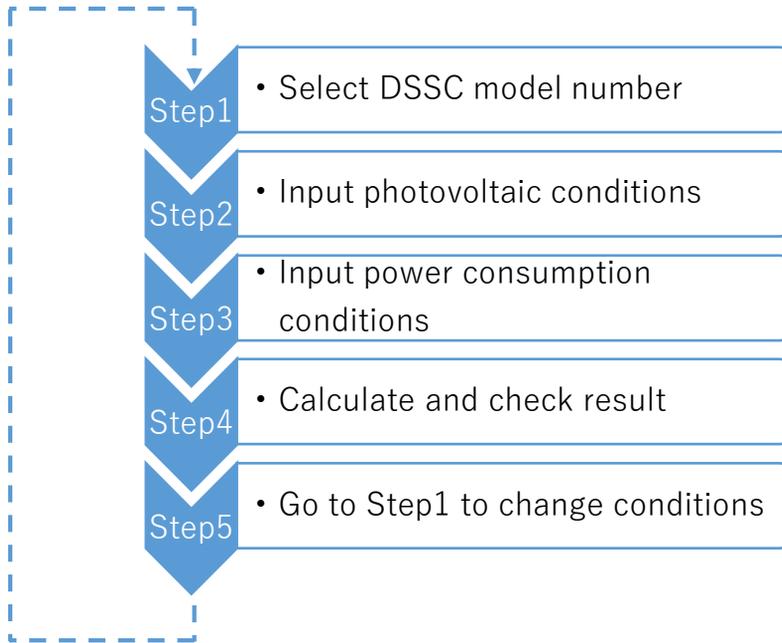


How to Use Energy Balance Simulator

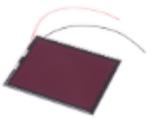
This simulator tells whether your IoT device can run by DSSC power supply or not. You can accelerate your development because you don't have to repeat try and error on prototype tests. For the final judgement which one to use, please test with an actual DSSC.



Step1 Select DSSC model number

Select DSSC model number you want to try.

Step 1 Select a DSSC to use



FDSC-FSC7FGC
: 70.0 x 92.0 mm, Thickness 2.5 mm
Effective area 50.2 cm²



FDSC-FSC10FGC
: 39.9 x 35.0 mm, Thickness 2.5 mm
Effective area 6.7 cm²



FDSC-FSC4FGC
: 56.0 x 112.0 mm, Thickness 2.5 mm
Effective area 48.2 cm²



FDSC-FSC12FGC
: 23.9 x 62.3 mm, Thickness 2.5 mm
Effective area 7.2 cm²



FDSC-FSC5FGC (under development)
: 70.0 x 92.0 mm, Thickness 2.5 mm
Effective area 26.4 cm²

How to Use Energy Balance Simulator

Step2 Input photovoltaic conditions

2-1 Light irradiation

Input/Select light irradiation conditions.

- ① Illuminance
Select illuminance value in pull down list (min:100 lx, max:10,000 lx)
When over 10,000 lx, please select 10,000 lx because DSSC power generation is almost same over 10,000lx.
- ② DSSC surface temperature
Select DSSC surface temperature in pull down list (min:-30° C, max:60° C)
- ③ Light irradiation time
Input light irradiation time per day (max:24h/day)

Step 2 Input parameters about power generation

(Please use the default value if unknown)

2-1 Parameters about lighting

Illuminance = lx

Estimated surface temperature of DSSC = °C

Lighting time = hr(s)/day (0~24)

2-2 DSSC power management circuit design

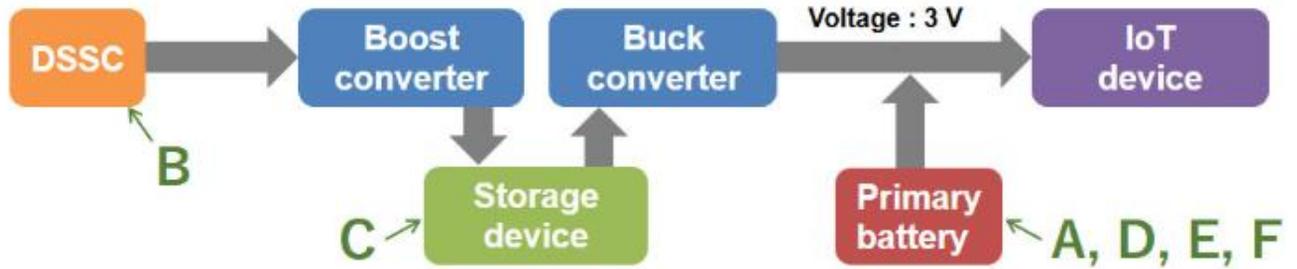
Input/Select power source configurations.

- A) Primary battery
Select "YES" to add a primary battery for backup.
- B) Number of DSSC
Input number of DSSC to use.
- C) Capacity of lithium ion capacitor
Select capacity of lithium ion capacitor in pull down list (20F or 40F).
- D) Capacity of primary battery (If A= "YES")
Input capacity of primary battery for backup as a positive number.
- E) Effective capacity ratio of primary battery (If A= "YES")
Input how much % of the capacity to be used by natural number.
- F) Expected life of primary battery (If A= "YES")
Input expected life of primary battery as a positive number.

How to Use Energy Balance Simulator

2-2 Parameters about power circuit design

Block diagram of DSSC power module



- A. Use primary battery =
- B. Number of DSSC = pcs.
- C. Capacity of Lithium ion capacitor = F
- D. Capacity of primary battery = mAh (3.0V lithium battery)
- E. Effective capacity ratio of primary battery = %
- F. Expected life of primary battery = year(s) (0~10)

Step3 Power consumption of your IoT device

Input/select power consumption conditions of your IoT device.

- G) Work pattern
Select "Single work pattern" for single work pattern
Select "Double work pattern" for double work patterns

Example

Single work pattern : Sense and transmit data periodically and simultaneously

Double work pattern : Sense multiple times and transmit all data at once

Step 3

Input parameters about current consumption of your IoT device

(Please use the default value if unknown)

G. Work pattern =

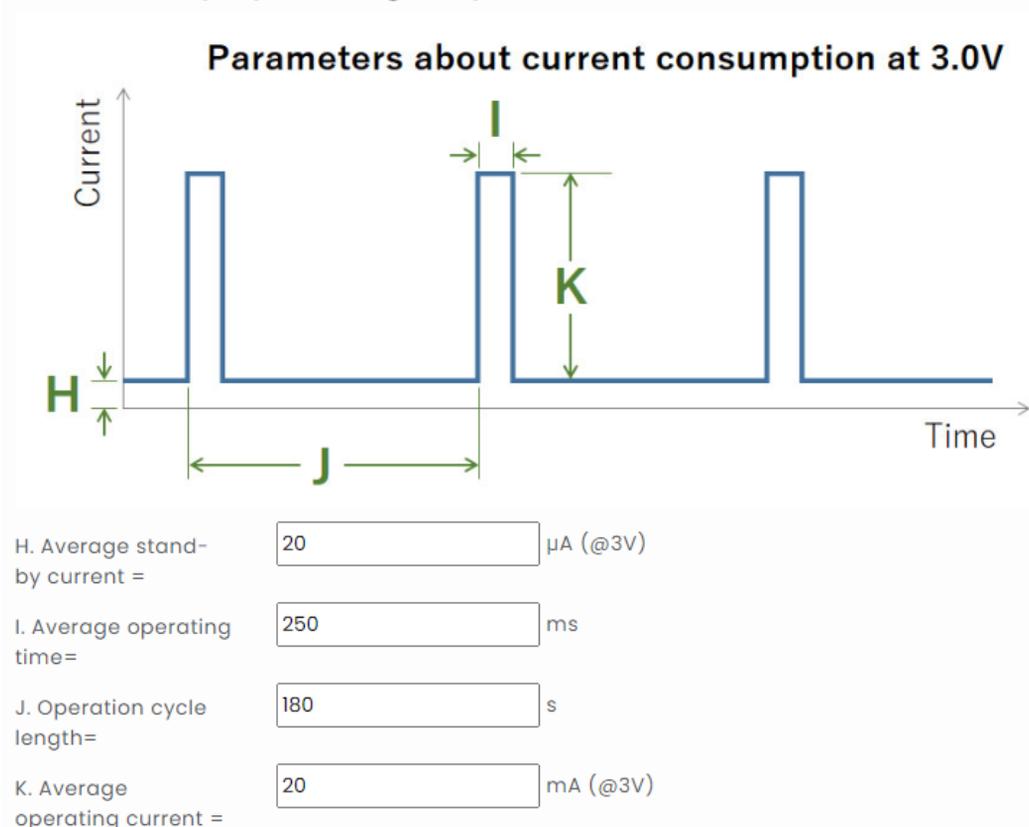
How to Use Energy Balance Simulator

3-1 Primary Operating Sequence

Input parameters of single work pattern.

- H) Average stand-by current
Input average stand-by current as a positive number.
- I) Average operating time
Input average operating time as a positive number.
- J) Operation cycle length
Input operation cycle length as a positive number.
- K) Average operating current
Input average operating current as a positive number.

3-1 Primary operating sequence



3-2 Secondary Operating Sequence

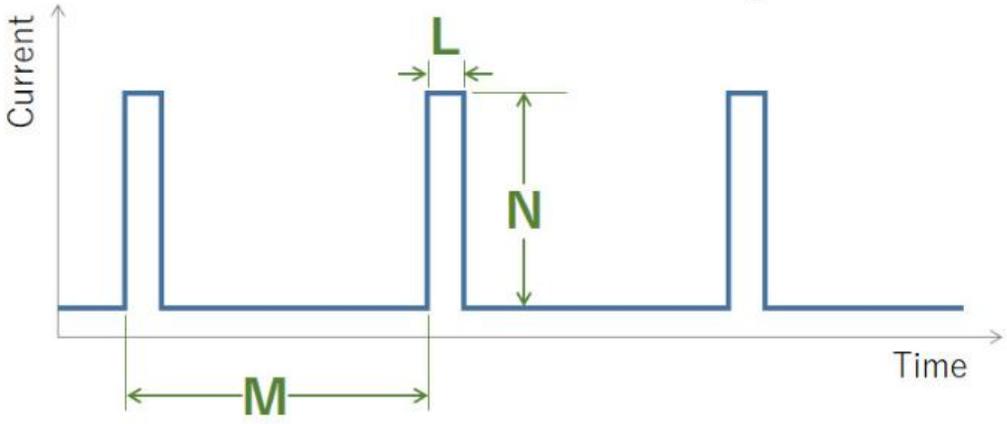
Input parameters of the other work pattern (only if G= "Double work pattern")

- L) Average operating time
Input average operating time as a positive number.
- M) Operation cycle length
Input operation cycle length as a positive number.
- N) Average operation current
Input average operation current as a positive number.

How to Use Energy Balance Simulator

3-2 Secondary operating sequence

Parameters about current consumption at 3.0V



L. Average operating time = ms (@3V)

M. Operation cycle time = s

N. Average operating current = mA (@3V)

Step4 Calculation

- Push "calculate" button to calculate.
- Push "reset" button to reset above parameters.

Step 4 Check input parameters and push "calculate" to calculate.

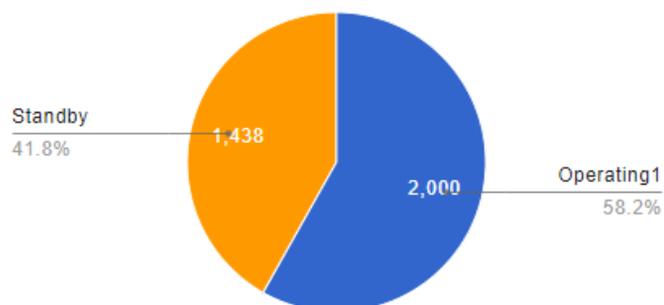


What do the results mean?

Total power Consumption

This pie graph shows necessary electric power for device operation and stand by per day. You can easily understand which one to be selected to reduce the whole device power consumption effectively when it is unable to run your IoT device with selected DSSC model.

Total Power Consumption ($\mu\text{Wh/day}$)



How to Use Energy Balance Simulator

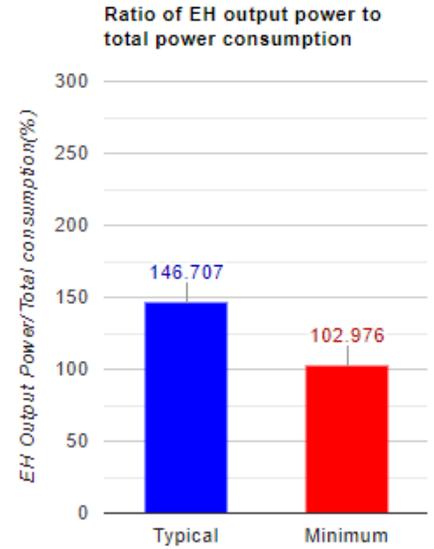
Ratio of EH output power to total power consumption

Left bar shows the ratio of typical DSSC power generation^{*1)} to necessary electric power of your IoT device. Right bar shows the ratio of minimum DSSC power generation^{*2)} to that.

If the bar is over 100%, selected DSSC is capable to run the device. On the other hand, if the bar is under 100%, you need to change to larger DSSC or to reduce the power consumption of the device. Another option is a hybridization with primary battery. To activate this option, select "YES" at section 2-2 A. Use primary battery.

*1) Typical DSSC power generation : typical output which is described in the specification sheet

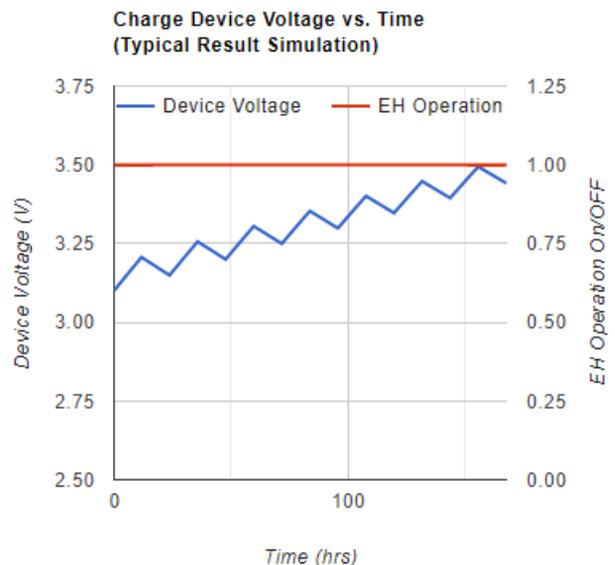
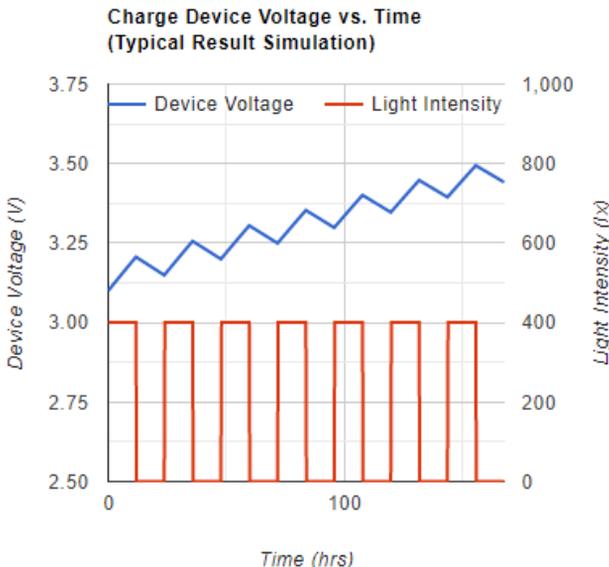
*2) Minimum DSSC power generation : specified output which is described in the specification sheet



Charge Device Voltage vs. Time (Typical Result Simulation)

The blue lines in these graphs show voltage fluctuation of the lithium ion capacitor when the DSSC output is typical value. The horizontal axis means time span of 1 week or 168 hours. In this calculation, upper voltage limit is set to 3.7 V to prevent overcharging, lower voltage limit is set to 3.0 V to prevent over discharging. These are fixed value. If the voltage is higher than the initial value after 24 hours from time zero, that means the DSSC power generation exceeds the power consumption of the IoT device. If the voltage is lower, that means the DSSC power generation is not enough to run it. In this case, select larger DSSC, reduce power consumption of the IoT device, or add primary battery and then calculate again.

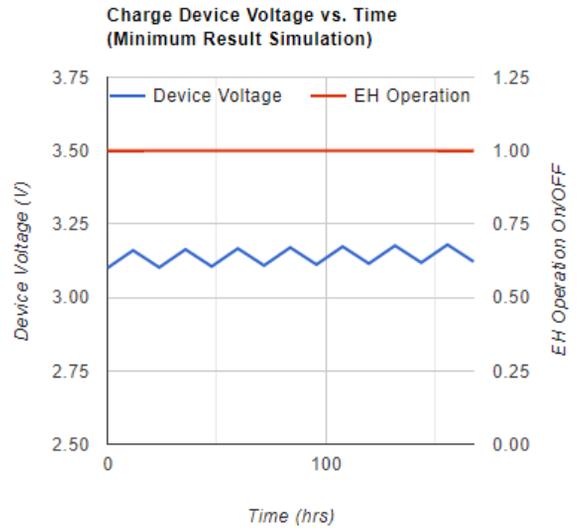
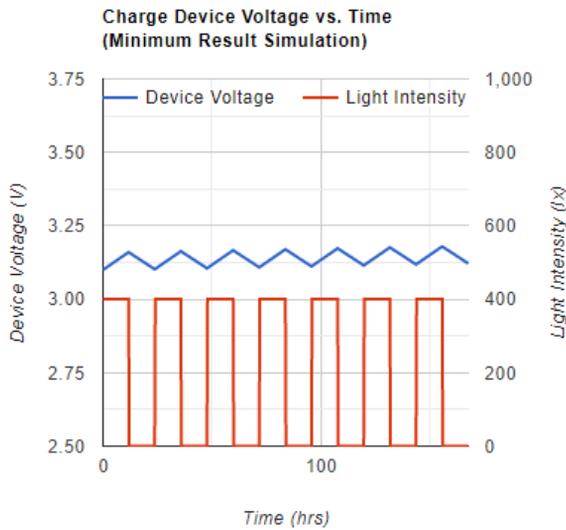
In the left graph, red line shows the illuminance and light irradiation time which is input at Step 2-1. In the right graph, red line shows availability of rated power output by DSSC. Value 1.00 means the rated power output is available and 0.00 means not available. When you adopt primary battery, 0.00 means the IoT device runs by it, not by DSSC.



How to Use Energy Balance Simulator

Charge Device Voltage vs. Time (Minimum Result Simulation)

This part shows the same result when the DSSC output is minimum value.



DSSC applicability by illuminance and irradiation time

Below tables show DSSC applicability under each illuminance and irradiation time condition. The vertical axis shows illuminance (lx) and the horizontal axis shows irradiation time (hours/day).

This result changes by with or without primary battery.

WITHOUT primary battery

Green color means both of the typical output and minimum output is higher than the power consumption of the IoT device.

Yellow color means the typical output is higher but the minimum output is lower than that.

Red color means both of the output are lower than that.

WITHOUT primary battery

Illuminance(lx)	2 hr/d	4 hr/d	8 hr/d	12 hr/d	24 hr/d	Legend
100	Red	Red	Red	Red	Red	Bad
200	Red	Red	Red	Red	Yellow	Marginal
300	Red	Red	Red	Yellow	Green	Good
400	Red	Red	Red	Green	Green	Good
500	Red	Red	Yellow	Green	Green	Good
600	Red	Red	Green	Green	Green	Good
700	Red	Red	Green	Green	Green	Good
800	Red	Yellow	Green	Green	Green	Good
900	Red	Yellow	Green	Green	Green	Good
1000	Red	Yellow	Green	Green	Green	Good
1500	Red	Green	Green	Green	Green	Good
2000	Yellow	Green	Green	Green	Green	Good
2500	Green	Green	Green	Green	Green	Good
3000	Green	Green	Green	Green	Green	Good
4000	Green	Green	Green	Green	Green	Good
5000	Green	Green	Green	Green	Green	Good
6000	Green	Green	Green	Green	Green	Good
Over 10000	Green	Green	Green	Green	Green	Good

How to Use Energy Balance Simulator

WITH primary battery

In this case, judgement criteria is to meet F: expected life of primary battery in step 2-2 or not.

Green color means both of the typical output and minimum output is capable to achieve the expected primary battery life.

Yellow color means only the typical output is capable.

Red color means both of the output aren't capable.

And blue green color means the DSSC output is enough then primary battery isn't required to run the IoT device.

WITH primary battery

Illuminance(lx)	2 hr/d	4 hr/d	8 hr/d	12 hr/d	24 hr/d	Legend	
100	Red	Red	Red	Red	Red	Bad	
200	Red	Red	Red	Red	Green		Average
300	Red	Red	Red	Green	Green		
400	Red	Red	Yellow	Green	Green		Excellent
500	Red	Red	Green	Green	Green		
600	Red	Yellow	Green	Green	Green		
700	Red	Yellow	Green	Green	Green		
800	Red	Green	Green	Green	Green		
900	Red	Green	Green	Green	Green		
1000	Red	Green	Green	Green	Green		
1500	Yellow	Green	Green	Green	Green		
2000	Green	Green	Green	Green	Green		
2500	Green	Green	Green	Green	Green		
3000	Green	Green	Green	Green	Green		
4000	Green	Green	Green	Green	Green		
5000	Green	Green	Green	Green	Green		
6000	Green	Green	Green	Green	Green		
Over 10000	Green	Green	Green	Green	Green		