Warmup

My stove runs on 220V and the largest burner has a resistance of 22Ω. How much power does it dissipate (i.e., turn into heat) when it is on?

$V = IR \qquad I = \frac{V}{R} \qquad \frac{220V}{22\Omega} = 10A$

$P = IV \qquad 10A \cdot 220V = 2200W$

$2.2\,kW$

Respond at **pollev.com/stevenbell**

Warmup

My stove runs on 220V and the largest burner has a resistance of 22Ω. How much power does it dissipate (i.e., turn into heat) when it is on?

Does the smaller burner have a higher or lower resistance?

Respond at **pollev.com/stevenbell**

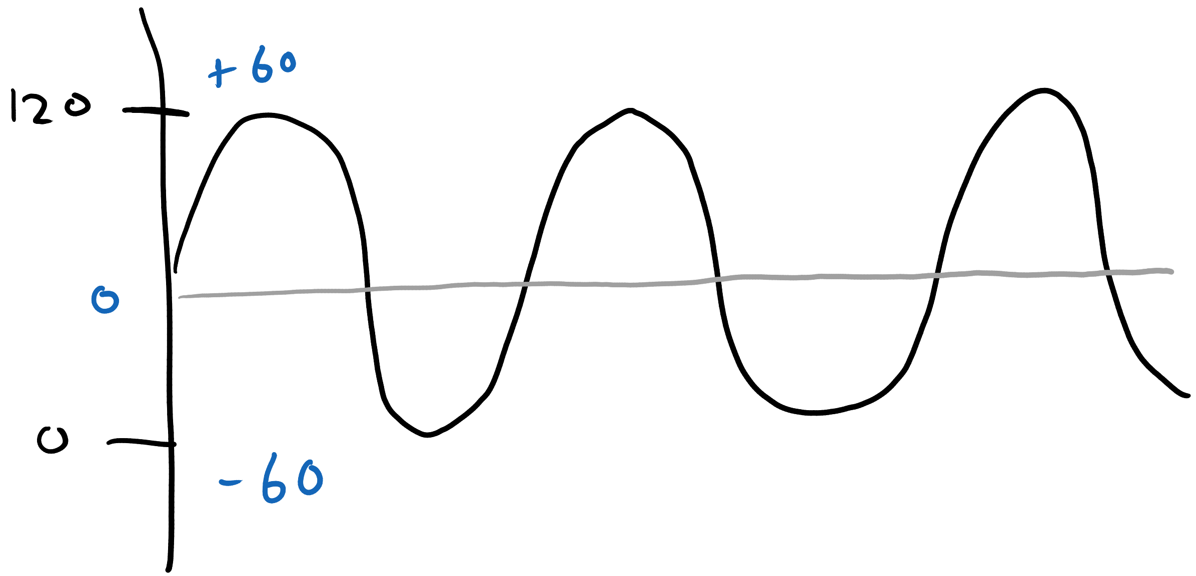
EN 1: Engineering in the Kitchen

Steven Bell

13 September 2023

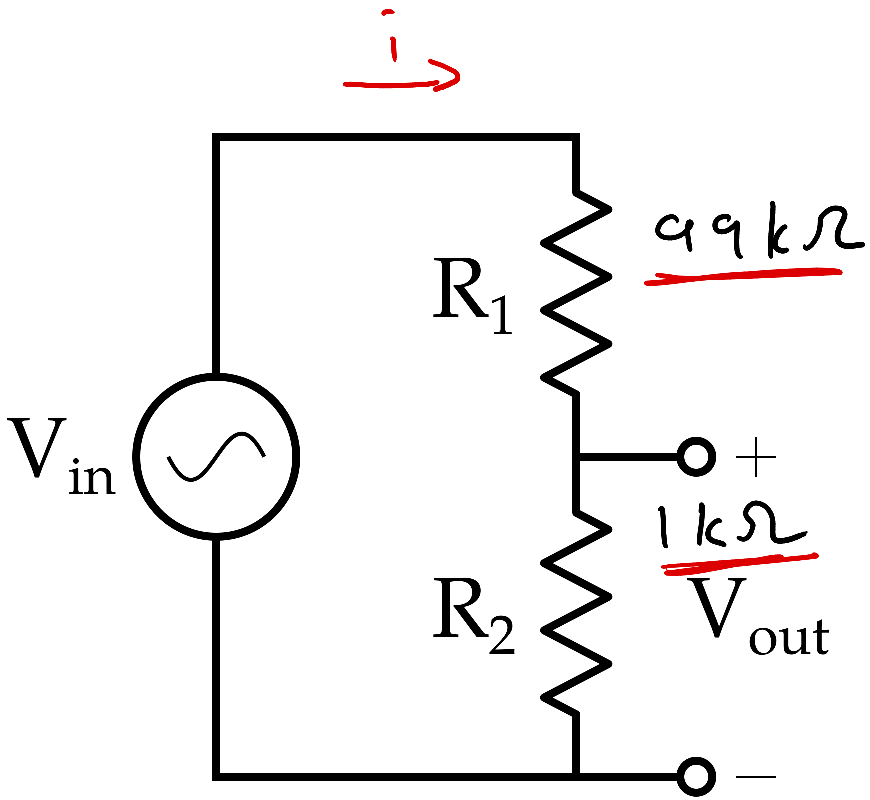
What voltage is "wall power"?

(in North America)



Respond at **pollev.com/stevenbell**

Measuring big voltages



$$V = IR$$

$$V_{in} = i \cdot R_1 + i R_2$$

$$V_{in} = i(R_1 + R_2)$$

$$i = \frac{V_{in}}{R_1 + R_2}$$

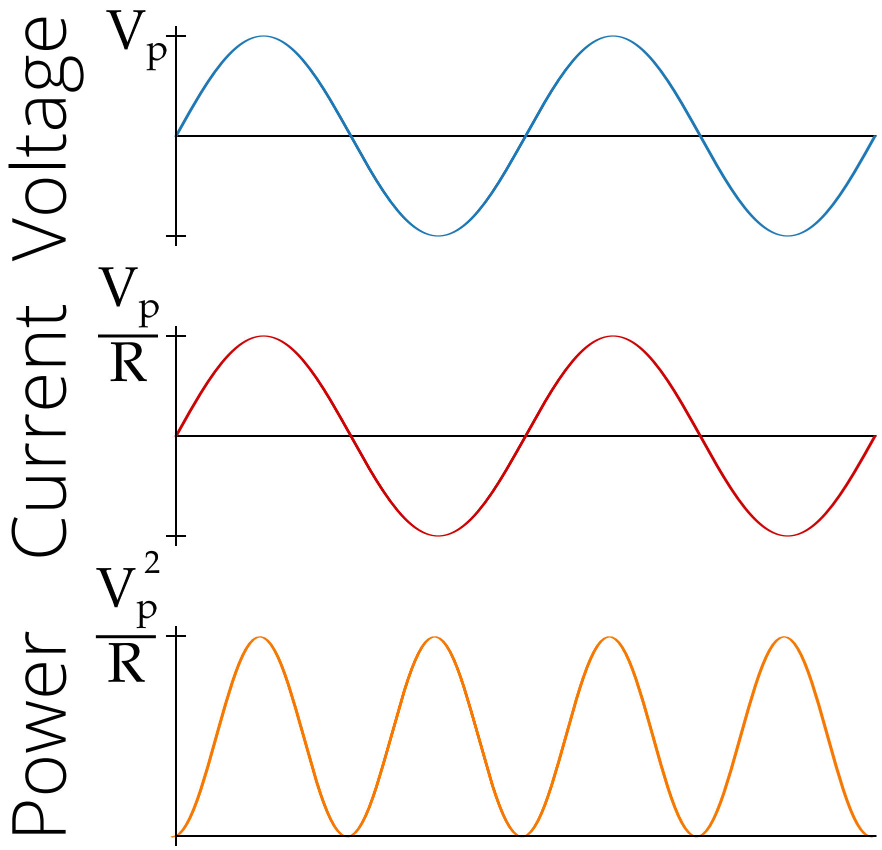
$$\frac{V_{out}}{V_{in}} = \frac{1k\Omega}{99k\Omega + 1k\Omega}$$

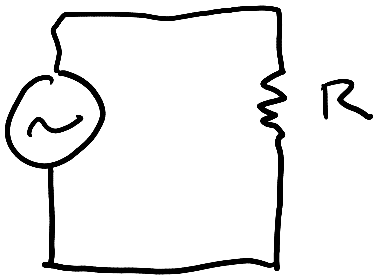
$$V_{out} = R_2 \cdot i$$

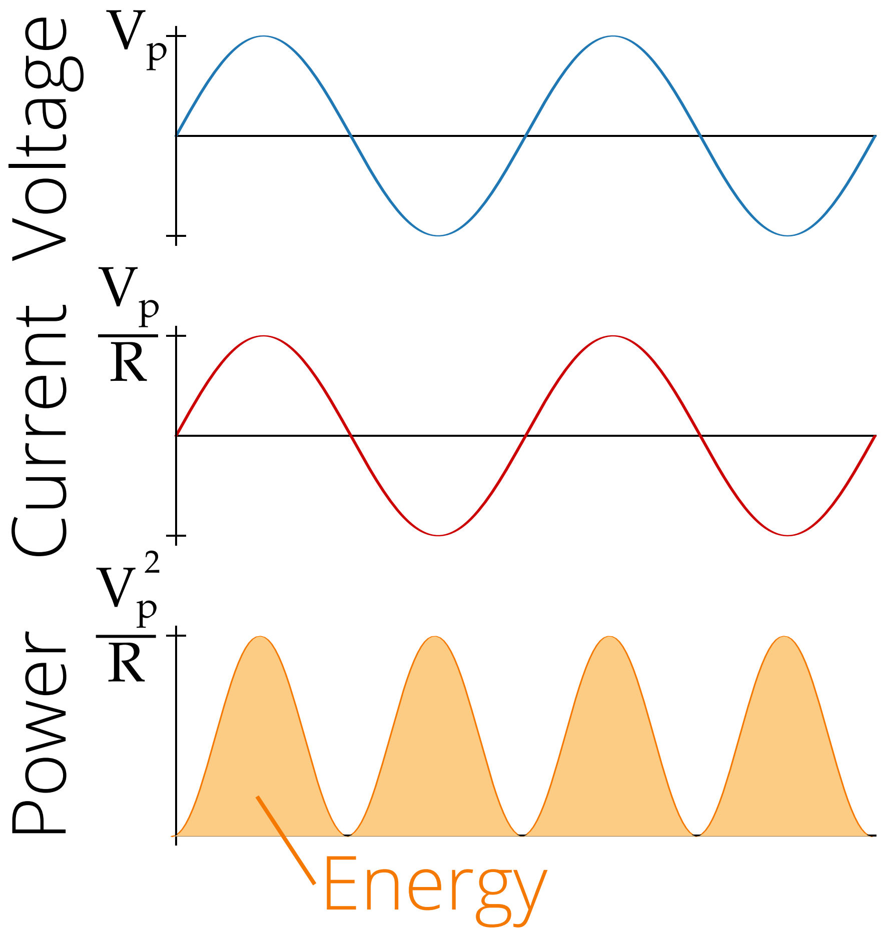
$$i = \frac{V_{out}}{R_2}$$

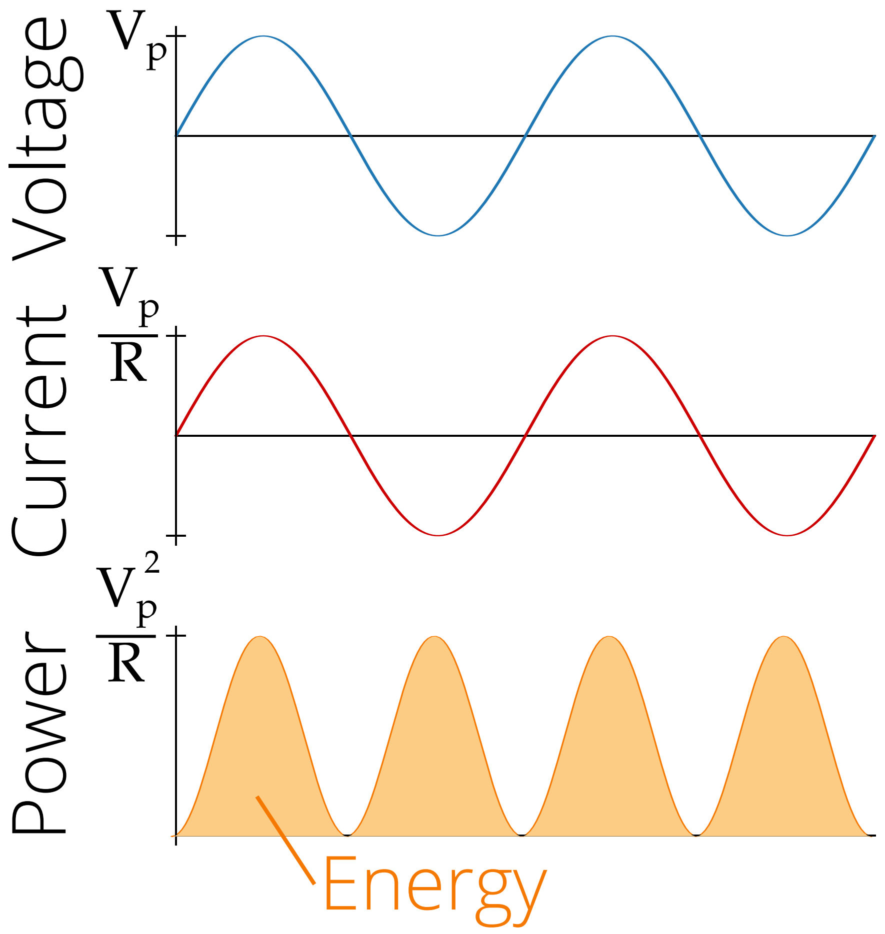
$$\frac{V_{out}}{R_2} = \frac{V_{in}}{R_1 + R_2}$$

$$\frac{V_{out}}{V_{in}} = \frac{R_2}{R_1 + R_2}$$


Voltage
V_p
Current
$\frac{V_p}{R}$
Power
$\frac{V_p^2}{R}$

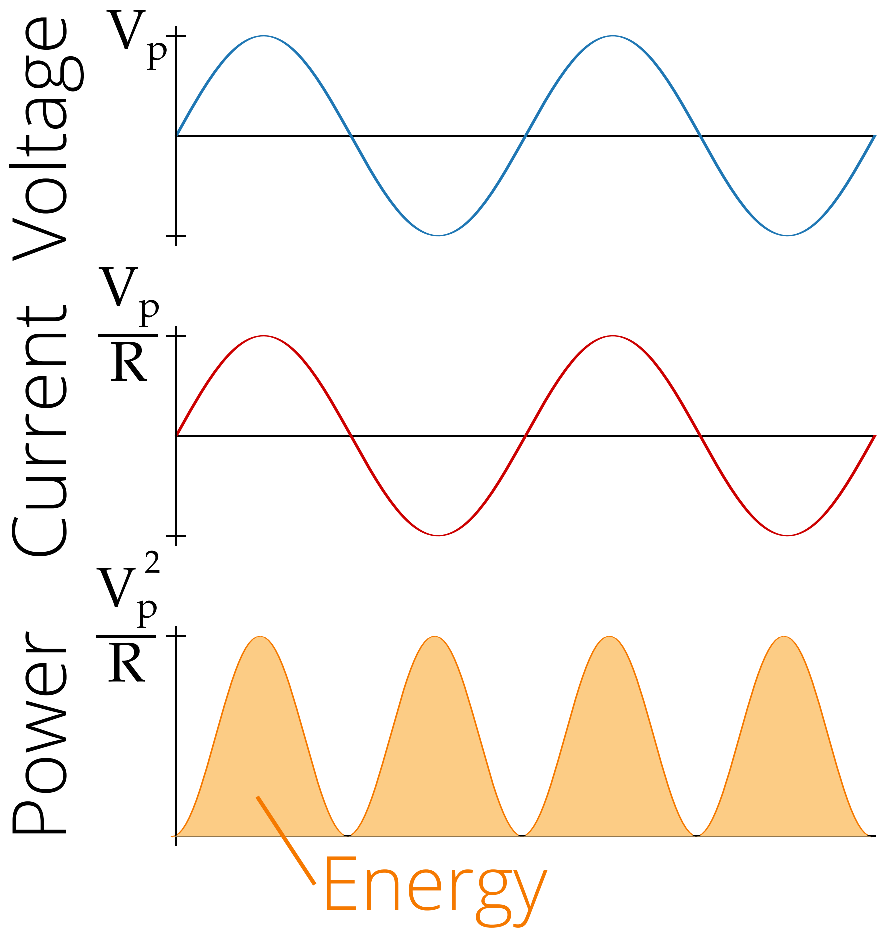

R


Voltage
V_p
Current
$\frac{V_p}{R}$
Power
$\frac{V_p^2}{R}$
Energy



Voltage
V_p
Current
$\frac{V_p}{R}$
Power
$\frac{V_p^2}{R}$
Energy

$\frac{V_{eff}^2}{R}$



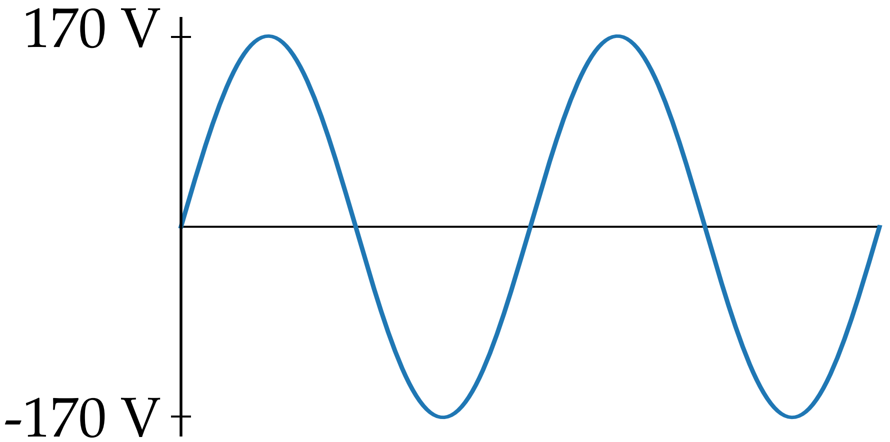
$$\frac{170V}{\sqrt{2}} = 120$$

$$\frac{V_{eff}^2}{R} = \frac{1}{R}\int_0^1 (V_p \sin(2\pi t))^2 \, dt$$

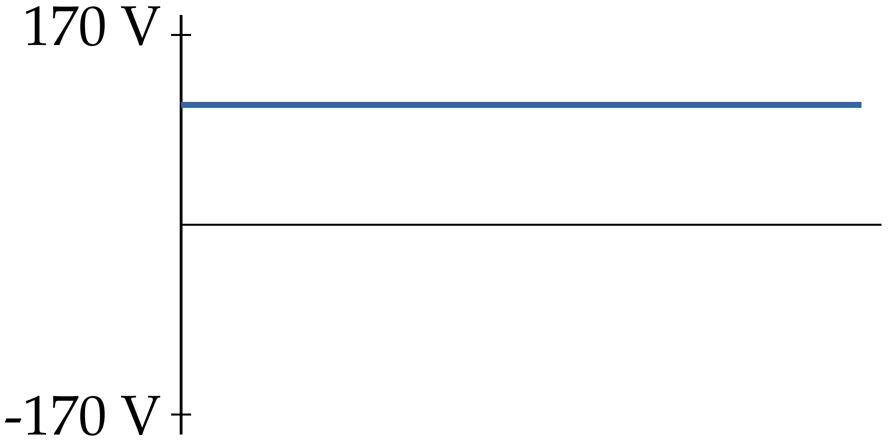
calculus happens...

$$V_{eff} = \frac{V_p}{\sqrt{2}}$$

So this AC waveform:

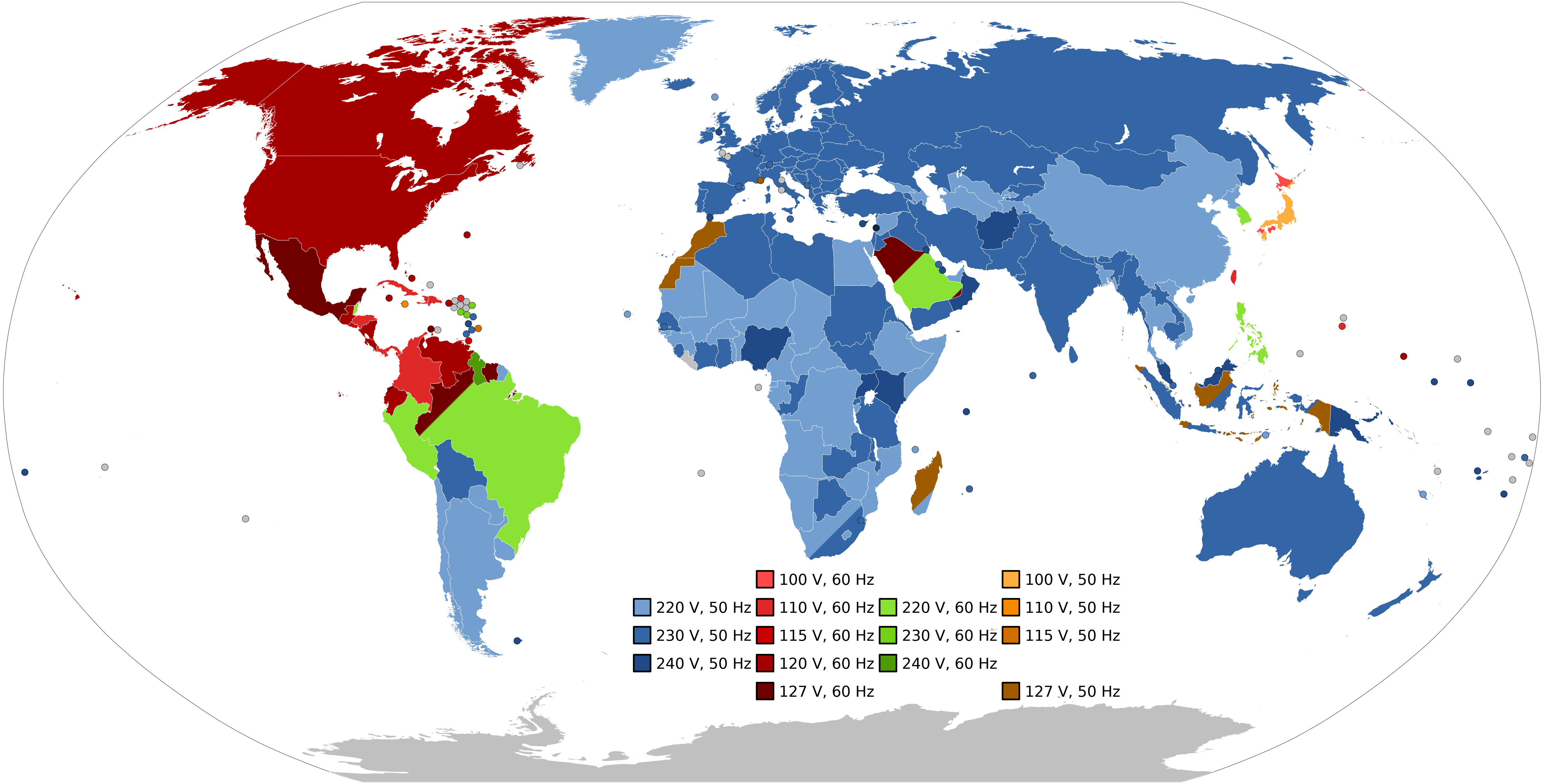


delivers the same power to a (resistive) load as a 120V DC supply:



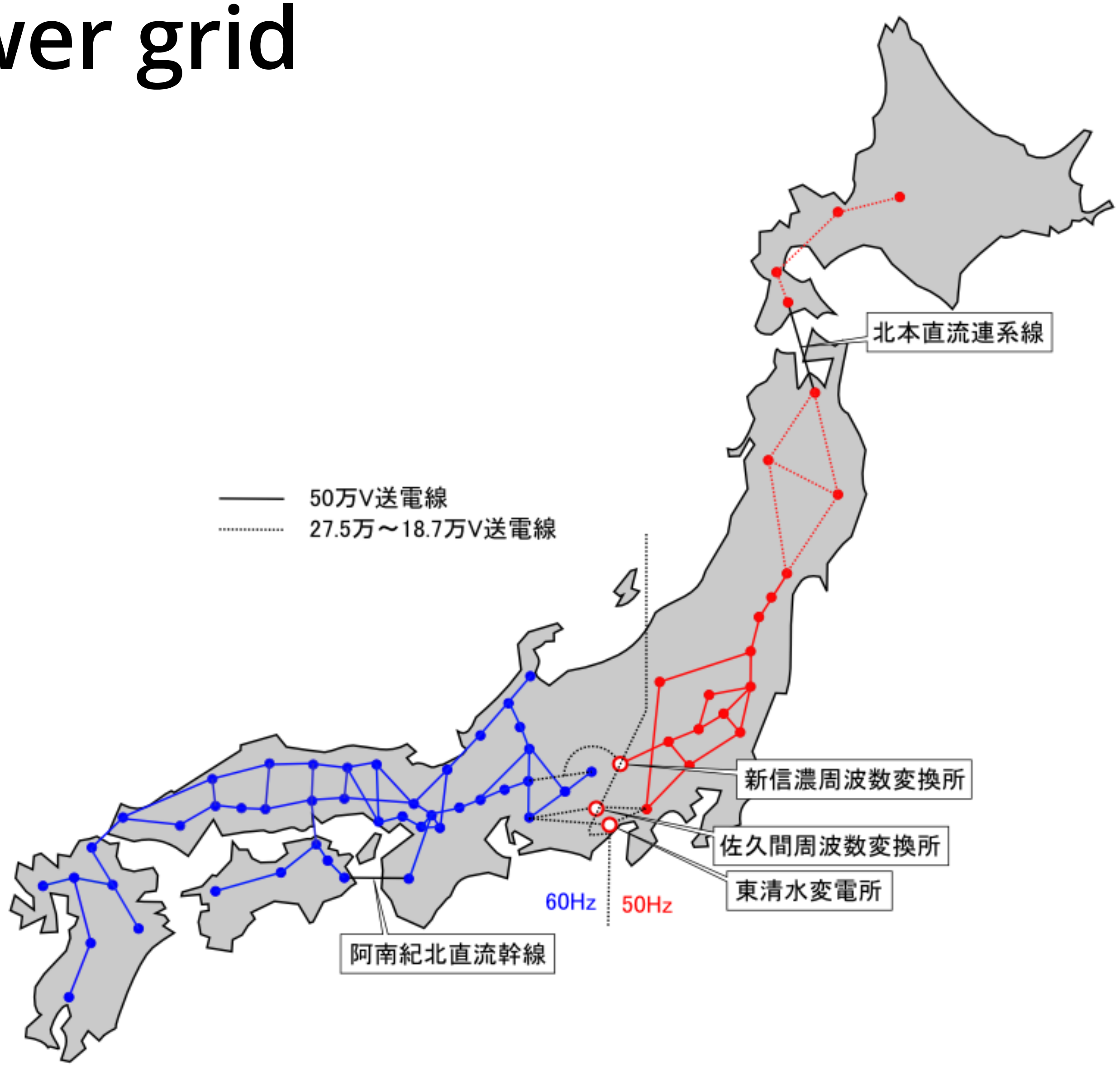
And that's why we call it 120V.

$$120\,V \cdot 15\,A = 1800\,W$$



Wikipedia, Mains Electricity by Country

Japanese power grid



https://commons.wikimedia.org/wiki/File:Power_Grid_of_Japan_J.PNG

Warmup a hot dog?

Project 1: things that get hot

1) Disassemble a device

2) Figure out how it works, and draw a schematic

3) Measure the heating elements, and calculate how much power the device uses. Compare this to the label and wall measurement.

4) Document the disassembly step-by-step and publish the results on the iFixit website.

About iFixit

ifixit.com

edu.ifixit.com/what-we-do

Reinventing repair: edu.ifixit.com/standard-join-a-team

Getting started

1) Create an iFixit account with your Tufts credentials

2) Go to ifixit.com/student and sign up with your team

3) Create your profile

4) Measure the power consumption of your device

5) Start writing your project proposal

For Monday

Finish your proposal by Sunday night

We'll be starting the projects in class, but you're expected to spend significant time out of class working on them.

University guideline is 3 hours/week per SHU,
so a 3-SHU class is 8-10 hours/week

Bring your device back for teardown day on Monday!