Energy Efficiency – Energy Loss

NaRiKa Corporation

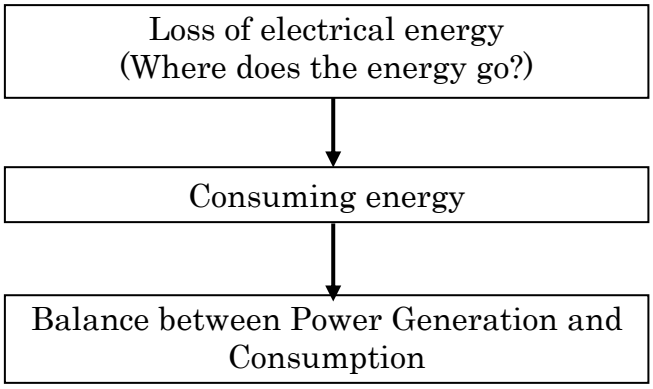
1. Learning Outcome

As a supplementary curriculum, in this unit, teachers help students understand how electricity is transferred from power stations to the towns/homes while some of the power is consumed (lost) on the way and not all of the generated power can reach to us due to the energy conversion from electricity to heat.

Based on this understanding, students learn basic concept like “Power consumption” and “Amount of Power Consumption” through the experiment to realize that a equipment of larger energy consumption requires more electric power. Also, students will know various type of fuel (source of energy) is needed to generate electric power.

Finally, students will go through the experiment to understand the balance between power generation amount and power consumption. Students to know blackout may happens in case power consumption surpasses the amount of power generation.

2. Overall Learning Scheme



3. Preparation for Experiment

In this unit, use the instrument as follows.

- P70-0395-10 Miniature Bulb and Socket (holder) with Leads & Clips: 10
- B10-2632-W0 GENECON DUE: 1
- B10-2634-W0 GENECON V3: 2

1. Miniature Bulb and Socket with Leads & Clips (P70-0395-10)

A miniature bulb is embedded in a socket (with a lead and electrical clips). Even early elementary grade students can connect it to dry-cell battery holder and electrical circuit.
Also, suitable for the experiment to light a miniature bulb with electrical energy stored by using B10-2632 GENECON DUE.

2. GENECON DUE & V3 (B10-2632-W0, B10-2634-W0)

GENECON is a user-friendly hand-held DC (Direct Current) generator extremely useful for the power generation to be used for experiments of energy conversion and electrolysis of water. GENECON DUE produces (up to) approx. 12V DC only by turning the handle. GENECON V3 produces (up to) approx. 3V DC only by turning the handle. GENECON is a power generator specialized for the educational use to self-produce electricity.

GENECON is quite simply designed with the built-in motor inside that works to generate power. Students may realize the structural interaction of embedded motor, gears, shafts and handle through the transparent body. Teachers may easily instruct the students about the identical/interchangeable correlation between “motor” and “generator”.

GENECON V3 (DC3V Type)

GENECON DUE (DC12V Type)

	GENECON V3	GENECON DUE
Available generating voltage	approx. 3V	approx. 12V
Most suitable bulb	2.5V Type	6.3V Type

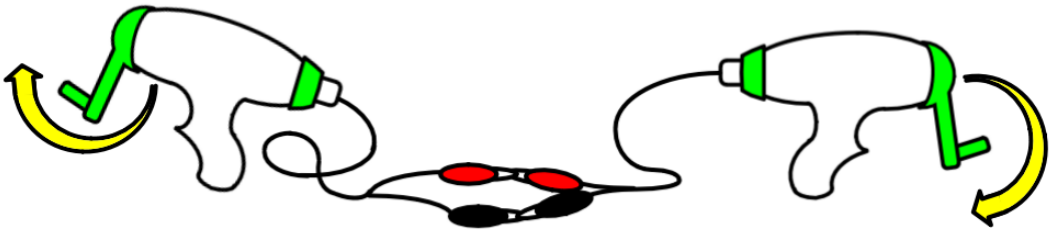
[Note] Specifications differ between GENECON V3 and GENECON DUE. In case lighting a miniature bulb 6.3V type, use GENECON DUE instead of GENECON V3. If you light 2.5V type with GENECON DUE, the bulb would be shortly broken.

4. Loss of electrical energy – Where does the energy go?

1. Transportation of energy

Electricity necessary for your daily life, as you can se in drawing below, comes from various power plants (e.g. thermal power plant) and is transported through electricity network to our homes. In addition, factories, transportation, or commercial buildings for which large amount of energy is necessary are supplied with energy in accordance with their actual demand.

In the previous unit, we were doing following experiment: using two GENECON V3 and connected them by their cables and by turning handle of one GENECON V3, handle of the other one was turning too.



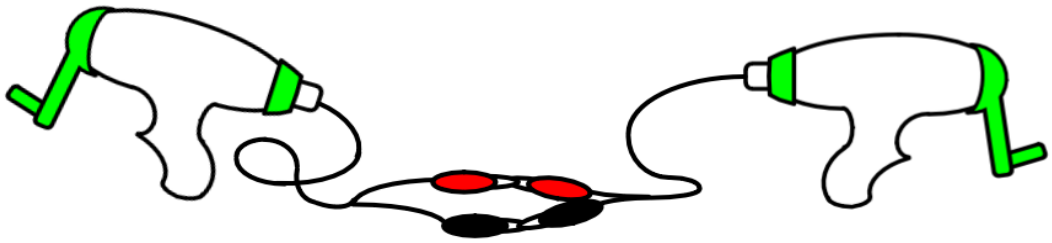
"Power plant" "Electricity network" "House or Factory"

During that experiment, it is possible to regard the GENECON V3 as a "power plant" where electricity is generated by turning the handle. We can regard the other GENECON V3 of building as a "house" or a "factory" where handle is turning by electricity. And then we can regard the cables connecting GENECON V3 as an "electricity network".

2. Where does the energy go? (Experiment)

1. Experiment

1) Connect two GENECON V3 to each other by their clips at the end of their cords. Connect red clip to red clip and black clip to black clip.



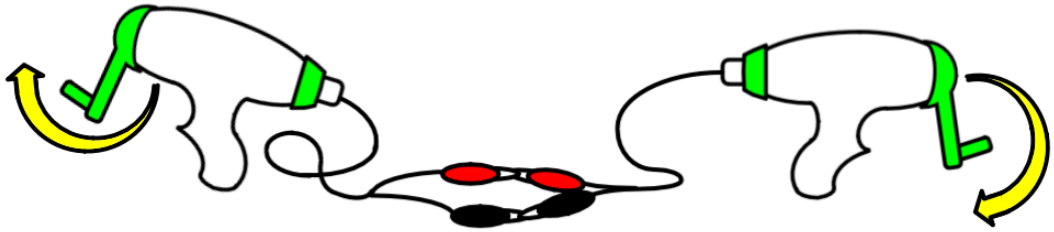
"Power plant" "Electricity network" "House or Factory"

2) Two students will make a pair and one will be doing "power plant" with one Genecon V3 and the other will be doing "house".

3) Person who is doing "power plant" will turn the handle of GENECON V3 10 times.

4) Person who is doing "house" will count how many times the handle of the other GENECON V3 will turn. And write down the results.

5) After that exchange roles and according to the table below repeat the experiment.



"Power plant" "Electricity network" "House or Factory"

6) Deduct the amount of turns of the handle of "house" from that of "Power plant" (= 10 turns), which is to be completed in the column for the "Difference in the amount of turns".

2. Experiment result

Number of experiment	Amount of turns of the handle of "power plant"	Difference in the amount of turns	Amount of turns of the handle of "house"
1.	10 turns	〔 〕turns	〔 〕turns
2.	10 turns	〔 〕turns	〔 〕turns
3.	10 turns	〔 〕turns	〔 〕turns
4.	10 turns	〔 〕turns	〔 〕turns
Average	10 turns	〔 〕turns	〔 〕turns
5.	20 turns	〔 〕turns	〔 〕turns
6.	20 times	〔 〕turns	〔 〕turns
7.	20 turns	〔 〕turns	〔 〕turns
8.	20 turns	〔 〕turns	〔 〕turns
Average	20 turns	〔 〕turns	〔 〕turns

* These changes depending on the rotation speed of "power plant" handle, but what matters is that the difference of turns.

3. Further study

Q1. How many times does the handle of "house" turns on average when you turn "power plant" handle 10 times? 〔 〕

Q2. What is the average of difference in amount of turns? 〔 %〕

Q3. What is the average of amount of turns of the handle of "house"? 〔 %〕

Q4. How many times does the handle of "house" turns on average when you turn "power plant" handle 20 times? 〔 〕

Q5. What is the average of difference in amount of turns this time? 〔 %〕

Q6. What is the average of amount of turns of the handle of "house"? 〔 %〕

Q7. Let's think about the reason why there is difference in the amount of turns of the handle of "power plant" and "house".

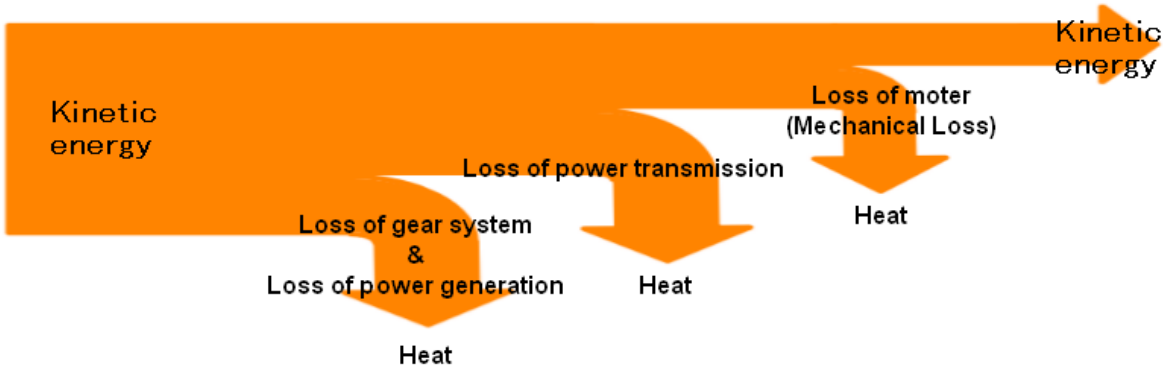
[1] In case of generating power by using the "Power plant" of Genecon V3, electrical quantity is determined at each of the following stages; (1) Kinetic energy to turn the handle will be transferred to; →(2) the Kinetic energy to turn the gears (totally three gears are used for one Genecon) that will be transferred to; →(3) the Kinetic energy to

turn the shaft of the generator that will be transferred to; →(4) the Electric energy. Note that this is because of the energy loss caused at each stage of energy conversion.

[2] In case of power distribution through cable, energy loss is caused; (1) electric resistance of the cable, and (2) connection resistance of the clips.

[3] In case of generating power by using the "House" of Genecon V3, energy loss is caused at each of the following stages; (1) Electricity to be transferred to the Kinetic energy to turn motor shaft; →(2) Kinetic energy to turn motor shaft is transferred to Kinetic energy to turn gears; →(3) Kinetic energy to turn gears is transferred to the Kinetic energy to turn the handle.

Q8. Can you think about the reason where the electric energy equivalent to the difference in the amount of turns disappeared?



Energy conversion from the Kinetic energy turning the handle of Genecon V3 to the Light energy lighting miniature bulb(s) always causes following energy losses.

1) Loss of Kinetic energy at gears
2) Loss of Electric energy at generator
3) Loss of Electric energy at electric transmission
4) Loss of Kinetic energy at motor

If this is amplified to the larger size, such as a city or town, note that energy losses always happen on the way from a power plant to houses/buildings/factories where the energy should be consumed.

Certain data also suggest that power generation efficiency of;

- Thermal electric power plant (using coals): 40~43%
- Hydro power plant: 80~90%
- Wind-power plant: less than 59%
- Dynamo for bicycle light: 20~65%

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