A story:

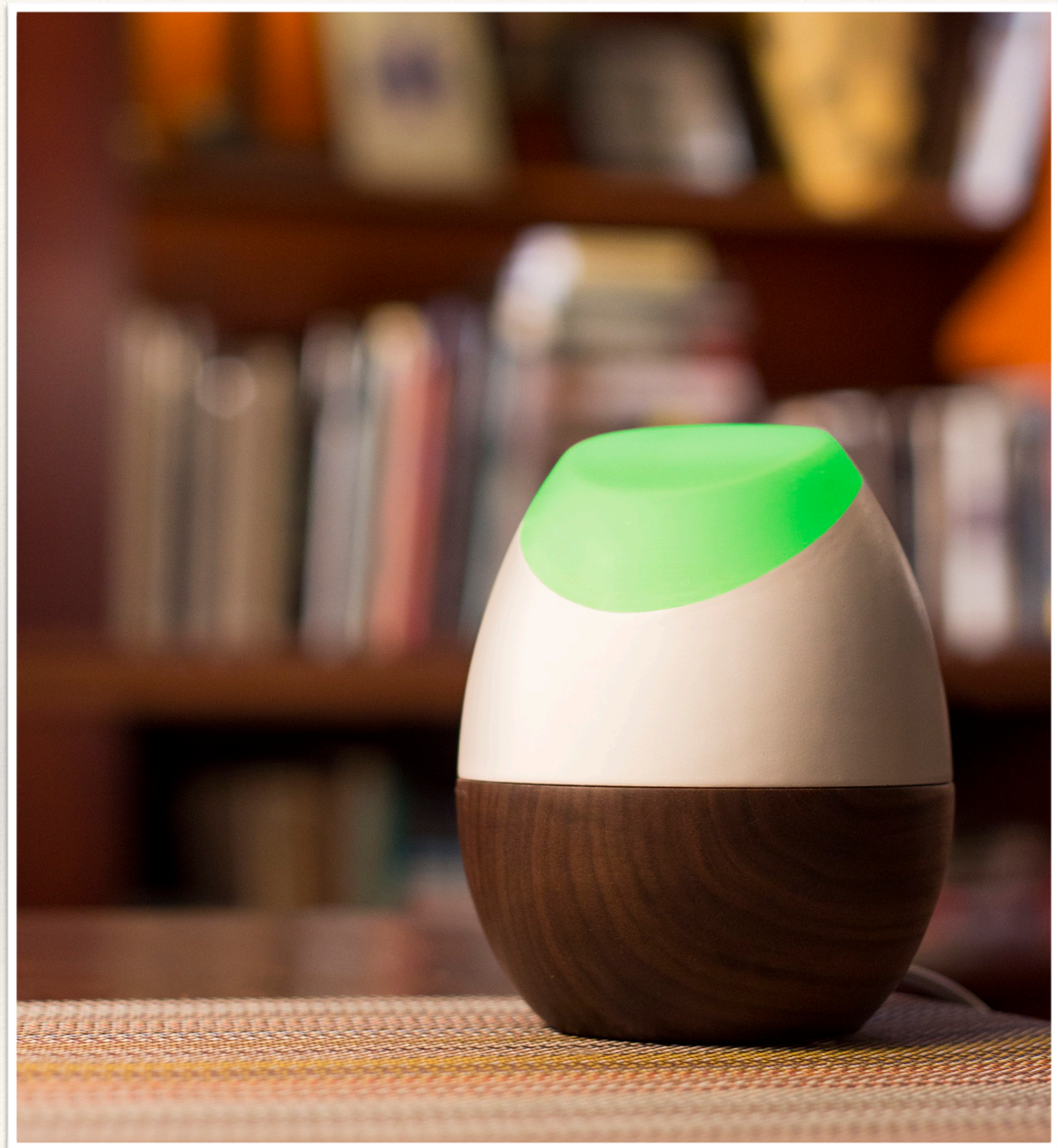
Apps to Electronics

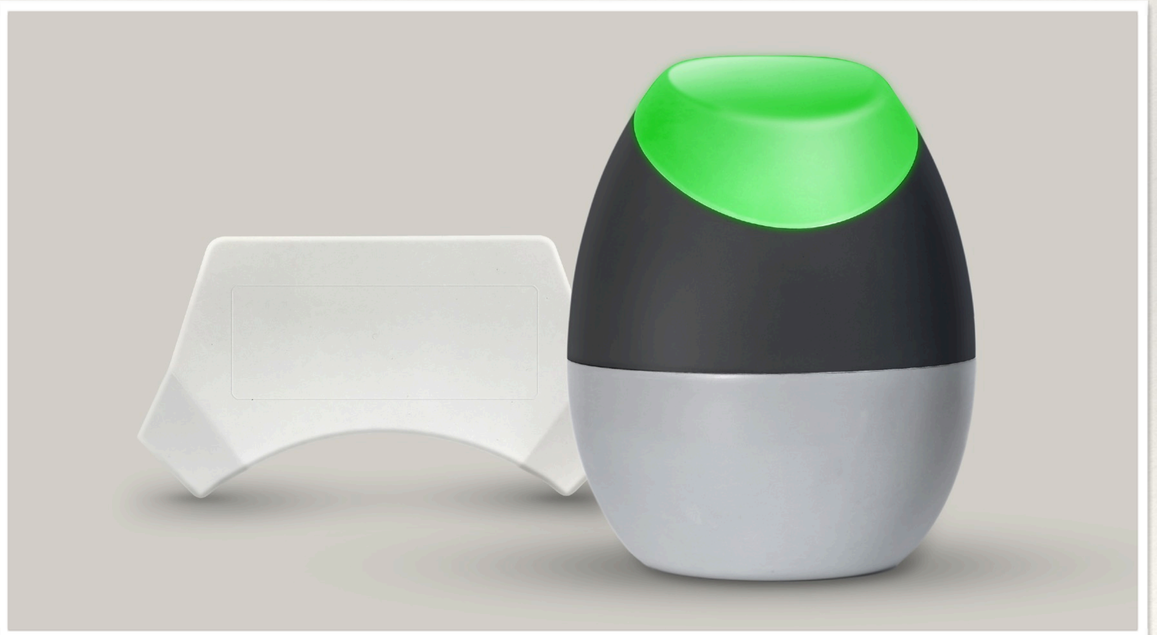
or iOS to IoT

Glow

the smart energy tracker for your home

- Some cool tech under the hood
- All custom hardware
- Bare metal firmware
- Backend Service
- Javascript web interface
- Mobile user interface





Who I am

- Mac Developer
  - Classic Mac On-Demand Ride Sharing Simulator
  - gNat - Mac OS X 10.0
  - SousChef - Mac OS X 10.4
  - … - 10.6/7 era
  - PhoneExpander - 10.10

Who I am

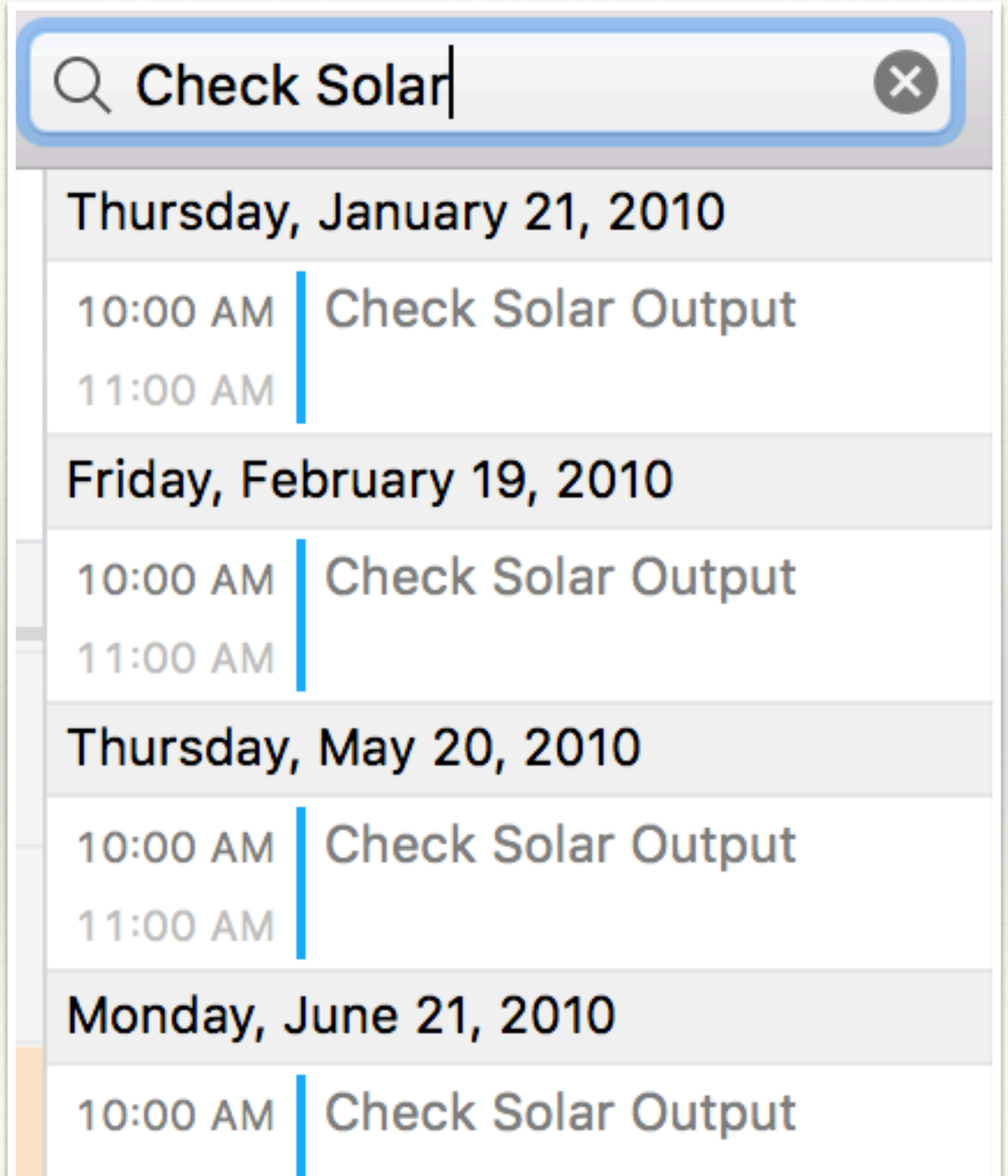
- iOS Developer
  - SousChef for iOS
  - Ita
  - TypeSnippets
  - Rapchat
  - Freelance Consulting — Reverb, Jelly, etc.

Who I am

- Energy Efficiency Nerd
  - Bought first home in 2008
    - 1920s energy efficiency nightmare
  - Started making the house more efficient
  - SousChef → Solar panels in 2009
    - New Goal: Electricity Net Zero

Wait. Solar hides usage!?

My “Solution”


Check Solar
Thursday, January 21, 2010
10:00 AM
Check Solar Output
11:00 AM
Friday, February 19, 2010
10:00 AM
Check Solar Output
11:00 AM
Thursday, May 20, 2010
10:00 AM
Check Solar Output
11:00 AM
Monday, June 21, 2010
10:00 AM
Check Solar Output

February 6, 2013 at 2:50 PM

Solar output

1/21 -- 2255
2/19 -- 2439
3/4 -- 2535
3/22 -- 2912
4/1 -- 3081
4/21 -- 3585
5/1 -- 3807
5/20 -- 4187
6/1 -- 4462
6/21 -- 4907
7/1 -- 5146
7/21 -- 5608
8/1 -- 6002 (reported)
8/19 -- 6273
9/1 -- 6581
9/20 -- 6986
10/1 -- 7190
10/19 -- 7546
11/1 -- 7788
11/17 -- 8051
12/1 -- 8226
12/20 -- 8330
1/1 -- 8394
1/21 -- 8541
2/1 -- 8605
2/22 -- 8850
3/1 -- 8904
3/22 -- 9217
4/1 -- 9372
4/21 -- 9698
5/1 -- 9884
5/23 -- 10255
6/1 -- 10470
6/21 -- 10938
7/1 -- 11112
7/22 -- 11580
8/1 -- 11802
8/22 -- 12277
9/1 -- 12502
9/21 -- 12827
10/1 -- 12962
10/20 -- 13240

5/1 -- 9884
5/23 -- 10255
6/1 -- 10470
6/21 -- 10938
7/1 -- 11112
7/22 -- 11580
8/1 -- 11802
8/22 -- 12277
9/1 -- 12502
9/21 -- 12827
10/1 -- 12962
10/20 -- 13240
11/1 -- 13371
11/18 -- 13645
12/1 -- 13789
12/21 -- 13970
1/1 -- 14067
1/24 -- 14292
2/1 -- 14387
2/21 -- 14669
3/1 -- 14801
3/21 -- 15155
4/1 -- 15376
4/20 -- 15833
5/1 -- 16035
5/21 -- 16509
6/1 -- 16741
6/20 -- 17169
7/1 -- 17399 (estimated)
7/20 -- 17859
8/1 -- 18099
8/20 --
9/1 -- 19026 (estimated)
9/19 -- 19145
10/1 -- 19574 (extrapolated)
10/18 -- 19809 (bad date)
11/1 -- 20032 (estimated)
11/16 -- 20105
12/1 -- 20328 (extrapolated)
12/19 -- 20491
1/1 -- 20534 (estimated)
1/21 --
2/1 -- 20825

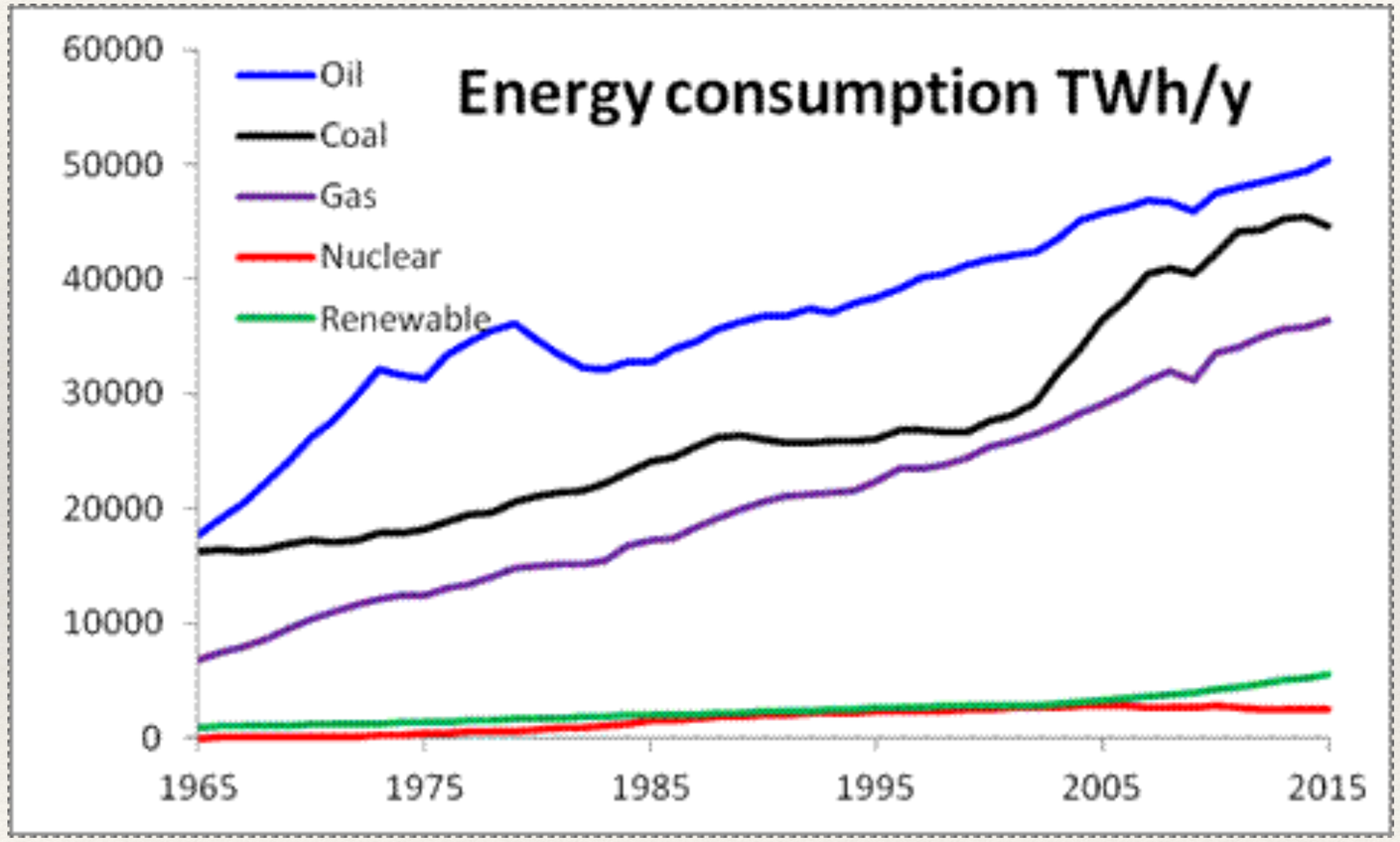
So how did I get here?

- Looking at the world around me
- Wondering about what a technologist can do to impact it
- What are my options?
  - Make software that is cool: hard to create change
  - Career change: go back to school
  - Maybe something else…?
- Where to attempt change?

Sidebar: Energy & Climate Change

- Likely biggest threat to humanity
- Solution: move to renewable energy sources as quickly as possible
  - How much do we need?

Sidebar: Energy & Climate Change



2014 total: 155,481 TWh/y

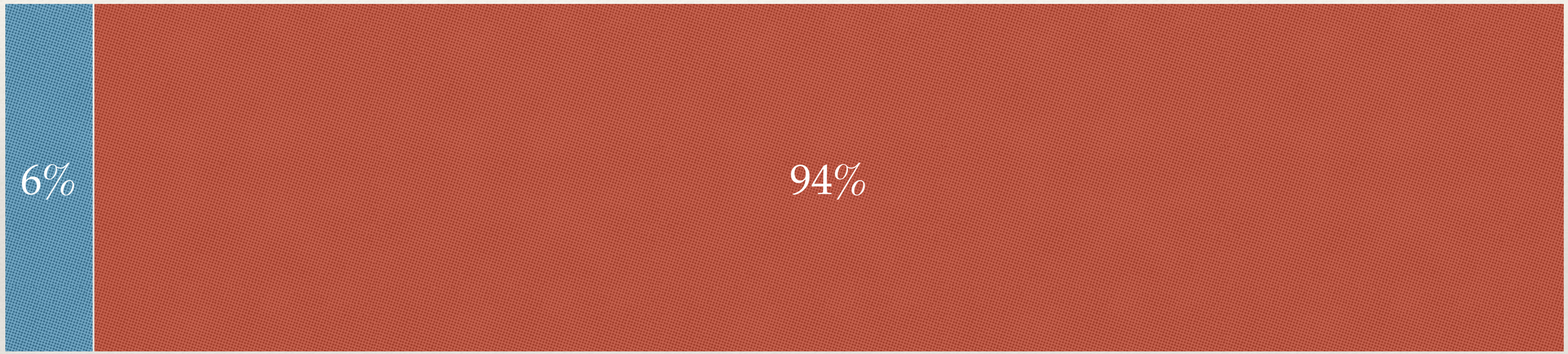
2014 renewables: 19%

Solar/Wind/Hydro/Geo:

6%

Sidebar: Energy & Climate Change

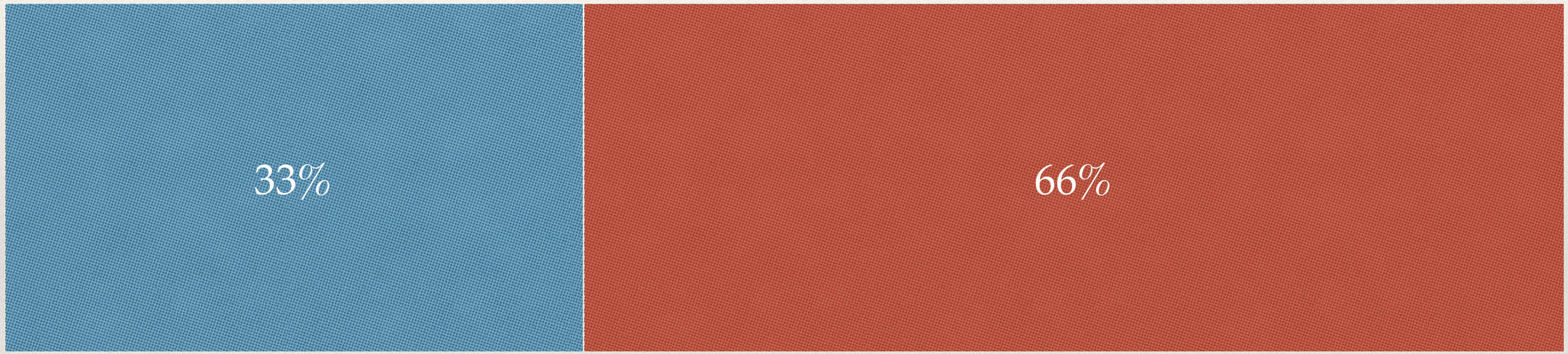
2014



Renewables CAGR: 20%

Sidebar: Energy & Climate Change

+10 years



Renewables: **58,000 TWH/y**

Thought about pure software solutions

- They all sucked
- I tried anyway
  - Approached multiple hardware vendors about partnering, etc.
  - No positive results
- When you need hardware, it becomes pretty apparent

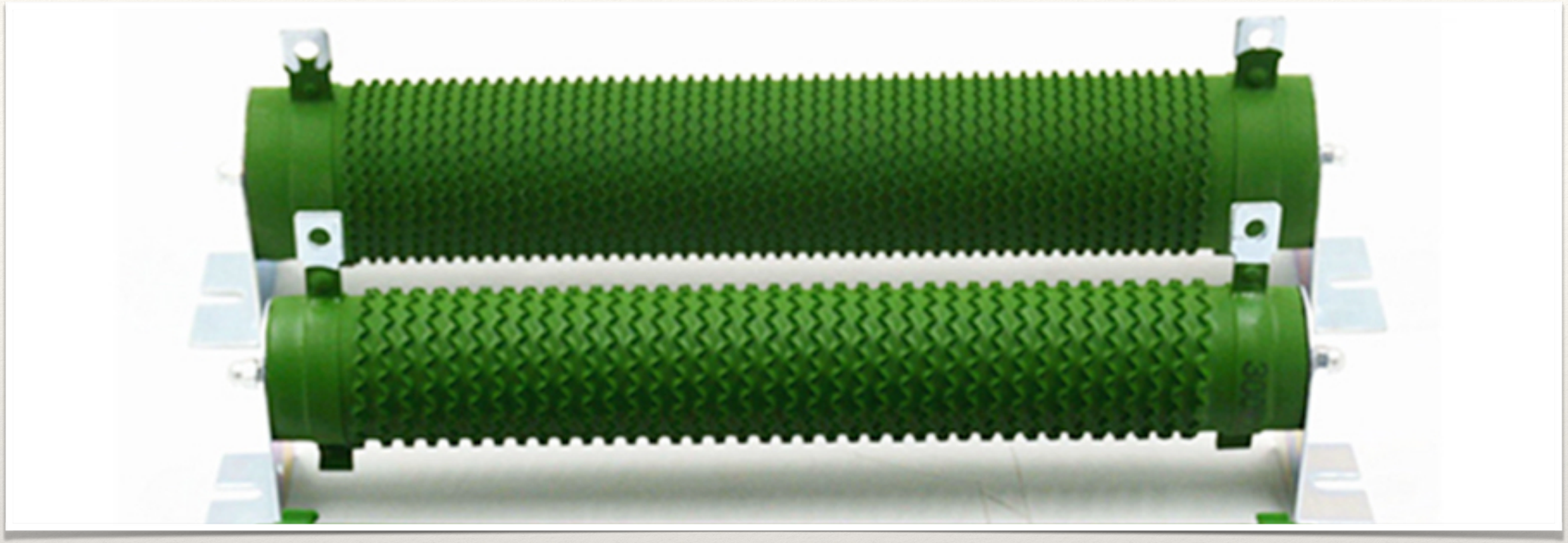
Met a Guy

- 2013
- We started talking about energy efficiency ideas
- And playing with hardware
- Our goal: “an energy monitor for the masses”

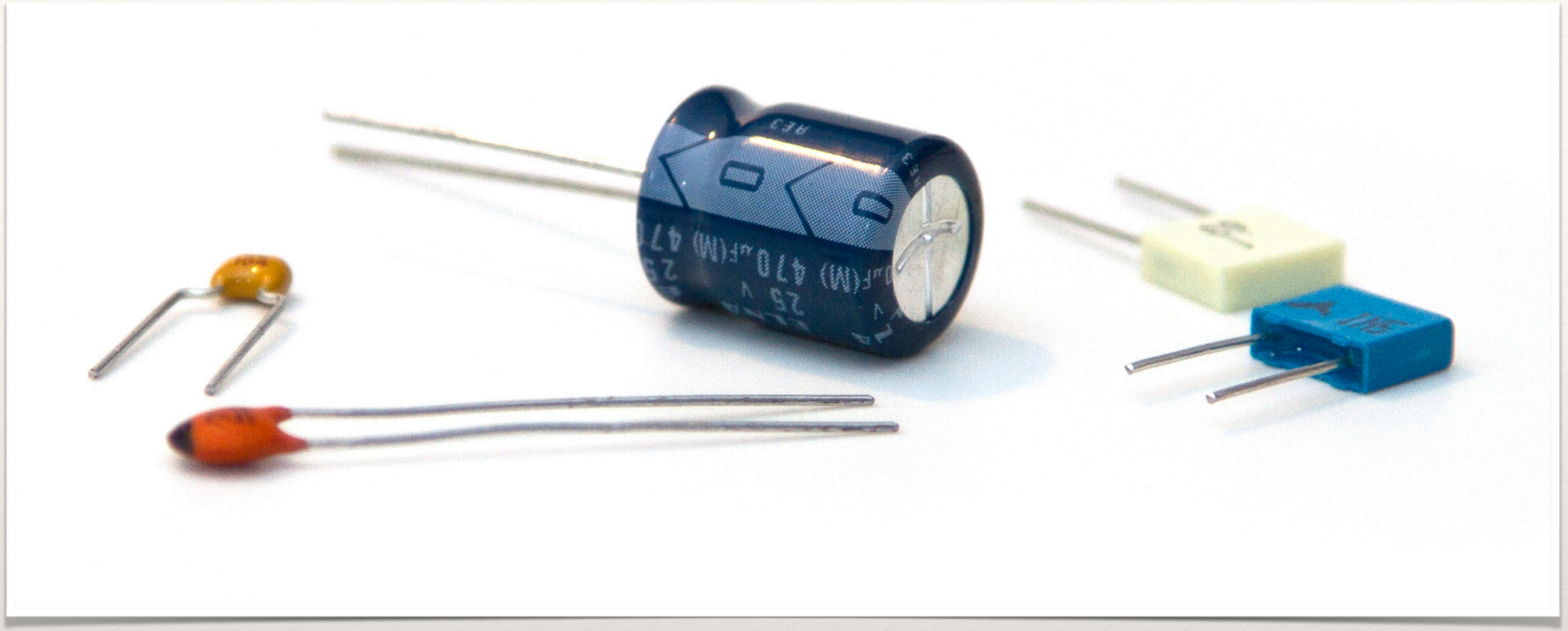
Robin

- He's like, a real Electrical Engineer.
- He talks a lot about interrupts and GPIO lines and other things I didn't understand…
  - Turns out, my CS courses, even things like Operating Systems, weren't all that low level.
- …also RC circuits
  - I thought this meant Remote Control. Seriously.

A list of a FEW electrical engineering things I didn't know much about

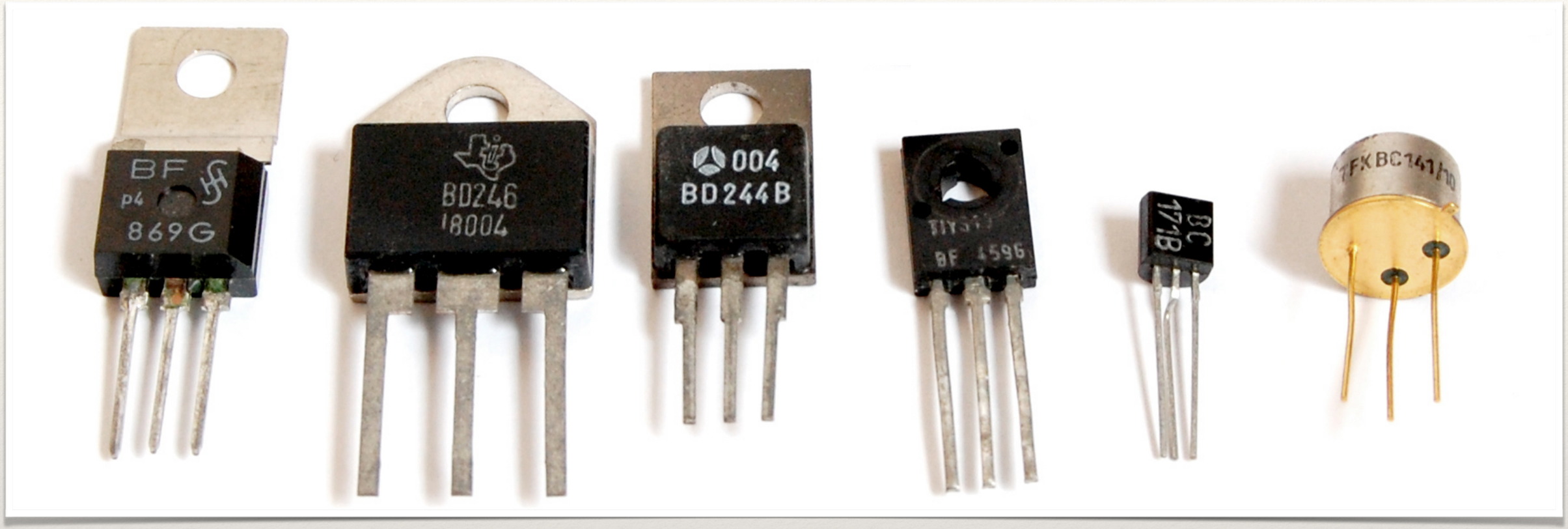


Big Resistors



Capacitors

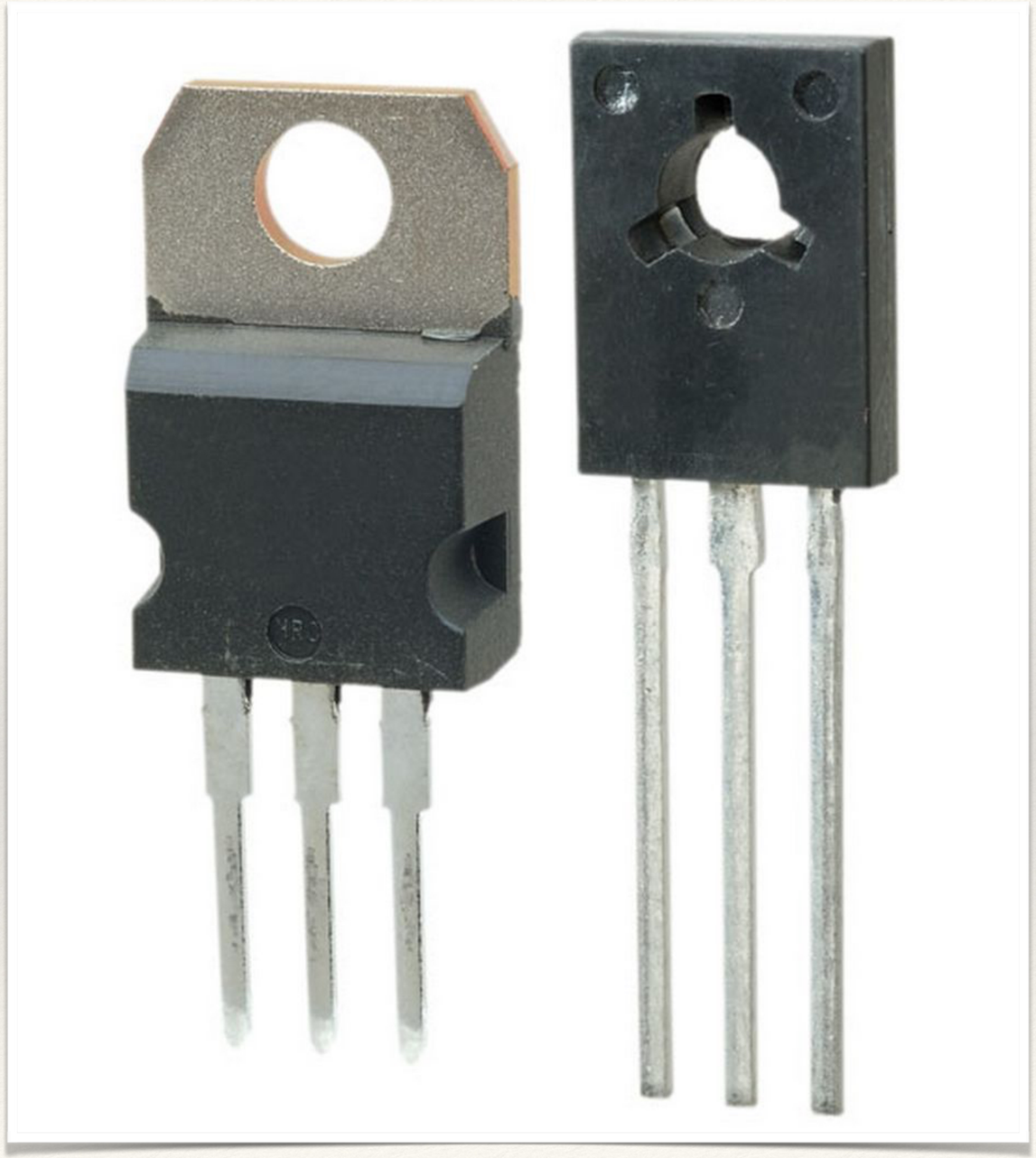
(secret: they still seem like magic)



Transistors

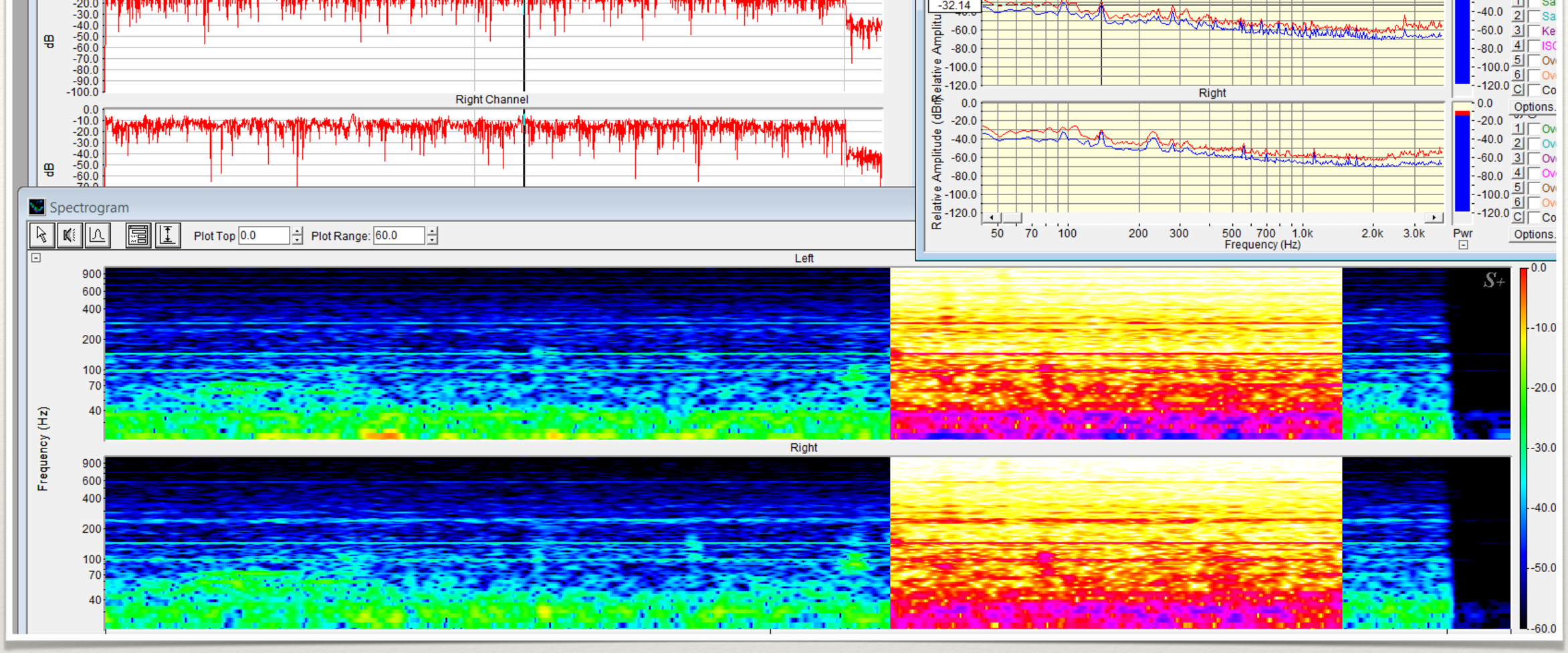
Relays

Triacs

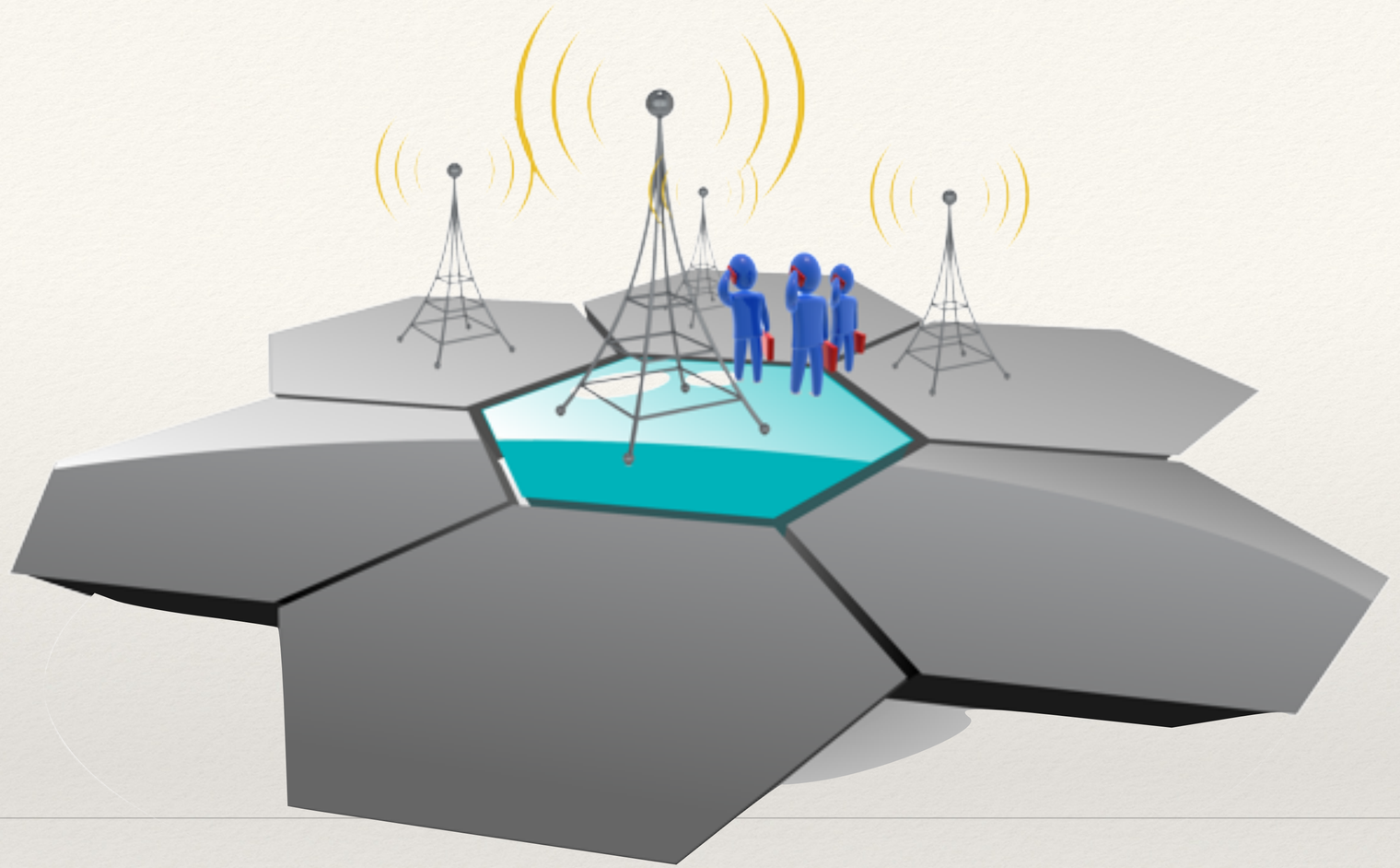


Common mode choke

AC / AC transformers



Voltage Spectral Noise



Basically anything RF

(despite having a CS degree focused on networking and communications, this is how I believe RF works)

I still think like an app developer

- I just know a bit more about electrical engineering than I used to.
  - Mainly through watching a LOT of a EE intro videos on YouTube
- I still focus on the high level problem/solution, use cases, & business

What does 2013 Ben wish he knew?

1. How to think about the customer
2. What makes you different?
3. A bunch of things about Hardware

1. How to think about the customer

How to think about the customer

- Same: What do they want?
- Same: What will they do to get that?
- Similar: What makes them buy/or not buy your product?
- Different: How are they going to buy this thing?

The Switch

Push
(pain)

Habit
(current solution)

Pull
(appeal)

Anxiety
(new solution)

Cognitive Process of Buying

Need Recognition

Information Search

Evaluation of Alternatives

Purchase

Post-Purchase Evaluation

Ben's Cognitive Process of Buying

Interest

Consideration

Decision

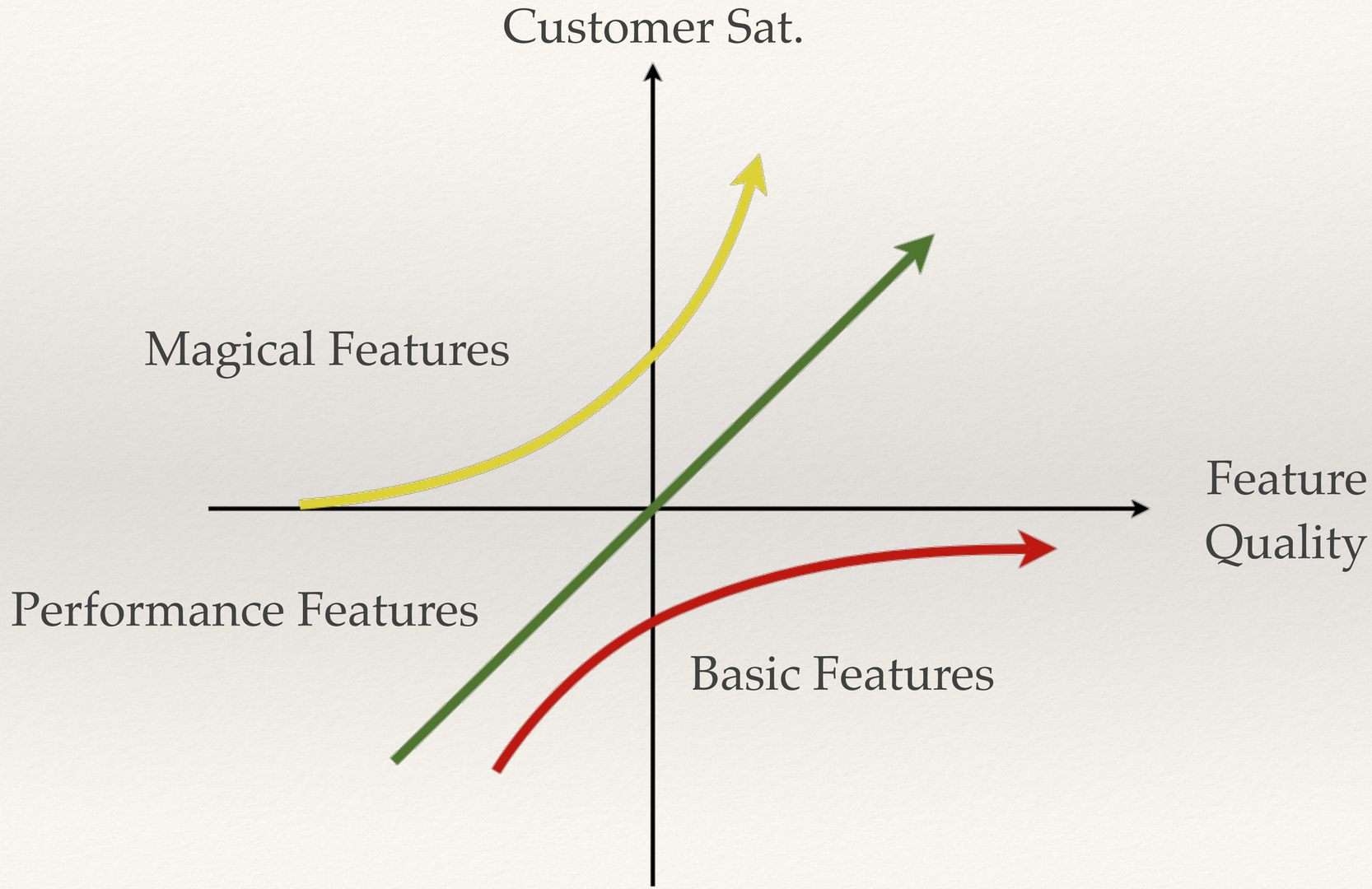
Purchase

2. What makes you different?

What makes you different?

- Ideas don’t count
- Nicer isn't usually enough
- How easy is it to copy?
- End-to-end experience design

Kano Model (-style)



Where are your brains?

- In the Cloud
- On the board
- On mobile
- Where do integrations happen?

3. Hardware

Some things are hard

- Physics
- Thermodynamics
- DSP
- Memory Management

Some are expensive

- Engineers
- Good SOC solutions
- Turn-key Services

Some aren't

- Silicon is pretty cheap
- Memory is cheap
- Experimenting is deceptively easy
  - Arduino
  - Raspberry Pi
  - Javascript

Hardware Cost

- Cost: It's easier to go up than down. Duh, but really.
- People sometimes talk about scaling up.
  - It's gonna be a long time 'til you're making 10K units/month

Top Down Pricing

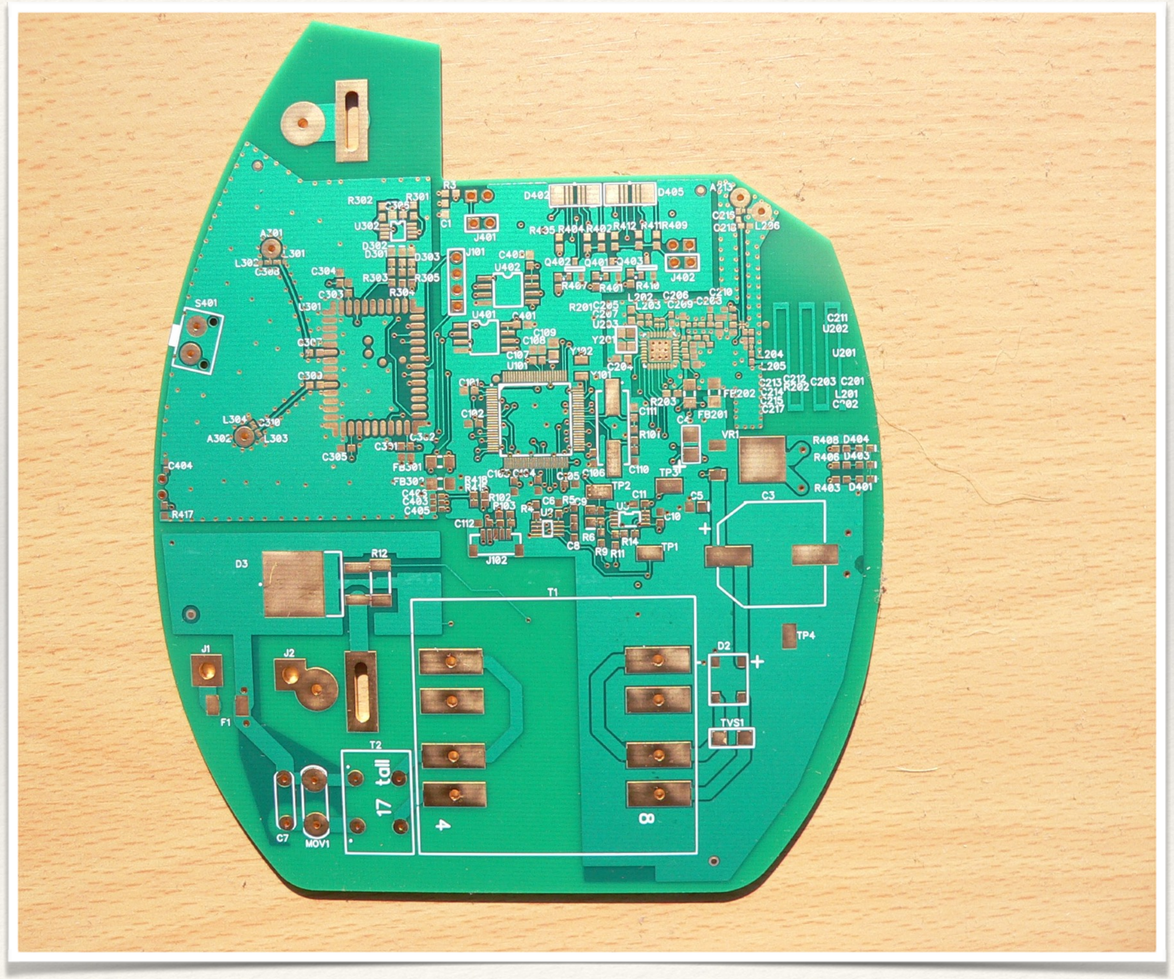
		Retail	Direct
MSRP		$150.00	$150.00
Less Retail Margin	40%	$90.00	
Return Allowance	5%	$85.50	
Shipping	$7	$78.50	$143.00
Credit card	3%	$76.15	$138.71
Revenue		$76.15	$138.71
Assembled Cost	$15	$65.00	$65.00
BOM		$50.00	$50.00
Gross Margin		**14.6%**	**53.1%**

Bottom Up Pricing

		Retail	Direct
BOM		$50.00	$50.00
Assembly	$15	$65.00	$65.00
Add Gross Margin	**50%**	$130.00	$130.00
Credit card	3%	$133.90	$133.90
Shipping	$7	$140.90	$140.90
Return Allowance	5%	$147.95	
Wholesale	40%	$98.63	
Total		$246.58	$140.90

Industrial Design

- Brings it's own set of requirements
- It often complicates / changes things engineers work on
- What kind of ID?
  - Consumer: start early
  - Commercial: you likely need an Mechanical Engineer



Supplier lock-in is a real thing

- What happens when component X goes away?
  - Think of it like a library you depend on just disappearing
- Glow's Link Radio

Certification

- FCC
- UL
- Euro certs (often more stringent)

BONUS: Experiential- vs Requirement-based development

Both can be good for different types of problems

Thinking about the Whole Thing

Questions?

http://meetglow.com

- http://worrydream.com/ClimateChange/
- https://en.wikipedia.org/wiki/World_energy_consumption
- Bob Moesta “Job to be Done” Talk: https://vimeo.com/81153746
- https://en.wikipedia.org/wiki/Kano_model
- https://learn.adafruit.com/how-to-build-a-hardware-startup/pricing-your-product

Available at: http://meetglow.com/docs/2017-360-talk.pdf