Interesting Facts about Electricity

I. Introduction

220V is the rated voltage in Korea whereas US utilizes 110V. Why is it so? In addition, I'm going to write about some electricity shock accident.

II. Rated Voltage

A. Korea vs. US

The rated voltage is 220V. At this voltage, compared to 110V, more power transfer is guaranteed. 22.9kV (usually 22.9kV nearby town but this voltage really depends on location and other factors) is transformed into 220V after the transformer around your house. Now let's suppose we have an electrical device that consumes 1kW.

$$\mathrm{V_{US}} = 110\ V$$

$$\mathrm{V_{KR}} = 220\ V$$

$$V_{KR} = 2V_{US}$$

i. KR

$$I_{KR} = \frac{P}{V_{KR}} = 4.55\ A$$

The power loss (P_r) can be calculated by

$$P_{r1} = I_{KR}^2 X$$

Where X is some reactance.

ii. US

$$I_{US} = \frac{P}{V_{US}} = 9.09\ A$$

$$P_{r2} = I_{US}^2 X$$

iii. Comparison

$$I_{KR} = \frac{1}{2} I_{US}$$

$$P_{r1} = I_{KR}^2 X = 0.25 I_{US}^2 X = 0.25 P_{r2}$$

$$P_{r1} = \frac{1}{4} P_{r2}$$

We may conclude that the power loss in Korea is a quarter of that in the US. Then, why the US still utilizes 110V after all of this loss? I think, first, it's because of the insulation fee occurred for higher voltage level. Imagine the cost of insulating every single cable in the US. Thicker clothing(for insulation) on cable causes extra money, extra danger, and extra expense at individual house level.

To support, Japan still uses 100V whereas 220V (50Hz) for China. Japan and the US went through industrial revolution way earlier than Korea and China. They already supplied so many 110/100V electrical devices which means change in voltage level would require replacement of all the old electrical devices that customers should pay.

III. Resistance of Human Body

It is usually known that human body resistance is $100{,}000\ \Omega$ for dry condition. If it's wet, then it quickly drops to $1{,}000\ \Omega$. The following table is from the international electrotechnical commission:

Voltage	5%	50%	95%
25 V	1,750 Ω	3,250 Ω	6,100 Ω
100 V	1,200 Ω	1,875 Ω	3,200 Ω
220 V	1,000 Ω	1,350 Ω	2,125 Ω
1000 V	700 Ω	1,050 Ω	1,500 Ω

Figure.

When electric shock occurs, human body skin quickly gets damaged which reduces its resistance. It could drop all the way down to $500\ \Omega$.

So, what current destroys your body? It may not be that accurate that usually 70mA for 1 seconds can explode your heart. Let me calculate this energy:

$$\mathrm{E} = \mathrm{P} \cdot \mathrm{time} = (70\mathrm{mA})^2 \cdot 100{,}000\ ohm \cdot 1 seconds = 490\ \mathrm{Joule} = 117\ \mathrm{cal}$$

I'm not sure it means that this amount of energy striking on our heart can cause destruction or something.

IV. References

[1] https://en.wikipedia.org/wiki/Electrical_injury