2028 | 2.5 |
| 2031 | 3 |

Average EE index currently used at all households

Assumed stepwise introduction of MEPS

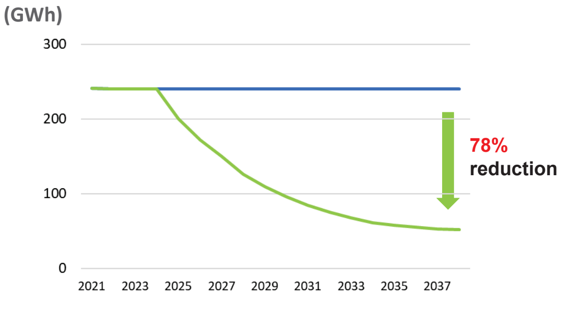
**Average EE index will be 2.6 in 2038 used at all households**

---

# Energy Efficiency & Conservation (EEC) Roadmap

- **Electric power consumption of lighting equipment has been estimated to be reduced by 78% with EE Scenario compared with BAU Scenario in 2038.**
- **Energy efficiency of lighting equipment in use at households will be 4.7 times more efficient compared with that of currently used in 2038 in EE Scenario with Introduction of MEPS.**

**Electric Power Consumption by Lighting Equipment up to 2038 (BAU and EE Scenario)**



**Assumed MEPS (EE Index) introduction for lighting equipment in EE Scenario**

| EE index | |
|---|---|
| Present | 1 |
| 2025 | 3 |
| 2028 | 4 |
| 2031 | 4.5 |
| 2034 | 5 |

Average EE index currently used at all households

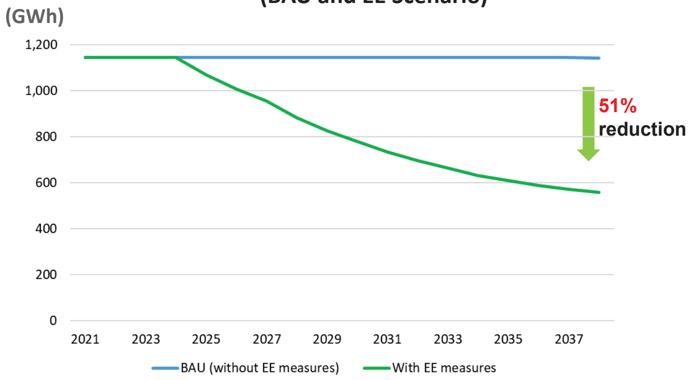
Assumed stepwise introduction of MEPS

**Average EE index will be 4.65 in 2038 used at all households**

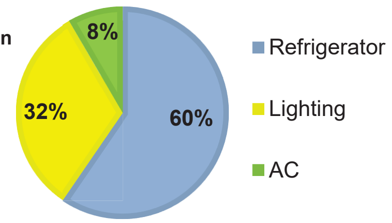
## Energy Efficiency & Conservation(EEC) Roadmap

- With MEPS introduction targeting refrigerator, lighting equipment and air conditioner, it has been estimated power consumption will be reduced by 51% in 2038.

**Energy Saving Potential in Residential Sector up to 2038 (BAU and EE Scenario)**



**Energy Saving Ratio by Appliance in 2038 (EE Scenario)**



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# 3. Energy Efficiency & Conservation Roadmap -Commercial Sector-

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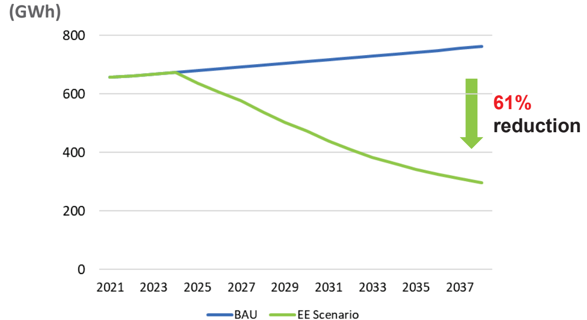
## Energy Efficiency & Conservation Roadmap -Commercial-

- Electric power consumption of air conditioner has been estimated to be reduced by 61% with EE Scenario compared with BAU Scenario in 2038.
- Energy efficiency of air conditioner in use at households will be 2.6 times more efficient compared with that of currently used in 2038 in EE Scenario with Introduction of MEPS.

**Electric Power Consumption by Air Conditioner up to 2038 (BAU and EE Scenario)**



**Assumed MEPS (EE Index) introduction for air conditioner in EE Scenario**

| EE index | |
|---|---|
| Present | 1 |
| 2025 | 2 |
| 2028 | 2.5 |
| 2031 | 3 |

Average EE index currently used in commercial field

Assumed stepwise introduction of MEPS

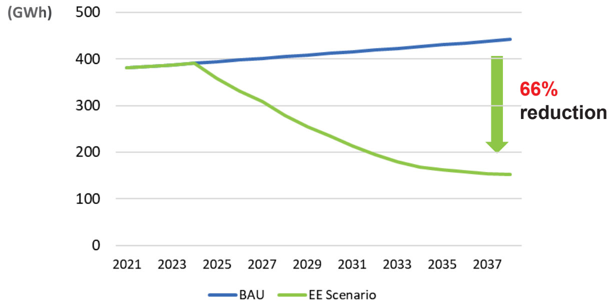
Average EE index will be 2.6 in 2038 used in commercial field

---

## Energy Efficiency & Conservation Roadmap -Commercial-

- Electric power consumption of lighting equipment has been estimated to be reduced by 66% with EE Scenario compared with BAU Scenario.
- Energy efficiency of lighting equipment in use at households will be 2.9 times more efficient compared with that of currently used in 2038 in EE Scenario with Introduction of MEPS.

**Electric Power Consumption by Lighting Equipment up to 2038 (BAU and EE Scenario)**



**Assumed MEPS (EE Index) introduction for lighting equipment in EE Scenario**

| EE index | |
|---|---|
| Present | 1 |
| 2025 | 2 |
| 2028 | 2.5 |
| 2031 | 3 |

Average EE index currently used in commercial field

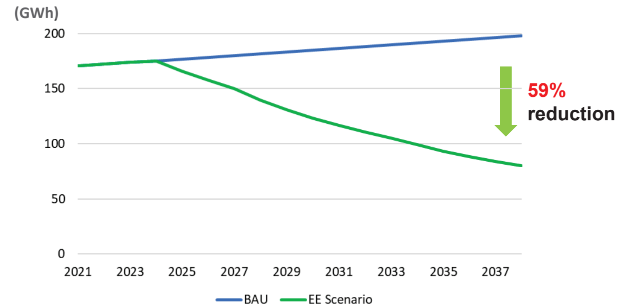
Assumed stepwise introduction of MEPS

Average EE index will be 2.9 in 2038 used in commercial field

# Energy Efficiency & Conservation Roadmap -Commercial-

- Electric power consumption of refrigerator has been estimated to be reduced by 59% with EE Scenario compared with BAU Scenario in 2038.
- Energy efficiency of refrigerator in use at commercial field will be 2.5 times more efficient compared with that of currently used in 2038 in EE Scenario with Introduction of MEPS.

Electric Power Consumption by Refrigerator up to 2038 (BAU and EE Scenario)



Assumed MEPS (EE Index) introduction for refrigerator in EE Scenario

| EE index | |
|---|---|
| Present | 1 |
| 2025 | 2 |
| 2028 | 2.5 |
| 2034 | 3 |

Average EE index currently used in commercial field

Assumed stepwise introduction of MEPS

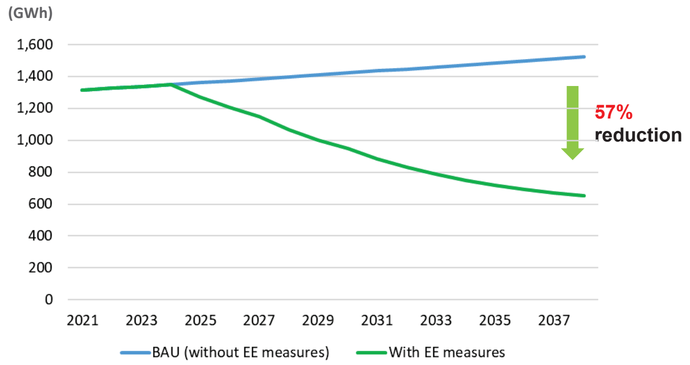
Average EE index will be 2.5 in 2038 used in commercial field

---

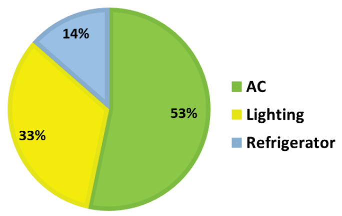
# Energy Efficiency & Conservation Roadmap -Commercial-

- With MEPS introduction targeting refrigerator, lighting equipment and air conditioner, it has been estimated power consumption will be reduced by 57% in 2038.

Energy Saving Potential in Commercial Sector up to 2038 (BAU and EE Scenario)



Energy Saving Share by Equipment in 2038 (EE Scenario)

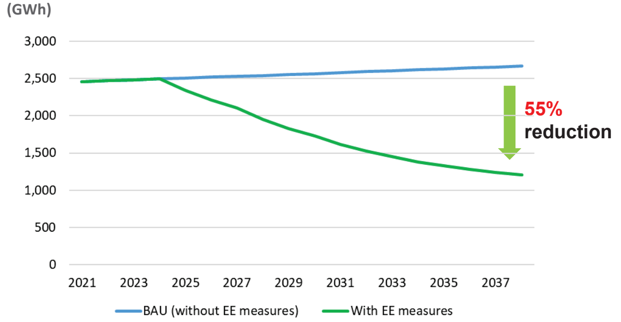


---

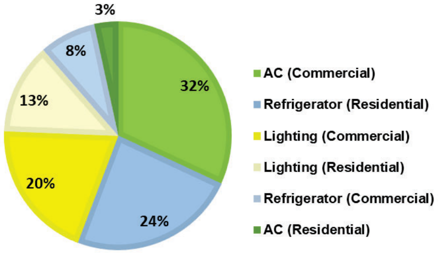
# EE&C Roadmap -Residential + Commercial Sectors-

- With MEPS introduction targeting refrigerator, lighting equipment and air conditioner, it has been estimated power consumption will be reduced by 55% in residential and commercial sectors in 2038.

Energy Saving Potential in Residential + Commercial Sector up to 2038 (BAU and EE Scenario)



Energy Saving Share by Equipment and Sector in 2038 (EE Scenario)



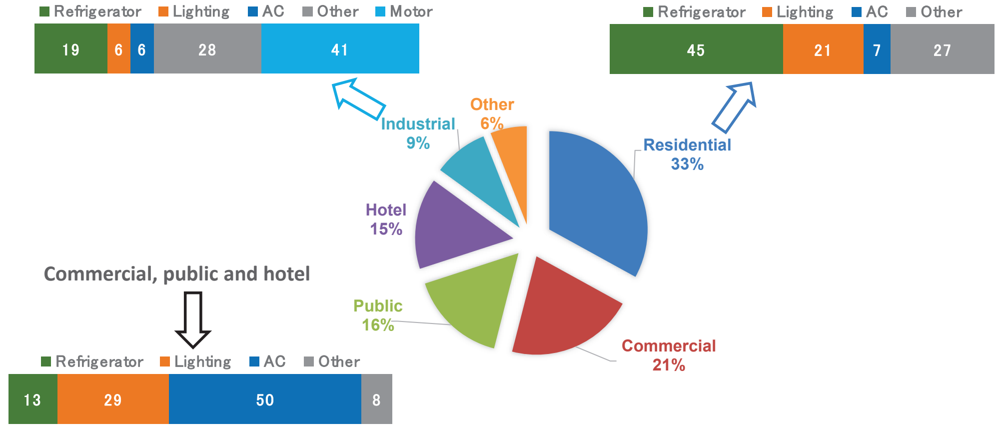
| | |
|---|---|
| AC (R+C) | 35% |
| Lighting (R+C) | 33% |
| Refrigerator (R+C) | 32% |

---

# Energy Efficiency & Conservation(EEC) Roadmap

- Ref: Current situation: Electricity consumption by sector and end-use

Electricity sales by demand group (last 10 years) and end-use



Source: JET with reference to Barbados NATIONAL ENEGY POLICY (2019-2030) and material by the Government of Barbados

# 4. Promising Energy Efficient Technologies in non-industrial sectors

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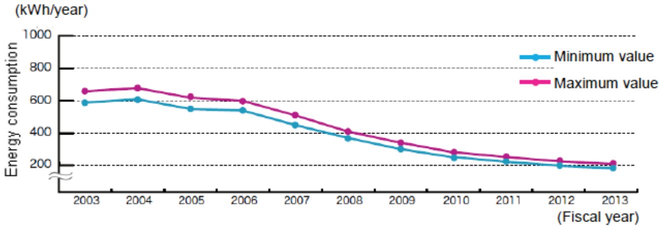
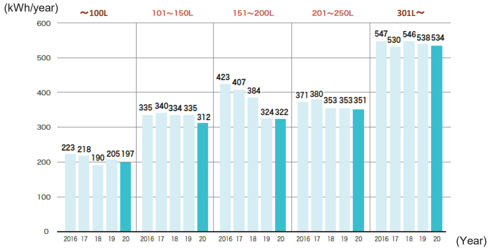
## Trends of EE Improvement of Refrigerator (Res), Japan

### Trends in Annual Energy Consumption of Refrigerator (401 –450ℓ, 2003 - 2013)



Source: Energy Saving Catalogue 2014 Summer (METI)

### Trends in Annual Energy Consumption (2016 – 2020)



Source: Energy Saving Catalogue 2021 (METI)

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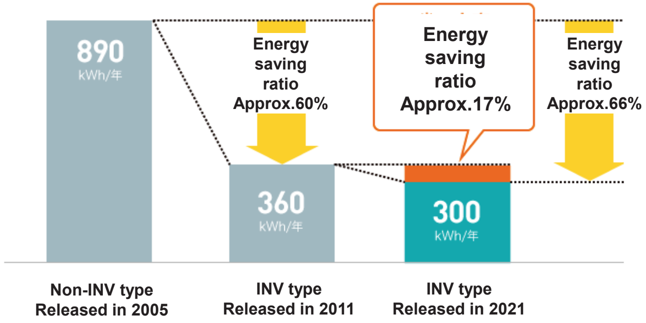
## EE Improvement of Refrigerator (Commercial), Japan

### Comparison of Annual Energy Consumption of Refrigerator (Commercial)



Source: HOSHIZAKI CORPORATION

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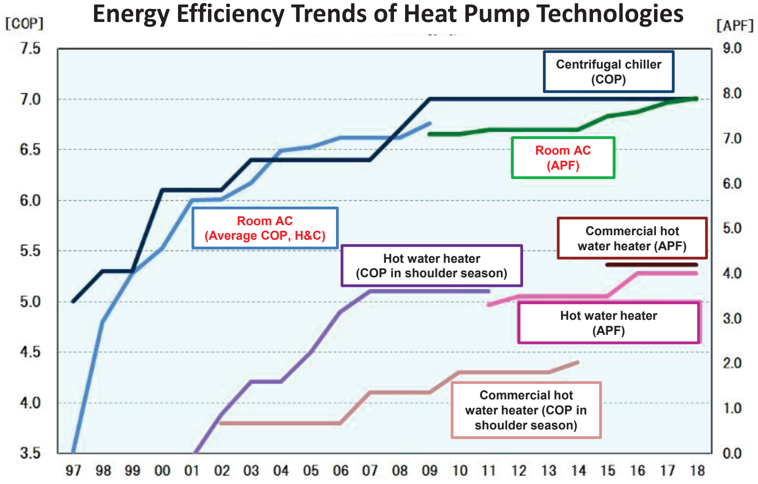
## Trends of EE Improvement of various ACs, Japan

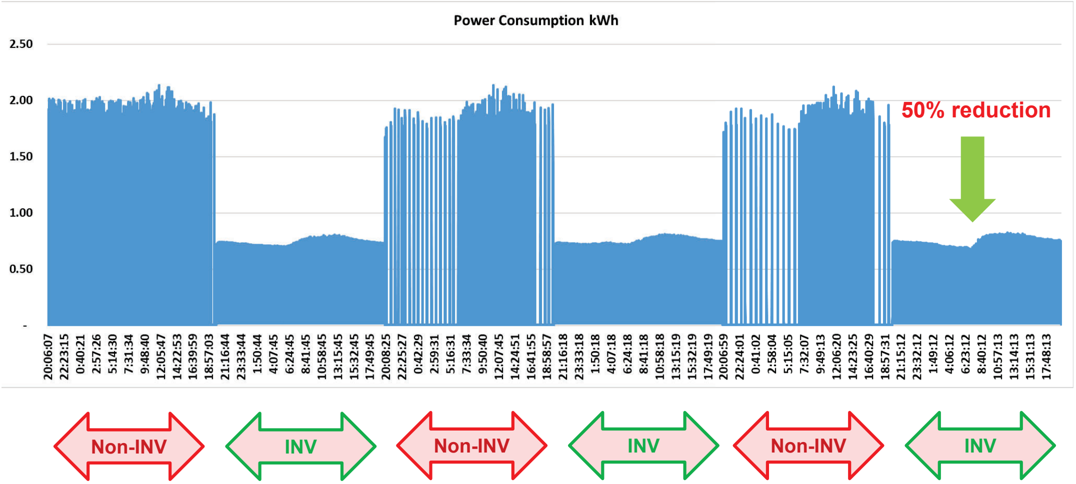
### Energy Efficiency Trends of Heat Pump Technologies



Source: Manufactures' Catalogue, Energy Saving Catalogue (METI)

Note 1: COP stands for Coefficient of Performance, energy efficiency at rated operation (kWh/kWh)
Note 2: APF stands for Annual Performance Factor, energy efficiency throughout a year (kWh/kWh)

# Results of Comparison Experiment, INV vs Non-INV AC



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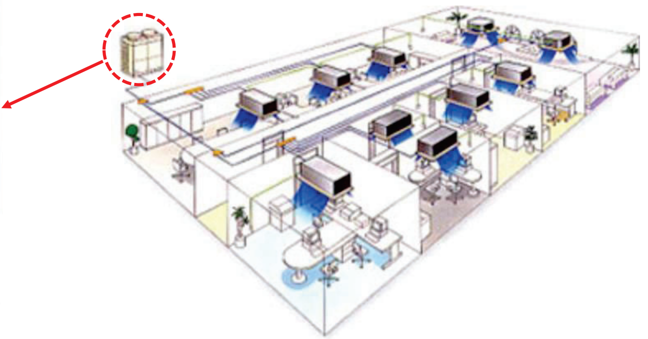
# Variable Refrigerant Flow (VRF) for middle-scale buildings

**Variable Refrigerant Flow (VRF, Inverter always equipped)**
**is efficient AC equipment for middle scale buildings**

**VRF (Inverter equipped) outdoor unit**



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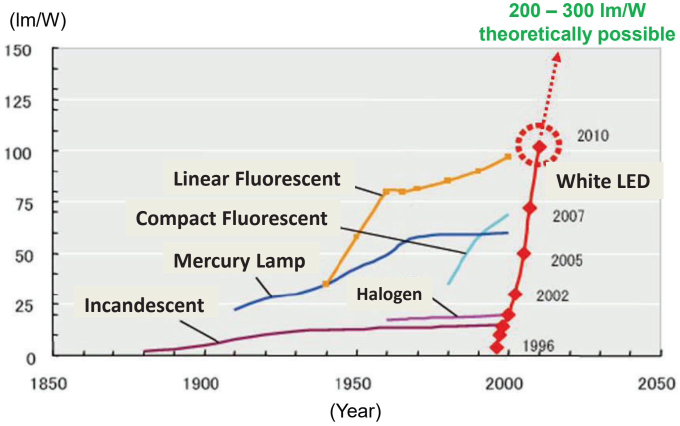
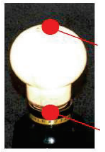
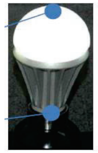
# Trends of EE Improvement of Lighting Equipment, Japan

### Trends of Luminous Efficiency



Source: Ministry of Economy and Trade and Industry, METI

### Comparison of heat generation (Incandescent lamp vs LED lamp)

| Incandescent Lamp (810 lm, 54W) | LED lamp (810 lm, 9W) |
|---|---|
| 30 minutes after lighting | |
|  80 ℃<br>110 ℃ |  26 ℃<br>55℃ |

**Contributes less AC demand**

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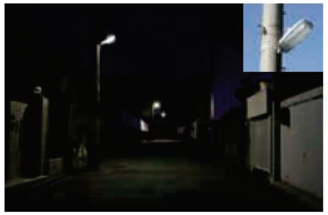
# Introduction Examples of LED streetlamps (1)

### Daytime view

| Road width | 4.8 m |
|---|---|
| Installation interval | Approx. 35 m |
| Installation height | Approx. 4.5 m |

### Before refurbishment: Mercury lamp 80W



| Horizontal plane (average) | | 2.75 Lux |
|---|---|---|
| Vertical plane (Min.) | Road center | 0.41 Lux |
| | Both sides of the road | 0.39 Lux |

### After refurbishment: LED 33W

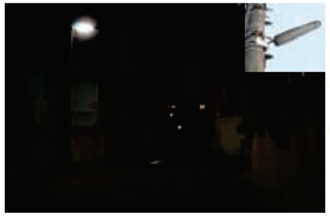
| Horizontal plane (average) | | 7.09 Lux |
|---|---|---|
| Vertical plane (Min.) | Road center | 1.59 Lux |
| | Both sides of the road | 1.49 Lux |

Source: Japan security systems association

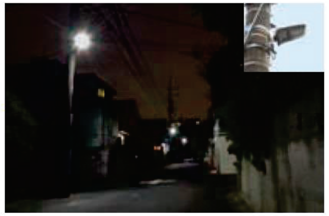
# Introduction Examples of LED streetlamps (2)

**Daytime view**

**Before refurbishment: CFL 20W**



**After refurbishment: LED 17W**



| | |
|---|---|
| Road width | 5.1 m |
| Installation interval | Approx. 30 m |
| Installation height | Approx. 5.0 m |

| | | |
|---|---|---|
| Horizontal plane (average) | | 1.76 Lux |
| Vertical plane (Min.) | Road center | 0.17 Lux |
| | Both sides of the road | 0.12 Lux |

| | | |
|---|---|---|
| Horizontal plane (average) | | 5.56 Lux |
| Vertical plane (Min.) | Road center | 0.78 Lux |
| | Both sides of the road | 0.64 Lux |

Source: Japan security systems association

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# Introduction Examples of LED on Highways

Source: IWASAKI ELECTRIC CO., LTD.

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# 5. References

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# EEC Implementation Best Practice - Commercial Sector -

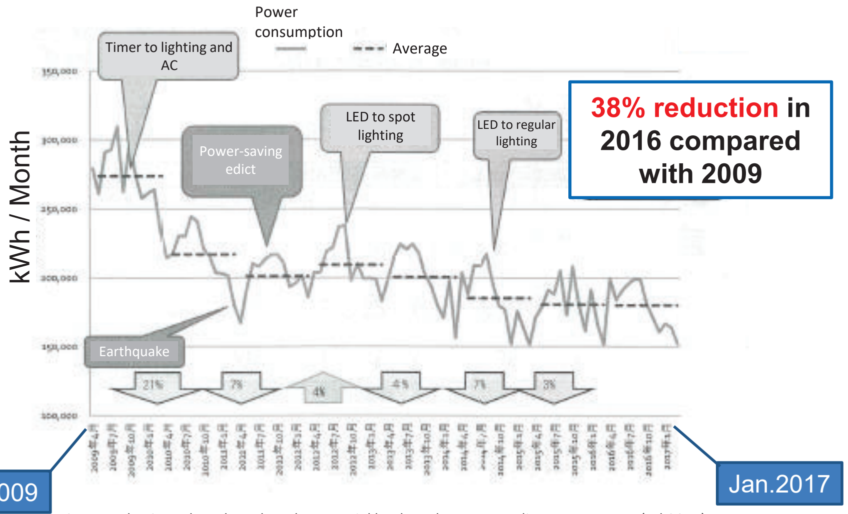
- **Outline of the building**
  - **Location: Tokyo**
  - **Floor area: 19,550$m^2$**
  - **Building structure: RC ( Basement 1F – 4 floors)**
  - **AC system: DHC (District Heating and Cooling) + AC units (partially)**
  - **Number of workers: Approx.200 persons**

- EEC approaches (STEP by STEP)
  - Introduction of auto timer to lighting and AC in 2009. (ON/OFF switch was operated manually in the past)
  - Introduction of LED to spot lighting equipment (approx. 1,000 units) in 2012
  - Introduction of LED to regular lighting equipment (approx. 2,000 units) in 2014

# EEC Implementation Best Practice - Commercial Sector -

## Trend of Power Consumption Reductions

(approx.8years: Apr.2009-Jan.2017)



**38% reduction in 2016 compared with 2009**

Source: The Consultant based on the material by the Tokyo metropolitan government (Jul.2017)

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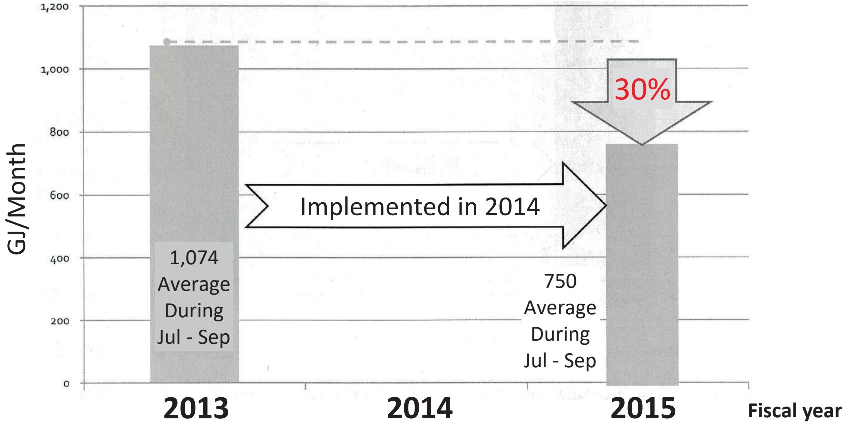
# EEC Implementation Best Practice - Commercial Sector -

## Effects on Cooling Demand Reductions with Introduction of LED to Regular Lighting System



Source: JET based on the material by the Tokyo Metropolitan government (Jul.2017)

Introduction of LED realized reductions of waste heat from lighting equipment and achieved cooling demand reductions (30%) in summer.

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# EEC Implementation Best Practice - Commercial Sector -

## Evaluation of Energy Consumption Reductions on Primary Energy Basis

| | Before | | After | | Primary energy consumption reductions |
|---|---|---|---|---|---|
| Energy | 2009 | 2013 | 2015 | 2016 | |
| Electric power consumption | 275 MWh x 12 = 3,300 MWh/year | | | 171 MWh x 12 = 2,052 MWh/year | |
| **Primary energy consumption** | 3,300 x 9.97 = **32,901** GJ/year | | | 2,052 x 9.97 = **20,458** GJ/year | 32,901 – 20,458 = **12,443 GJ/year** |
| Cooling& heating demand | | 445 GJ x 12 = 5,340 GJ/year | 325 GJ x 12 = 3,900 GJ/year | | |
| **Primary energy consumption** | | 5,340 GJ x 1.36 =**7,262** GJ/year | 3,900 GJ x 1.36 =**5,304** GJ/year | | 7,262 – 5,304 = **1,958 GJ/year** |
| **Total** | 32,901 + 7,262 = 40,163 GJ/year | | 20,458 + 5,304 = 25,762 GJ/year | | **14,401 GJ/year (36%)** |

Note1: Calculation was made by JET
Note2: Conversion factors for electric power and DHC were based on the guide for completing periodical report regarding EE law . (METI, Aug.2017)
Note3: Changes of both heating and cooling demands by the introduction of LED are taken into account.
Source: JET based on the material by the Tokyo Metropolitan government (Jul.2017)

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Thank you very much for your kind attention !

Technical Cooperation to Promote
Energy Efficiency in Caribbean Countries

# Information Sharing Material
# - Energy Efficiency Policy in Japan -

Jamaica, March 2023

Nippon Koei Co., Ltd.
PADECO Co., Ltd.

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## Energy Efficiency - Energy Policy incl. EE&C in Japan -

| Year | Policy |
|---|---|
| 2002 | **Basic Act on Energy Policy** |
| 2003-2014 | **Released Basic Energy Policies 4 times in 2003, 2007, 2010, 2014** |
| 2015 | **Long-term outlook for energy demand and supply**<br>●**Energy Mix** in 2030 (ratio of power sources): RE: 22-24%, Nuclear: 20-22% |
| 2018 | **5th Basic Energy Policy**<br>●2030: To achieve Energy Mix surely<br>●2050: Challenge to energy conversion and decarbonization |
| Oct.2020 | **Prime Minister's speech**<br>●Greenhouse gas emissions to zero by 2050<br>●Establishment of a stable energy supply by thorough EE as well as introducing RE to the maximum extent. |

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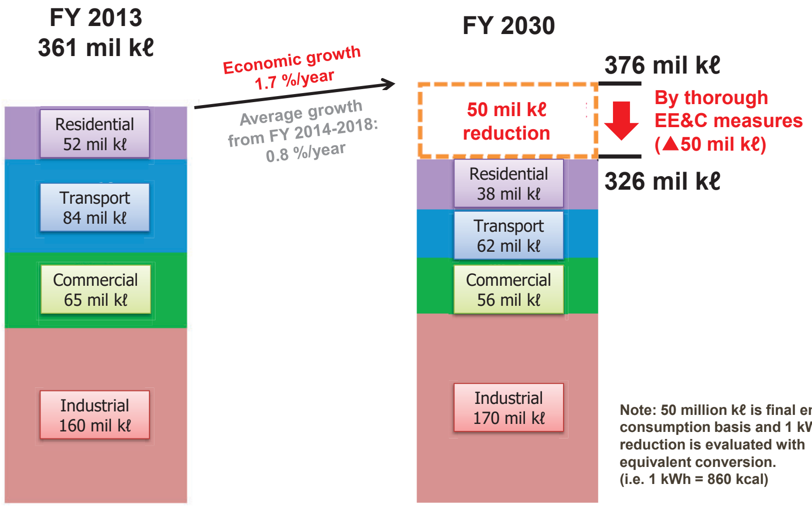
## Energy Efficiency - EE&C Targets in Energy Mix -

### EE&C Target for 2030 in Long-term Outlook for Energy Demand and Supply (energy mix)



Note: 50 million kℓ is final energy consumption basis and 1 kWh reduction is evaluated with equivalent conversion.
(i.e. 1 kWh = 860 kcal)

Source: JET based on the Ministry of Economy, Trade and Industry's (METI) material. Mar.2021

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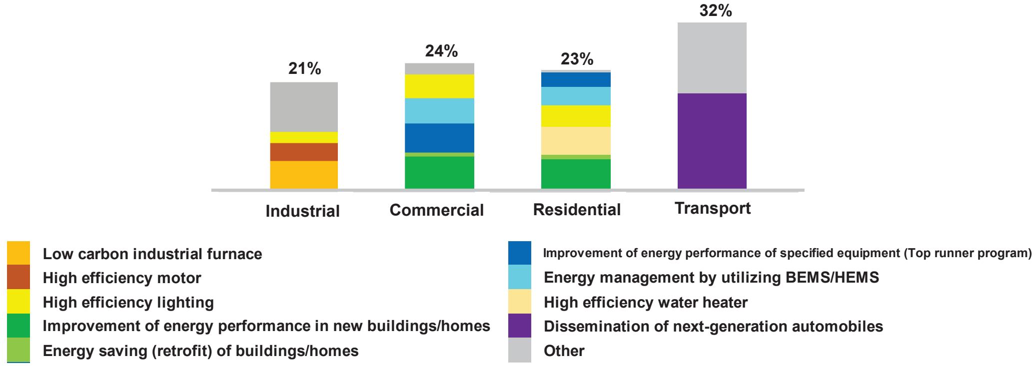
## Energy Efficiency - EE&C Targets in Energy Mix -

- **EE&C 2030 targets were developed sector by sector as well as technology by technology (bottom-up approach)**

### EE&C 2030 Targets by Sector (in Energy Mix)



# Energy Efficiency - EE&C Targets in Energy Mix -

- **Various EE&C technologies / approaches could be applied across the sectors, and these exceeded 40% of the energy-saving target amount.**

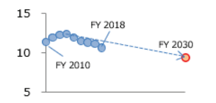
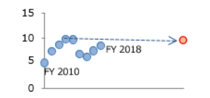
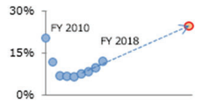
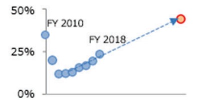
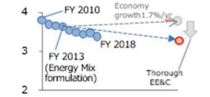
## Cross Sectorial EE&C Approaches (in Energy Mix targets)

(%)

| | | Industrial | Commercial | Residential | Total |
|---|---|---|---|---|---|
| 🟩 | Improvement of energy performance in new buildings/homes | | 6.6 | 6.2 | 12.8 |
| 🟨 | High efficiency lighting | 2.1 | 4.5 | 4 | 10.6 |
| 🟦 | Energy management by utilizing BEMS / HEMS | | 4.7 | 3.5 | 8.2 |
| 🟦 | Improvement of energy performance of specified equipment (Top runner program) | | 5.5 | 2.7 | 8.2 |
| 🟩 | Energy saving (retrofit) of buildings/homes | | 0.8 | 0.8 | 1.6 |
| | Total | 2.1 | 22.1 | 17.2 | 41.4 |

---

# Energy Efficiency - Progress of Energy Mix -

| | FY 2018 results | Targets in FY 2030 | Progress |
|---|---|---|---|
| 1. Energy-originated $CO_2$ emissions (total GHG emissions) | 1.06 billion Ton<br>(GHG:1.24 billion Ton) | 0.93 billion Ton<br>(GHG:1.04 billion Ton) |  |
| 2. Electricity cost (fuel cost + FIT purchase cost) | 8.5 Tera Yen<br>• Fuel cost : 5.7 Tera Yen (Crude oil cost: 63$/bbl)<br>• FIT cost : 2.8 Tera Yen | 9.2~9.5 Tera Yen<br>• Fuel cost : 5.3 Tera Yen (Crude oil cost: 128$/bbl)<br>• FIT cost : 3.7～4.0 Tera Yen |  |
| 3. Energy self-sufficiency rate (whole primary energy) | 12% | 24% |  |
| 4. Zero emission power supply ratio | 23%<br>• RE: 17%<br>• Nuclear: 6% | 44%<br>• RE: 22~24%<br>• Nuclear: 22~20% |  |
| 5. EE&C (final energy consumption in crude oil equivalent) | 339 mil kℓ<br>• Commercial/industry : 210<br>• Residential : 50<br>• Transport:80 | 326 mil kℓ<br>• Commercial/industry : 230<br>• Residential : 40<br>• Transport:60 |  |

Source: JET based on METI's material. Jul.2020

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# Energy Efficiency - Energy Efficiency & Conservation Policy in Japan -

- **Energy savings achieved in FY 2018 = ▲13.4 mil kℓ**
  - **Progress rate = 26.6%  # Average progress rate = 33.3% (2013-2030)**

## Progress of Energy Savings by Sector

| Sector | FY 2018 results | | | |
|---|---|---|---|---|
| | Energy savings | Progress rate | Progress rate by EE&C measure | |
| Residential | ▲2.9 mil kℓ | 24.9% | • Introduction of LED, etc.<br>• EE improvements of appliances<br>• EE improvements of house | 72%<br>24%<br>10% |
| Commercial | ▲3.3 mil kℓ | 27.1% | • Introduction of LED, etc.<br>• Energy management by BEMS, etc.<br>• Introduction of efficient refrigerator -freezer and router / server, etc. | 63%<br>25%<br>18% |
| Industrial | ▲2.8 mil kℓ | 26.3% | • Introduction of LED, etc.<br>• Energy management by FEMS, etc.<br>• Introduction of efficient motor<br>• Introduction of industrial heat pump | 66%<br>18%<br>9%<br>8% |
| Transport | ▲4.4 mil kℓ | 27.6% | • Other measures in transport sector<br>• Diffusion of next generation vehicle | 47%<br>14% |

Source: JET based on METI's material, Mar.2021

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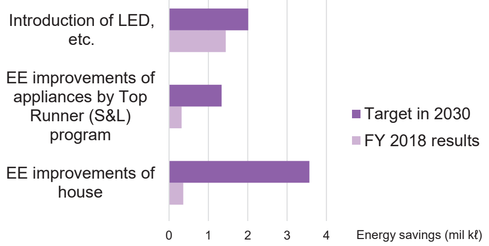
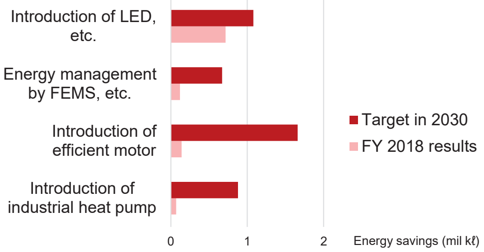
# Energy Efficiency - Energy Efficiency & Conservation Policy in Japan -

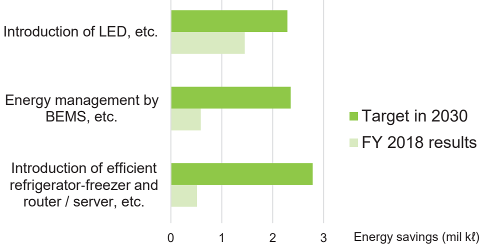
**Progress of Major EE&C Measures in Residential Sector**



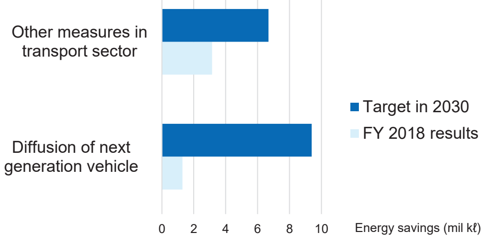
**Progress of Major EE&C Measures in Industrial Sector**



**Progress of Major EE&C Measures in Commercial Sector**

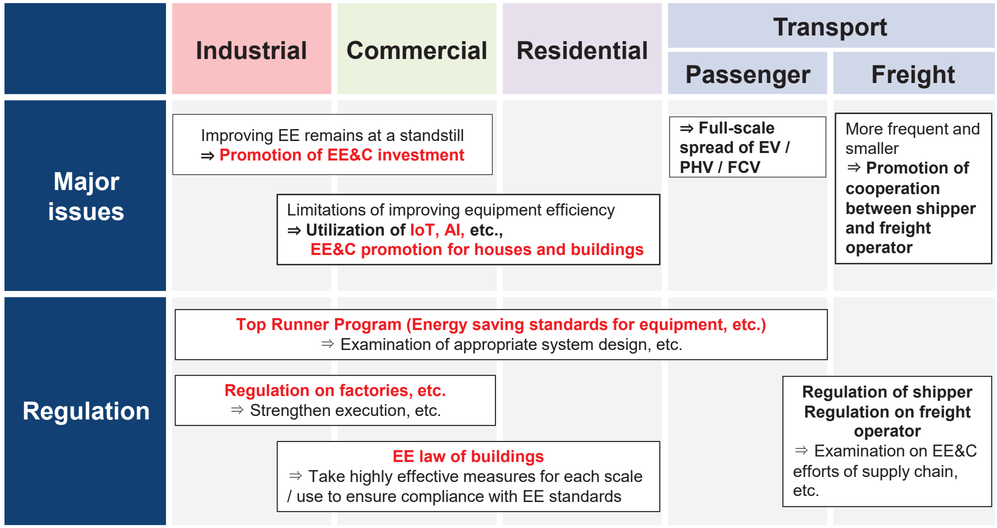


**Progress of Major EE&C Measures in Transport Sector**



Source: JET based on METI's material, Mar.2021

## Major Issues and EE&C Regulations by Sector



| | Industrial | Commercial | Residential | Transport: Passenger | Transport: Freight |
|---|---|---|---|---|---|
| **Major issues** | Improving EE remains at a standstill<br>⇒ **Promotion of EE&C investment** (Industrial–Commercial) | Limitations of improving equipment efficiency<br>⇒ **Utilization of IoT, AI, etc., EE&C promotion for houses and buildings** (Commercial–Residential) | | **⇒ Full-scale spread of EV / PHV / FCV** | More frequent and smaller<br>**⇒ Promotion of cooperation between shipper and freight operator** |
| **Regulation** | **Top Runner Program (Energy saving standards for equipment, etc.)**<br>⇒ Examination of appropriate system design, etc.<br><br>**Regulation on factories, etc.**<br>⇒ Strengthen execution, etc. | **EE law of buildings**<br>⇒ Take highly effective measures for each scale / use to ensure compliance with EE standards | | | **Regulation of shipper**<br>**Regulation on freight operator**<br>⇒ Examination on EE&C efforts of supply chain, etc. |

Source: JET based on METI's material, Mar.2021

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- **Top runner program started in 1998 which was defined in EE law (establishment: 1979)**
  - **Standards for performance of appliances, etc. are set at the top runner performance in that year.**
  - **Other products (runner-up, etc.) are required to catch up and qualify the top runner level in designated duration.**

### Current Target Products of Top Runner Program (32 products)

| | | | |
|---|---|---|---|
| Passenger Vehicles | Video Tape Recorders | Vending Machines | Printers |
| Freight Vehicles | Electric Refrigerators | Transformers | Heat Pump Water Heaters |
| Air Conditioners | Electric Freezers | Electric Rice Cookers | AC Motors |
| TV Sets | Space Heaters (Gas/Oil) | Microwave Ovens | Bulbs |
| Copying Machines | Gas Cooking Appliances | DVD Recorders | Refrigerating Showcases |
| Computers | Gas Water Heater | Routers | Insulation Materials |
| Magnetic Disk Units | Oil Water Heaters | Switches | Sashs |
| Lighting equipment | Electric Toilet Seats | Multi-function Printers | Double Glazing |

Source: JET based on METI's homepage

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Thank you very much for your kind attention !

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# Energy Efficiency & Conservation (EEC) Materiel Technical Cooperation to Promote Energy Efficiency in Caribbean Countries

## - Energy Efficiency Building Code -

Jamaica, March 2023

Nippon Koei Co., Ltd.
PADECO Co., Ltd.

# Contents

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# 1. Outline of EE Regulations in Residential Building

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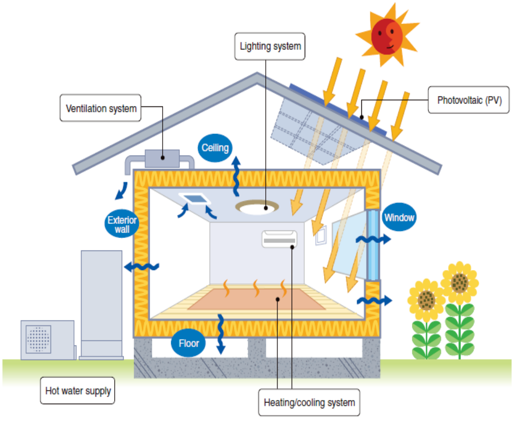
## 1. Outline of EE Regulations in Residential Building

- **Overview of the Energy Efficiency Standards for Residential Buildings**

**The evaluation of energy efficiency (EE) performance for residential buildings uses the following two standards:**

- **Standards to evaluate envelope performance (e.g. windows, exterior walls of residential buildings**
- **Standards to evaluate the primary energy consumption amount of equipment and appliances etc.**



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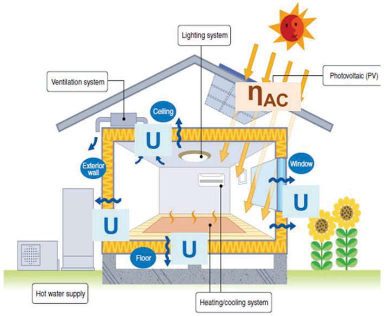
## 1. Outline of EE Regulations in Residential Building

- **Envelope performance**
  - **Average outer shell heat transmission coefficient ($U_A$)**

$$U_A\ (\mathrm{W/m^2 \cdot K}) = \frac{\text{Amount of total heat loss per unit of temperature difference}}{\text{Total surface area of exterior}}$$

- **$U_A$**
  - ✓ **An indicator of the ease of heat transfer between indoor and outdoor air.**
  - ✓ **When the temperature difference between the inside and outside of the building is 1 °C, the amount of heat released per unit time from the inside of the building to the outside of building is divided by the total surface area of exterior.**
  - ✓ **The smaller the value, the more difficult it is for heat to enter and exit, and the higher the insulation performance.**



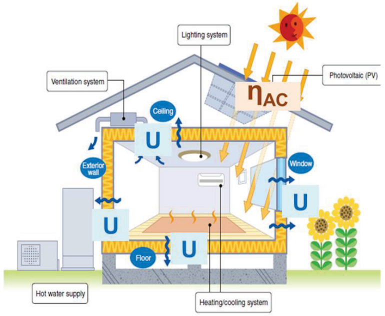
# 1. Outline of EE Regulations in Residential Building

- **Envelope performance**
  - Average solar heat gain coefficient during cooling period ($\eta_{AC}$)

$$\eta_{AC} = \frac{\text{Amount of total solar heat gain per unit of solar radiation intensity}}{\text{Total surface area of exterior}} \times 100$$

(-)

- $\eta_{AC}$
  - ✓ An indicator of how easily solar radiation enters the room.
  - ✓ Amount of heat acquired inside the building from solar radiation per unit of solar radiation intensity averaged by the cooling season and divided by the total surface area of exterior.
  - ✓ The smaller the value, the less sunlight enters and the higher the shielding performance.



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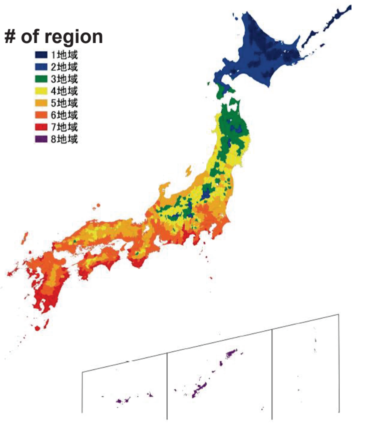
# 1. Outline of EE Regulations in Residential Building

❑ **Envelope performance**

$U_A$ Design Value ≦ Standard Value
$\eta_{AC}$ Design Value ≦ Standard Value

✓ Standard values of $U_A$ and $\eta_{AC}$ are defined by region by region. (regions are classified in 8 regions in Japan)



| Region | 1&2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| Standard Value of $U_A$ | 0.46 | 0.56 | 0.75 | 0.87 | 0.87 | 0.87 | - |
| Standard Value of $\eta_{AC}$ | - | - | - | 3.0 | 2.8 | 2.7 | 6.7 |

Revised in Apr.2020 as previous value was too strict (3.2)

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# 1. Outline of EE Regulations in Residential Building

- **Primary energy consumption amount**

+ heating/cooling system primary energy consumption amount
+ ventilation system primary energy consumption amount
+ lighting system primary energy consumption amount
+ hot water supply primary energy consumption amount
+ other (household appliances) primary energy consumption amount
- reduction amount of primary energy consumption through PV, etc

= **primary energy consumption amount**

❑ **Evaluation of primary energy consumption amount**

$$\frac{\text{Design value (excludes home appliances etc.)}}{\text{Standard value (excludes home appliances etc.)}} \leqq 1.0$$

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# 1. Outline of EE Regulations in Residential Building

❑ **Promulgated on June 17, 2022 (Ministry of Land, Infrastructure, Transport and Tourism Housing Bureau**

- Mandate that **all new residential and nonresidential buildings** comply with EEC standards
- Conducted as part of the building permit process, integrated with the structural safety regulation conformity assessment.
- **Enforcement will be made by FY2025**, while ensuring a sufficient preparation period in consideration of small and medium-sized construction firms and the development of the screening system.

| | current | |
|---|---|---|
| | Non-residential | Residential |
| large-scale<br>2,000m$^2$ or more | Compliance obligation | Notification obligation |
| mid-scale | Compliance obligation | Notification obligation |
| Less than 300m$^2$<br>small scale | Explanation obligation | Explanation obligation |

➡

| | revision | |
|---|---|---|
| | Non-residential | Residential |
| large-scale<br>2,000m$^2$ or more | Compliance obligation | Compliance obligation |
| mid-scale | Compliance obligation | Compliance obligation |
| Less than 300m$^2$<br>small scale | Compliance obligation | Compliance obligation |

# 2. Examples of Simplified Calculation in Residential Building (6 Region)

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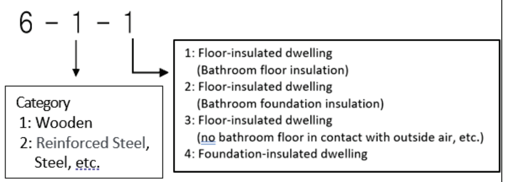
## 2. Examples of Simplified Calculation in Residential Building (6 Region)

### Simplified Calculation

**Envelope performance**

| Region | Legend of sheet number |
|---|---|
| **6<br>Region** | |
| **wooden** | |



6 − 1 − 1

Category
1: Wooden
2: Reinforced Steel, Steel, etc.

1: Floor-insulated dwelling (Bathroom floor insulation)
2: Floor-insulated dwelling (Bathroom foundation insulation)
3: Floor-insulated dwelling (no bathroom floor in contact with outside air, etc.)
4: Foundation-insulated dwelling

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## 2. Examples of Simplified Calculation in Residential Building (6 Region)

### Average heat transmission coefficient $U_A$

Please fill in the values in the bold frame below.

In the case where a single part has several different specifications, the heat transfer coefficient shall be that of the specification with the largest heat transfer coefficient. If the area of a window is less than or equal to the total floor area of the unit dwelling multiplied by 0.02, the window specification concerned may be excluded.

| | | | | Heat transmission coefficient $U$ | | Result | |
|---|---|---|---|---|---|---|---|
| Roof or ceiling | | 0.194 | × | 0.258 | = | 0.051 | (1) |
| Outer wall | general section | 0.489 | × | 0.430 | = | 0.211 | (2) |
| | Foundation wall (Entrance) | 0.004 | × | 4.11 | = | 0.017 | (3) |
| Floor | Bathroom | 0.009 | × | 3.34 | = | 0.031 | (4) |
| | Other Floors | 0.121 | × | 0.492 | = | 0.060 | (5) |
| Window | | 0.107 | × | 2.91 | = | 0.312 | (6) |
| Door | | 0.014 | × | 3.49 | = | 0.049 | (7) |

↑ Rounded up to the fourth decimal place

| | | | | Linear thermal transmittance $\psi$ | | Result | |
|---|---|---|---|---|---|---|---|
| Periphery of dirt floor, etc. | Entrance etc. | 0.021 | × | 0.99 | = | 0.021 | (8) |

↑Rounded up to the fourth decimal place

Average heat transmission coefficient of envelope: $U_A$ [W/(m$^2$·K)] Sum of (1)-(8) = 0.76

*Rounded up to the third decimal place (Conforming if the standard value is 0.87 [ W/(m$^2$·K)] or less)

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## 2. Examples of Simplified Calculation in Residential Building (6 Region)

### Average solar heat gain during cooling season $\eta_{AC}$

Please fill in the values in the bold frame below.

If a site has several different specifications, the thermal transmittance of the specification with the largest thermal transmittance should be used.
If a window has several different specifications, the vertical solar heat gain shall be the vertical solar heat gain of the specification with the largest vertical solar heat gain. If the area of a window is less than or equal to the total floor area of the unit dwelling multiplied by 0.04, the window specification concerned may be excluded.

| | | | | Heat transmission coefficient $U$ | | Result | |
|---|---|---|---|---|---|---|---|
| Roof or ceiling | | 0.659 | × | 0.258 | = | 0.171 | (9) |
| Outer wall | General section | 0.762 | × | 0.430 | = | 0.328 | (10) |
| | Foundation Wall (Entrance) | 0.004 | × | 4.11 | = | 0.017 | (11) |
| Door | | 0.020 | × | 3.49 | = | 0.070 | (12) |

↑Rounded up to the fourth decimal place

| | | | Coefficient of Vertical Surface Solar Heat Gain Coefficient $\eta_d$ | | Results | |
|---|---|---|---|---|---|---|
| Window | 4.356 | × | 0.32 | | 1.394 | (13) |

↑Rounded up to the fourth decimal place

Average solar heat gain during cooling season $\eta_{AC}$ [-] Sum of (9)-(13) = 2.0

*Rounds up to the second decimal place (Conforming if the standard value is 2.8 [-] or less)

# 2. Examples of Simplified Calculation in Residential Building (6 Region)

## Average solar heat gain during the heating season $\eta_{AH}$

Please enter the values in the bold boxes below.

If a site has several different specifications, the thermal transmittance of the specification with the largest thermal transmittance should be used.

If a window has several different specifications, the vertical surface solar heat gain shall be that of the specification with the lowest vertical surface solar heat gain. If the area of the window is less than or equal to the total floor area of the unit dwelling multiplied by 0.04, the window specification concerned may be excluded.

| | | | | Heat transmission coefficient $U$ | | Result | |
|---|---|---|---|---|---|---|---|
| Roof or ceiling | | 0.658 | × | 0.258 | = | 0.169 | (14) |
| Outer wall | general section | 0.882 | × | 0.430 | = | 0.379 | (15) |
| | Foundation Wall (Entrance) | 0.002 | × | 4.11 | = | 0.008 | (16) |
| door (Western-style) | | 0.014 | × | 3.49 | = | 0.048 | (17) |

↑Rounded down to the fourth decimal place

| | | | Coefficient of Vertical Surface Solar Heat Gain Coefficient $\eta_d$ | | Results | |
|---|---|---|---|---|---|---|
| window | 4.786 | × | 0.32 | = | 1,531 | (18) |

↑Rounded down to the fourth decimal place

Average solar heat gain during the heating season $\eta_{AH}$ [-] Sum of (14)-(18) = 2.1

*Rounded down to the second decimal place (Reference value: None)

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# 2. Examples of Simplified Calculation in Residential Building (6 Region)

## Simplified Calculation

## Primary energy consumption performance

**6**
**Region**

| Sheet No. | Principal living space | Other living space |
|---|---|---|
| 6-ENE-1 | Not installed | |
| 6-ENE-2 | Room air conditioner | |
| 6-ENE-3 | Hot water floor heating (Oil latent heat recovery hot water heater) | Room air conditioner |
| 6-EN-4 | Hot water floor heating (Gas latent heat recovery hot water heater) | Room air conditioner |

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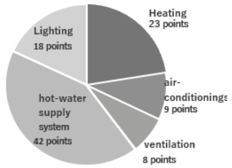
# 2. Examples of Simplified Calculation in Residential Building (6 Region)

Please fill in the envelope performance.

Please fill in the figures in the bold frame below.

| | |
|---|---|
| Average heat transmission coefficient $U_A$ [W/(㎡・K)] | 0.76 |
| Average solar heat gain during cooling season $\eta_{AC}$ [-] | 2.0 |
| Average solar heat gain during the heating season $\eta_{AH}$ [-] | 2.1 |

From the Point Listing page, post the points you selected in (1) through (5) in the bolded box below and calculate the total.



Reference] Approximate points for each facility (excluding other facilities)

Please fill in the points in the bold frame below.

| | | | | |
|---|---|---|---|---|
| heating facilities | Transcribe the numbers in (1) | = | 29 | (a) |
| air-conditioning facilities | Transcribe the numbers in (2) | = | 10 | (b) |
| ventilation equipment | Transcribe the numbers in (3) | = | 8 | (c) |
| hot-water supply system | Transcribe the numbers in (4) | = | 36 | (d) |
| Lighting equipment | Transcribe the numbers in (5) | = | 10 | (e) |

**Primary energy consumption performance points** Total of (a)-(e) = 93

(Conforming If less than or equal to 100 points)

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# 2. Examples of Simplified Calculation in Residential Building (6 Region)

## (1) Envelope performance and heating system

*Confirm the average heat transmission coefficient and the average solar heat gain during the heating season for the house in question, and check the points of the heating equipment with ☑ the relevant envelope performance value. (However, only if the average solar heat gain during the heating season is 1.8 or higher.

| Average heat transmission coefficient $U_A$ [W/(㎡・K)] | Average solar heat gain during the heating season $\eta_{AH}$ [-] | point |
|---|---|---|
| ☑ Greater than 0.69 0.78 or less | ☑ 1.8 or higher Less than 2.3 | 29 |
| | ☐ 2.3 or higher Less than 2.8 | 28 |
| | ☐ 2.8 or higher Less than 3.3 | 26 |
| | ☐ 3.3 or higher Less than 3.8 | 25 |
| | ☐ 3.8 or higher Less than 4.3 | 24 |
| | ☐ 4.3 or higher | 21 |

# 2. Examples of Simplified Calculation in Residential Building (6 Region)

### (2) Envelope performance and cooling system

*Confirm the average heat transfer coefficient of the external envelope of the house in question and the average solar heat gain during the cooling season, and check the points of the cooling system with ☑ the relevant external envelope performance value. (However, only if the average solar heat gain during the cooling season is 4.3 or less.

| Average heat transmission coefficient $U_A$ [W/($m^2$ · K)] | Average solar heat gain during the cooling season $\eta_{AC}$ [-] | point |
|---|---|---|
| ☑ 0.69 or more Less than 0.78 | ☐ 1.8 or less | 9 |
| | ☑ 1.8 Larger 2.3 or less | 10 |
| | ☐ 2.3 Larger 2.8 or less | 11 |
| | ☐ 2.8 Larger 3.3 or less | 13 |
| | ☐ 3.3 Larger 3.8 or less | 14 |
| | ☐ 3.8 Larger 4.3 or less | 16 |

### (3) Ventilation equipment

*Please check the points by ticking the appropriate ones.

| type | point |
|---|---|
| ☐ Ducted Type 1 Ventilation System | 13 |
| ☐ Ducted Type 2 ventilation equipment or ducted Type 3 ventilation equipment | 10 |
| ☐ Wall-mounted Type 1 ventilation equipment | 10 |
| ☑ Wall-mounted Type 2 ventilation equipment or Wall-mounted Type 3 ventilation equipment | 8 |

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# 2. Examples of Simplified Calculation in Residential Building (6 Region)

### (4) Hot-water supply system

*Please check the points by ticking the appropriate ones.

| type | Hot water-saving faucet*.1 | point |
|---|---|---|
| ☐ Not installed | - | 43 |
| ☐ Conventional gas water heater | ☐ No | 47 |
| | ☐ Yes | 44 |
| ☐ Gas latent heat recovery water heater | ☐ No | 40 |
| | ☐ Yes | 38 |
| ☐ Conventional oil water heaters | ☐ No | 42 |
| | ☐ Yes | 39 |
| ☐ Oil latent heat recovery water heater | ☐ No | 40 |
| | ☐ Yes | 38 |
| ☐ Electric heat pump water heater ($CO_2$ refrigerant) | ☑ No | 36 |
| | ☐ Yes | 34 |

*1: "Yes" can be selected for hot water-saving faucets when faucets with the following functions are installed in all "kitchen", "bathroom shower", and "washbasin" areas.
Kitchen": water shut-off function or priority water dispensing function
Bathroom shower: Hand-held shut-off function or low-flow discharge function
Washbasin": Priority water dispensing function

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# 2. Examples of Simplified Calculation in Residential Building (6 Region)

### (5) Lighting equipment

*Check the points for all fixtures in the main living room and all other living rooms by ☑ in the appropriate combination. However, lighting fixtures in non-occupied rooms must be non-incandescent.

| type | | point |
|---|---|---|
| Lighting fixtures in principal living rooms*.2 | Lighting fixtures in other living rooms *.2 | |
| ☐ Not installed | ☐ Not installed | 9 |
| | ☐ LED | 9 |
| | ☐ Other than incandescent lamps | 10 |
| | ☐ Incandescent lamp | 13 |
| ☑ LED | ☐ Not installed | 9 |
| | ☐ LED | 9 |
| | ☑ Other than Incandescent lamps | 10 |
| | ☐ Incandescent lamp | 13 |
| ☐ Other than incandescent lamps | ☐ Not installed | 11 |
| | ☐ LED | 11 |
| | ☐ Other than incandescent lamps | 11 |
| | ☐ Incandescent lamp | 14 |
| ☐ Incandescent lamp | ☐ Not installed | 15 |
| | ☐ LED | 15 |
| | ☐ Other than incandescent lamps | 16 |
| | ☐ Incandescent lamp | 18 |

2: "LED": LEDs are used in all devices.
"Non-incandescent": All equipment uses non-incandescent lamps.
"Incandescent": Incandescent lamps are used in any of the devices.

---

# 2. Examples of Simplified Calculation in Residential Building (6 Region)

## Primary energy consumption calculation results (residential version)

### 1. Design primary energy consumption etc.

| | | | | |
|---|---|---|---|---|
| (1) Name of housing type | ○○○○ residence ( detached house) | | | |
| (2) Floor area. | Principal living space | Other living space | Non-living space | Total |
| | 29.81 m2 | 51.34 m2 | 38.93 m2 | 120.08 m2 |
| (3) Regional classification | 6 Region | | ********** | |
| (4) Primary energy consumption (per dwelling) | | | Design primary [MJ]. | Standard Primary [MJ]. |
| | heating facilities | | 17236 | 15382 |
| | air-conditioning facilities | | 5390 | 5611 |
| | ventilation equipment | | 4583 | 4542 |
| | hot-water supply system | | 20940 | 25091 |
| | lighting equipment | | 5964 | 10763 |
| | Other equipment. | | 21241 | 21241 |
| | On-site consumption of electricity generated by power generation facilities *1 | | -- | -- |
| | Deductions related to the amount of electricity sold from cogeneration facilities *2 | | -- | -- |
| | total amount | | 75353 | 82629 |
| (5) BEI | Primary energy consumption (excluding others) [GJ/(unit/year)]. | | 54.2 | 61.4 |
| | BEI | | 0.89 | |

*1: Power generation facilities include cogeneration facilities and photovoltaic facilities. *2: This is the amount of primary energy consumption required to generate the electricity sold by the cogeneration facility.

# 3. Examples of Simplified Calculation in Residential Building (8 Region)

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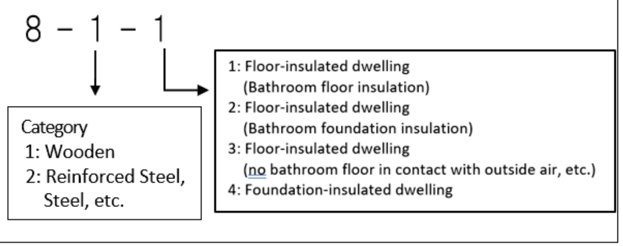
## 3. Examples of Simplified Calculation in Residential Building (8 Region)

**Simplified Calculation**

**Envelope performance**

| Region | Legend of sheet number |
|---|---|
| **8<br>Region** |  8 − 1 − 1<br>Category<br>1: Wooden<br>2: Reinforced Steel, Steel, etc.<br>1: Floor-insulated dwelling (Bathroom floor insulation)<br>2: Floor-insulated dwelling (Bathroom foundation insulation)<br>3: Floor-insulated dwelling (no bathroom floor in contact with outside air, etc.)<br>4: Foundation-insulated dwelling |
| **wooden** | |

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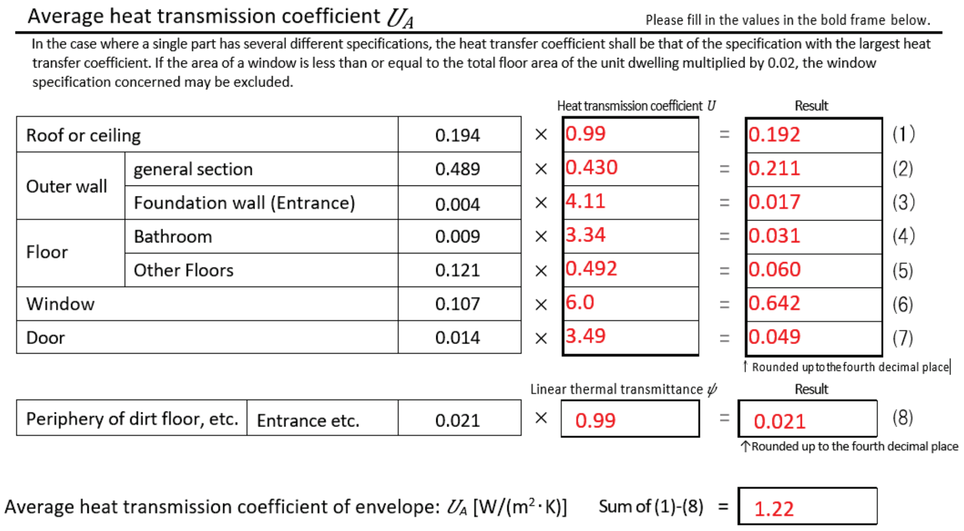
## 3. Examples of Simplified Calculation in Residential Building (8 Region)



Average heat transmission coefficient $U_A$ Please fill in the values in the bold frame below.

In the case where a single part has several different specifications, the heat transfer coefficient shall be that of the specification with the largest heat transfer coefficient. If the area of a window is less than or equal to the total floor area of the unit dwelling multiplied by 0.02, the window specification concerned may be excluded.

| | | | | Heat transmission coefficient $U$ | | Result | |
|---|---|---|---|---|---|---|---|
| Roof or ceiling | | 0.194 | × | 0.99 | = | 0.192 | (1) |
| Outer wall | general section | 0.489 | × | 0.430 | = | 0.211 | (2) |
| | Foundation wall (Entrance) | 0.004 | × | 4.11 | = | 0.017 | (3) |
| Floor | Bathroom | 0.009 | × | 3.34 | = | 0.031 | (4) |
| | Other Floors | 0.121 | × | 0.492 | = | 0.060 | (5) |
| Window | | 0.107 | × | 6.0 | = | 0.642 | (6) |
| Door | | 0.014 | × | 3.49 | = | 0.049 | (7) |

↑ Rounded up to the fourth decimal place

| | | | | Linear thermal transmittance $\psi$ | | Result | |
|---|---|---|---|---|---|---|---|
| Periphery of dirt floor, etc. | Entrance etc. | 0.021 | × | 0.99 | = | 0.021 | (8) |

↑Rounded up to the fourth decimal place

Average heat transmission coefficient of envelope: $U_A$ [W/(m²·K)] Sum of (1)-(8) = 1.22

Note 1: $U_A$ of roof /ceiling was adopted the standard value in region 8 while other values are set at same value as region 6 (there is no standard values for them).
Note 2: For window, adopted coefficient of vertical surface solar heat gain of single-layer glass.

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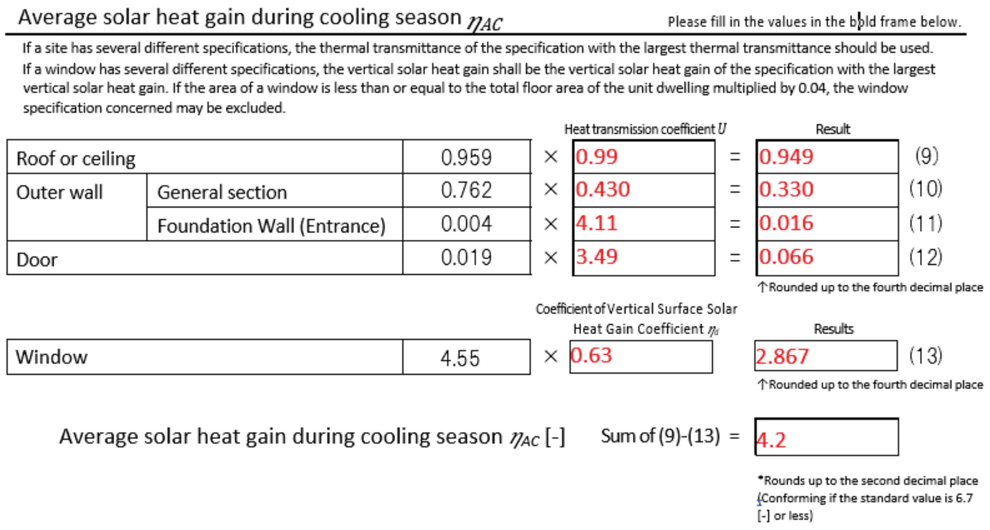
## 3. Examples of Simplified Calculation in Residential Building (8 Region)



Average solar heat gain during cooling season $\eta_{AC}$ Please fill in the values in the bold frame below.

If a site has several different specifications, the thermal transmittance of the specification with the largest thermal transmittance should be used.
If a window has several different specifications, the vertical solar heat gain shall be the vertical solar heat gain of the specification with the largest vertical solar heat gain. If the area of a window is less than or equal to the total floor area of the unit dwelling multiplied by 0.04, the window specification concerned may be excluded.

| | | | | Heat transmission coefficient $U$ | | Result | |
|---|---|---|---|---|---|---|---|
| Roof or ceiling | | 0.959 | × | 0.99 | = | 0.949 | (9) |
| Outer wall | General section | 0.762 | × | 0.430 | = | 0.330 | (10) |
| | Foundation Wall (Entrance) | 0.004 | × | 4.11 | = | 0.016 | (11) |
| Door | | 0.019 | × | 3.49 | = | 0.066 | (12) |

↑Rounded up to the fourth decimal place

| | | | Coefficient of Vertical Surface Solar Heat Gain Coefficient $\eta_d$ | Results | |
|---|---|---|---|---|---|
| Window | 4.55 | × | 0.63 | 2.867 | (13) |

↑Rounded up to the fourth decimal place

Average solar heat gain during cooling season $\eta_{AC}$ [-] Sum of (9)-(13) = 4.2

*Rounds up to the second decimal place
(Conforming if the standard value is 6.7 [-] or less)

Note : For window, adopted coefficient of vertical surface solar heat gain of single-layer glass.

## 3. Examples of Simplified Calculation in Residential Building (8 Region)

# Simplified Calculation

## Primary energy consumption performance

**8**
**Region**

| Sheet No. | Principal living space | Other living space |
|---|---|---|
| 8-ENE-1 | Not installed | |
| 8-ENE-2 | Room air conditioner | |

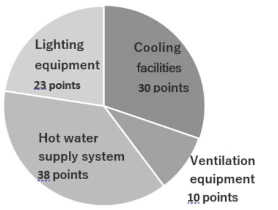
## 3. Examples of Simplified Calculation in Residential Building (8 Region)

Please fill in the envelope performance.

Please fill in the figures in the bold frame below.

| | |
|---|---|
| Average heat transmission coefficient $U_A$ [W/(㎡・K)] | 1.22 |
| Average solar heat gain during cooling season $\eta_{AC}$ [-] | 4.2 |

From the Point Listing page, post the points you selected in (1) through (4) in the bolded box below and calculate the total.



Reference] Approximate points for each facility (excluding other facilities)

Please fill in the points in the bold frame below.

| | | | | |
|---|---|---|---|---|
| air-conditioning facilities | Transcribe the numbers in (1) | = | 35 | (a) |
| ventilation equipment | Transcribe the numbers in (2) | = | 10 | (b) |
| hot-water supply system | Transcribe the numbers in (3) | = | 26 | (c) |
| Lighting equipment | Transcribe the numbers in (4) | = | 12 | (d) |

**Primary energy consumption performance points** Total of (a)-(d) = 83

(Conforming If less than or equal to 100 points)

## 3. Examples of Simplified Calculation in Residential Building (8 Region)

### (1) Envelope performance and cooling system

*Confirm the average heat transfer coefficient of the external envelope of the house in question and the average solar heat gain during the cooling season, and check the points of the cooling system with ☑ the relevant external envelope performance value. (However, only if the average solar heat gain during the cooling season is 8.7 or less.

| Average heat transmission coefficient $U_A$ [W/(㎡・K)] | Average solar heat gain during the cooling season $\eta_{AC}$ [-] | point |
|---|---|---|
| ☑ 1.05 or more Less than 1.50 | ☐ 1.7 or less | 19 |
| | ☐ 1.7 Larger 2.7 or less | 25 |
| | ☐ 2.7 Larger 3.7 or less | 30 |
| | ☑ 3.7 Larger 4.7 or less | 35 |
| | ☐ 4.7 Larger 5.7 or less | 40 |
| | ☐ 5.7 Larger 6.7 or less | 45 |
| | ☐ 6.7 Larger 7.7 or less | 50 |
| | ☐ 7.7 Larger 8.7 or less | 55 |
| ☐ 1.50 or more Less than 1.95 | ☐ 1.7 or less | 17 |
| | ☐ 1.7 Larger 2.7 or less | 22 |
| | ☐ 2.7 Larger 3.7 or less | 26 |
| | ☐ 3.7 Larger 4.7 or less | 30 |
| | ☐ 4.7 Larger 5.7 or less | 35 |
| | ☐ 5.7 Larger 6.7 or less | 40 |
| | ☐ 6.7 Larger 7.7 or less | 45 |
| | ☐ 7.7 Larger 8.7 or less | 49 |

## 3. Examples of Simplified Calculation in Residential Building (8 Region)

### (2) Ventilation equipment

*Please check the points by ticking the appropriate ones.

| type | point |
|---|---|
| ☐ Ducted Type 1 Ventilation System | 16 |
| ☐ Ducted Type 2 ventilation equipment or ducted Type 3 ventilation equipment | 13 |
| ☐ Wall-mounted Type 1 ventilation equipment | 13 |
| ☑ Wall-mounted Type 2 ventilation equipment or Wall-mounted Type 3 ventilation equipment | 10 |

### (3) Hot-water supply system

*Please check the points by ticking the appropriate ones.

| type | Hot water-saving faucet*.1 | point |
|---|---|---|
| ☐ Not installed | - | 38 |
| ☐ Conventional gas water heater | ☐ No | 42 |
| | ☐ Yes | 39 |
| ☐ Gas latent heat recovery water heater | ☐ No | 36 |
| | ☐ Yes | 33 |
| ☐ Conventional oil water heaters | ☐ No | 38 |
| | ☐ Yes | 35 |
| ☐ Oil latent heat recovery water heater | ☐ No | 36 |
| | ☐ Yes | 33 |
| ☐ Electric heat pump water heater ($CO_2$ refrigerant) | ☑ No | 26 |
| | ☐ Yes | 25 |

## 3. Examples of Simplified Calculation in Residential Building (8 Region)

### (4) Lighting equipment

*Check the points for all fixtures in the main living room and all other living rooms by ☑ in the appropriate combination. However, lighting fixtures in non-occupied rooms must be non-incandescent.

| type | | point |
|---|---|---|
| Lighting fixtures in principal living rooms*.[2] | Lighting fixtures in other living rooms *.[2] | |
| ☐ Not installed | ☐ Not installed | 11 |
| | ☐ LED | 11 |
| | ☐ Other than incandescent lamps | 12 |
| | ☐ Incandescent lamp | 16 |
| ☑ LED | ☐ Not installed | 11 |
| | ☐ LED | 11 |
| | ☑ Other than Incandescent lamps | 12 |
| | ☐ Incandescent lamp | 16 |
| ☐ Other than incandescent lamps | ☐ Not installed | 13 |
| | ☐ LED | 13 |
| | ☐ Other than incandescent lamps | 14 |
| | ☐ Incandescent lamp | 17 |
| ☐ Incandescent lamp | ☐ Not installed | 19 |
| | ☐ LED | 19 |
| | ☐ Other than incandescent lamps | 20 |
| | ☐ Incandescent lamp | 23 |

2: "LED": LEDs are used in all devices.

"Non-incandescent": All equipment uses non-incandescent lamps.

"Incandescent": Incandescent lamps are used in any of the devices.

---

## 3. Examples of Simplified Calculation in Residential Building (8 Region)

### 1. Design primary energy consumption etc.

| | | | | |
|---|---|---|---|---|
| (1) Name of housing type | ○○○○ residence ( detached house) | | | |
| (2) Floor area. | Principal living space | Other living space | Non-living space | Total |
| | 29.81 m2 | 51.34 m2 | 38.93 m2 | 120.08 m2 |
| (3) Regional classification | 8 Region | | ********** | |
| (4) Primary energy consumption (per dwelling) | | | Design primary [MJ]. | Standard Primary [MJ]. |
| | heating facilities | | 0 | 0 |
| | air-conditioning facilities | | 15483 | 21289 |
| | ventilation equipment | | 4583 | 4542 |
| | hot-water supply system | | 12338 | 17922 |
| | lighting equipment | | 5964 | 10763 |
| | Other equipment. | | 21241 | 21241 |
| | total amount | | 59609 | 75756 |
| (5) BEI | Primary energy consumption (excluding others) [GJ/(unit/year)]. | | 38.4 | 54.6 |
| | BEI | | 0.71 | |

*1: Power generation facilities include cogeneration facilities and photovoltaic facilities. *2: This is the amount of primary energy consumption required to generate the electricity sold by the cogeneration facility.

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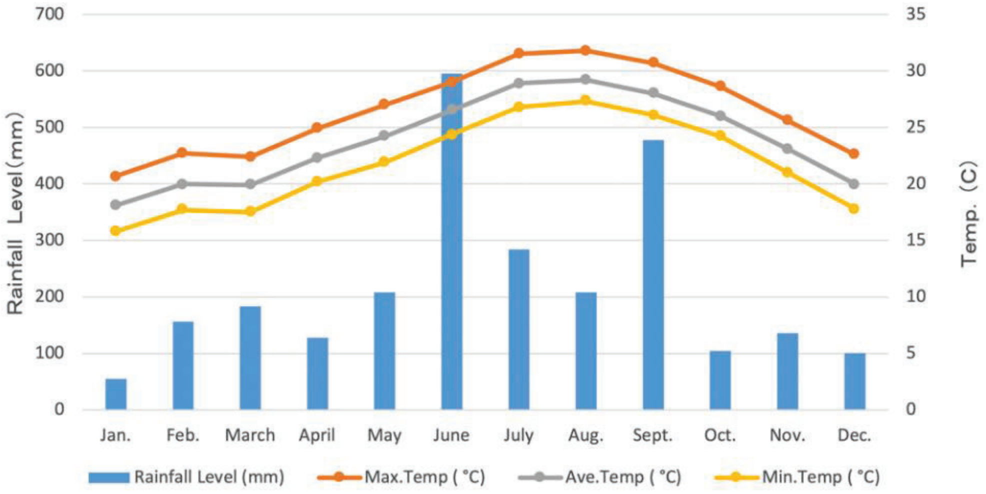
## [Ref] Rainfall level & average temperature in Okinawa, 8 Region, 2019



Data source: Japan Meteorological Agency

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# 4. EEC Unique Approaches in Residential Building, Okinawa, Japan

# 4. EEC Unique Approaches in Residential Building, Okinawa

## Energy Reduction Effects by Applying Efficient Technologies in Okinawa

| Use | Energy consumption standard value (GJ) | Efficient technology | Energy consumption rate (standard value is set at 1.0) more efficient → | | | |
|---|---|---|---|---|---|---|
| | | | Level 1 | Level 2 | Level 3 | Level 4 |
| Cooling | 10.3 (15%) | Use and control of natural wind | 0.96 | 0.91 | 0.88 | |
| | | Solar radiation shielding method | 0.9 | 0.8 | 0.75 | 0.7 |
| | | Cooling system plan (efficient AC, etc.) | 0.9 | 0.8 | 0.75 | 0.65 |
| Ventilation | 3.1 (5%) | Ventilation equipment: ducted | 0.7 | 0.5 | | |
| | 2.8 | Ventilation equipment: wall-mounted | 0.8 | | | |
| Hot water supply | 13.8 (21%) | Solar hot water supply | 0.9 | 0.7 | 0.5 | 0.3 |
| | | Hot water supply system | 0.9 | 0.8 | - | 0.6 |
| Lighting | 13.6 (20%) | Daylight use | 0.97～0.98 | 0.95 | 0.9 | |
| | | Lighting Equipment planning | 0.85 | 0.8 | 0.7 | |
| Appliances | 21.4 (32%) | Introduction of high-efficiency appliances | 0.8 | 0.6 | | |
| Other (Cooking) | 4.4 (7%) | | | | | |
| Total amount | 66.6<br>66.3 | | | | | |

Source: Energy efficient house guidelines (Okinawa prefecture, 2015)

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# 4. EEC Unique Approaches in Residential Building, Okinawa

## Adopted EE Methods and Estimation of Energy Saving Effects - Example of the Model House - (1)

| Use | Efficient technologies | Evaluation level | Energy consumption rate | Adopted EE methods |
|---|---|---|---|---|
| Cooling | Use of natural wind | 3 | 0.88 | • Openings on ventilation paths<br>• Openings with consideration of the prevailing wind direction<br>• Use of high windows |
| | Solar radiation shielding method | 4 | 0.7 | • Thermal barrier paint<br>• Thermal barrier block |
| | Cooling system planning | 3 | 0.75 | • High-efficiency air conditioner (COP 4 or higher) + fan |
| Hot water supply | Hot water supply system planning | 4 | 0.6 | • CO2 heat pump water heater |
| Ventilation | Ventilation system planning | 1 | 0.8 | • Simplified ventilation system |
| Lighting | Daylight use | 2 | 0.95 | • LD and individual rooms |
| | Lighting Equipment Planning | 3 | 0.7 | • High efficiency, control, and design ingenuity |
| Appliances | | 2 | 0.6 | • Efficient products + reduced standby power |

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# 4. EEC Unique Approaches in Residential Building, Okinawa

## Adopted EE Methods and Estimation of Energy Saving Effects - Example of the Model House - (2)

| Use | Standard value (GJ) | A | B | C | Design value (GJ) | Energy saving rate (%) | Note |
|---|---|---|---|---|---|---|---|
| Cooling | 10.3 | 0.88 | 0.7 | 0.75 | 4.76 | 53.7 | 4.76 = 10.3 X 0.88 X 0.7 X 0.75 |
| Hot water supply | 13.8 | 0.6 | | | 8.28 | 40.0 | 8.28 = 13.8 X 0.6 |
| Ventilation | 3.1 | 0.8 | | | 2.48 | 20.0 | 2.48 = 3.1 x 0.8 |
| Lighting | 13.6 | 0.95 | 0.7 | | 9.04 | 33.5 | 9.04 = 13.6 x 0.95 x 0.7 |
| Appliances | 21.4 | 0.6 | | | 12.84 | 40.0 | 12.84 = 21.4 x 0.6 |
| Other | 4.4 | | | | 4.4 | 0 | |
| Total | 66.6 | | | | 41.8 | 37.2 | |

Energy saving rate

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# 4. EEC Unique Approaches in Residential Building, Okinawa

## Key Points 1: Sunshine Shield

●Methods to shield sunshine

✓ It is basic to keep the building skeleton close to the ambient temperature, not to heat it.

✓ The strong sunshine of Okinawa should be blocked outside.

Sunshine Shield in Urban Area

Sunshine Shield in Suburban Area

## 4. EEC Unique Approaches in Residential Building, Okinawa

**Key Points 1: Sunshine Shield**

- Green roof

- Solar Heat Shielding Paint

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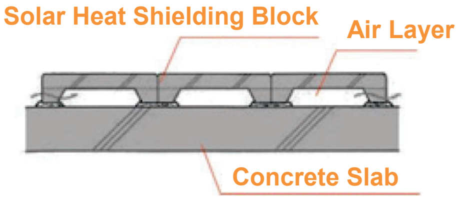
## 4. EEC Unique Approaches in Residential Building, Okinawa

**Key Points 1: Sunshine Shield**

- Solar Heat Shielding Block



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## 4. EEC Unique Approaches in Residential Building, Okinawa

**Key Points 1: Sunshine Shield**

- HANA Block

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## 4. EEC Unique Approaches in Residential Building, Okinawa

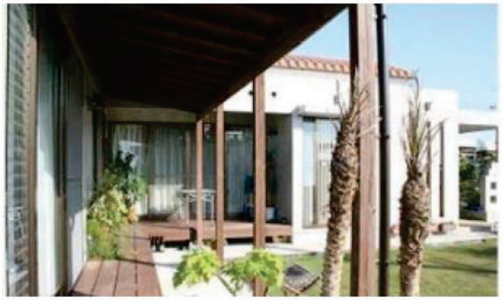
**Key Points 1: Sunshine Shield**

- Wall-surface Greening

## 4. EEC Unique Approaches in Residential Building, Okinawa

### Key Points 1: Sunshine Shield

- **AMAHAJI**



**AMAHAJI is Okinawa's traditional eaves where customers are welcomed as there is not entrance in Okinawa's unique houses.**

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## 4. EEC Unique Approaches in Residential Building, Okinawa

### Key Points 1: Sunshine Shield

- **Eaves**

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## 4. EEC Unique Approaches in Residential Building, Okinawa

### Key Points 1: Sunshine Shield

- **Louver**

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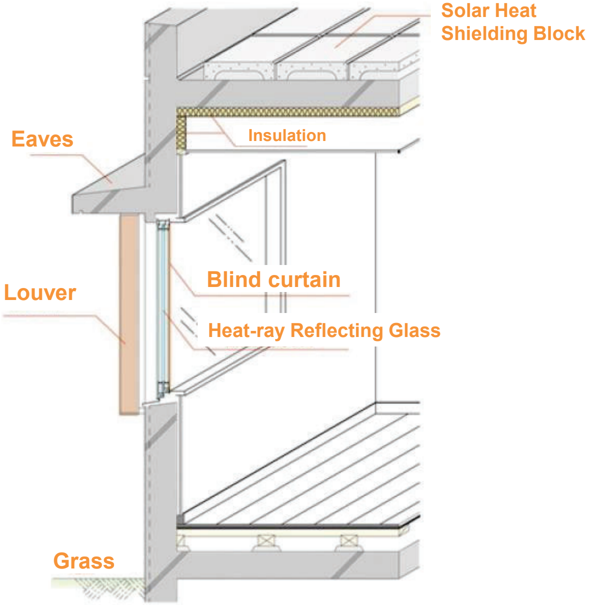
## 4. EEC Unique Approaches in Residential Building, Okinawa

### Key Points 1: Sunshine Shield

**Example of Solar Heat Shielding Measures for Opening and Roof** ⇨

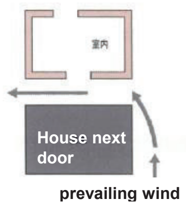


# 4. EEC Unique Approaches in Residential Building, Okinawa

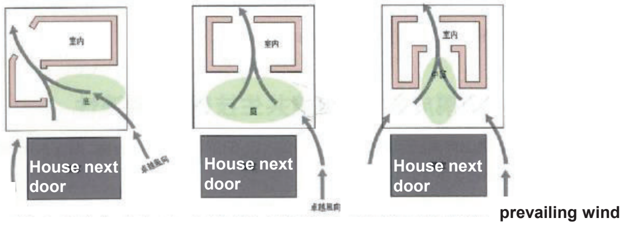
**Key Points 2: Create Cool Breeze, Bring Cool Breeze**

●Methods to Create Cool Breeze, Bring Cool Breeze

- ✓ It is basic to **bring cool breeze in rooms**
- ✓ Ingenuity in **building layout and window positions**
  - ➢ In summer, cool breezes are drawn into the building from the south.
  - ➢ In winter, the wind from the north should be blocked.



If the house is close to the house next door, the wind will blow parallel to the window. It will be difficult to have wind into the room.



**Wind can be taken in effectively if a certain space (e.g. garden) is provided without being in close contact with the house next door.**

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# 4. EEC Unique Approaches in Residential Building, Okinawa

**Key Points 2: Create Cool Breeze, Bring Cool Breeze**

➢ **Windows at high position**

Windows at high position (from outside)

Windows at high position (from inside)

---

# 4. EEC Unique Approaches in Residential Building, Okinawa

**Key Points 2: Create Cool Breeze, Bring Cool Breeze**

➢ **Security-friendly small window**

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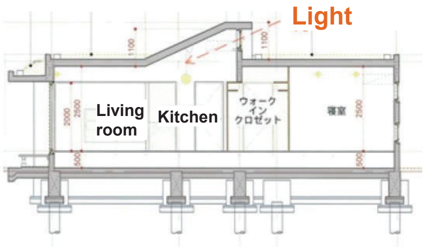
# 4. EEC Unique Approaches in Residential Building, Okinawa

**Key Points 3: Make good use of daylight**

●Methods to Make good use of daylight

- ✓ It is basic to **allow light to enter a room while blocking direct sunshine.**
- ✓ Utilization of **inner court, high sidelight (windows on high position) and louver**, etc.

➢ **High Sidelight**



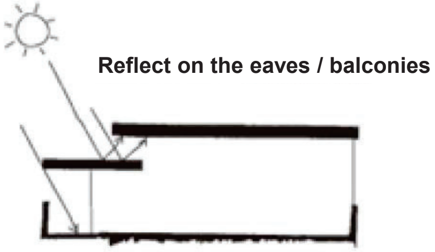
High Sidelight

High Sidelight (sunshine enters indirectly)

## 4. EEC Unique Approaches in Residential Building, Okinawa

### Key Points 3: Make good use of daylight

- **Introduction of light shelf concept**



- If the eaves on the south side of the building are made two-tiered, the eaves blocks direct sunshine from entering the window.
- The light reflected on the upper part of the eaves is diffusely reflected on the ceiling of the room and light up the back of the room.

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## 4. EEC Unique Approaches in Residential Building, Okinawa

### Key Points 3: Make good use of daylight

- **HANA Block**

Lighting with utilization of HANA block

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Thank you very much for your kind attention !