If you bill it, they will pay: Energy consumption in the cloud will be irrelevant until directly billed for

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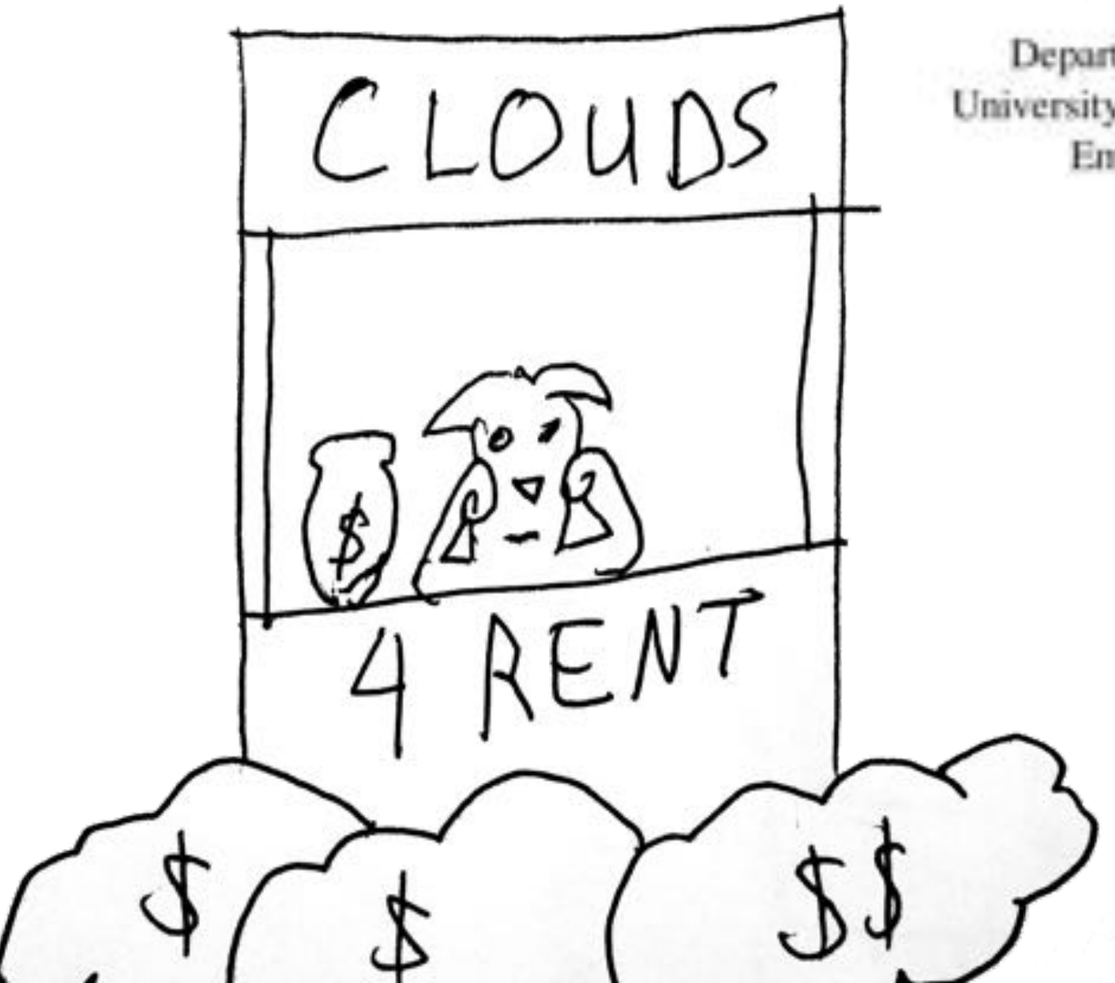
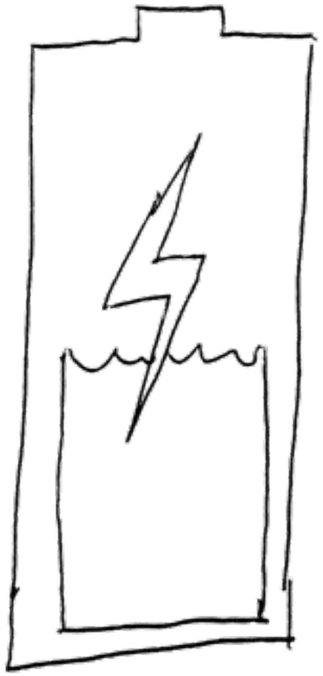
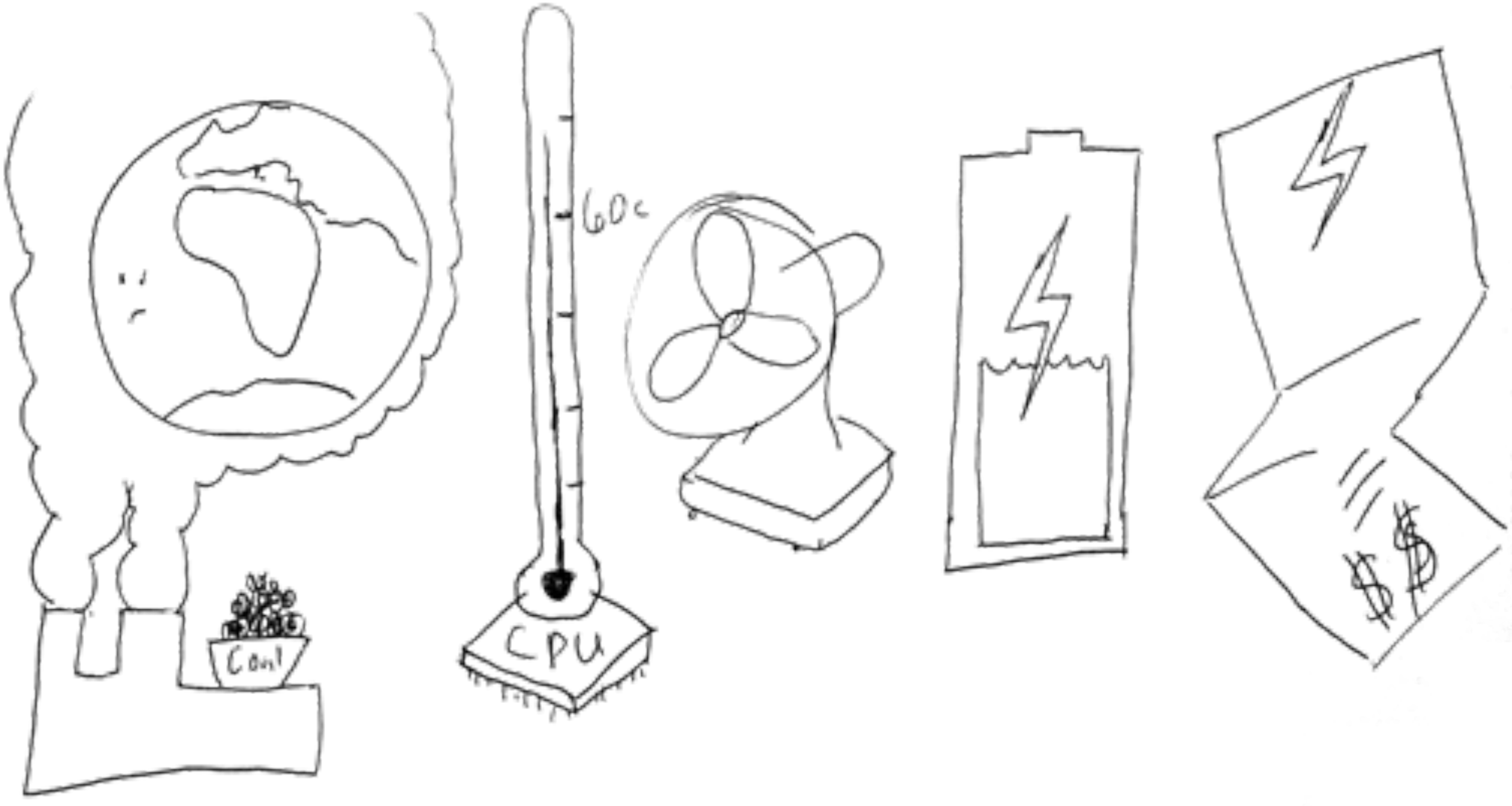
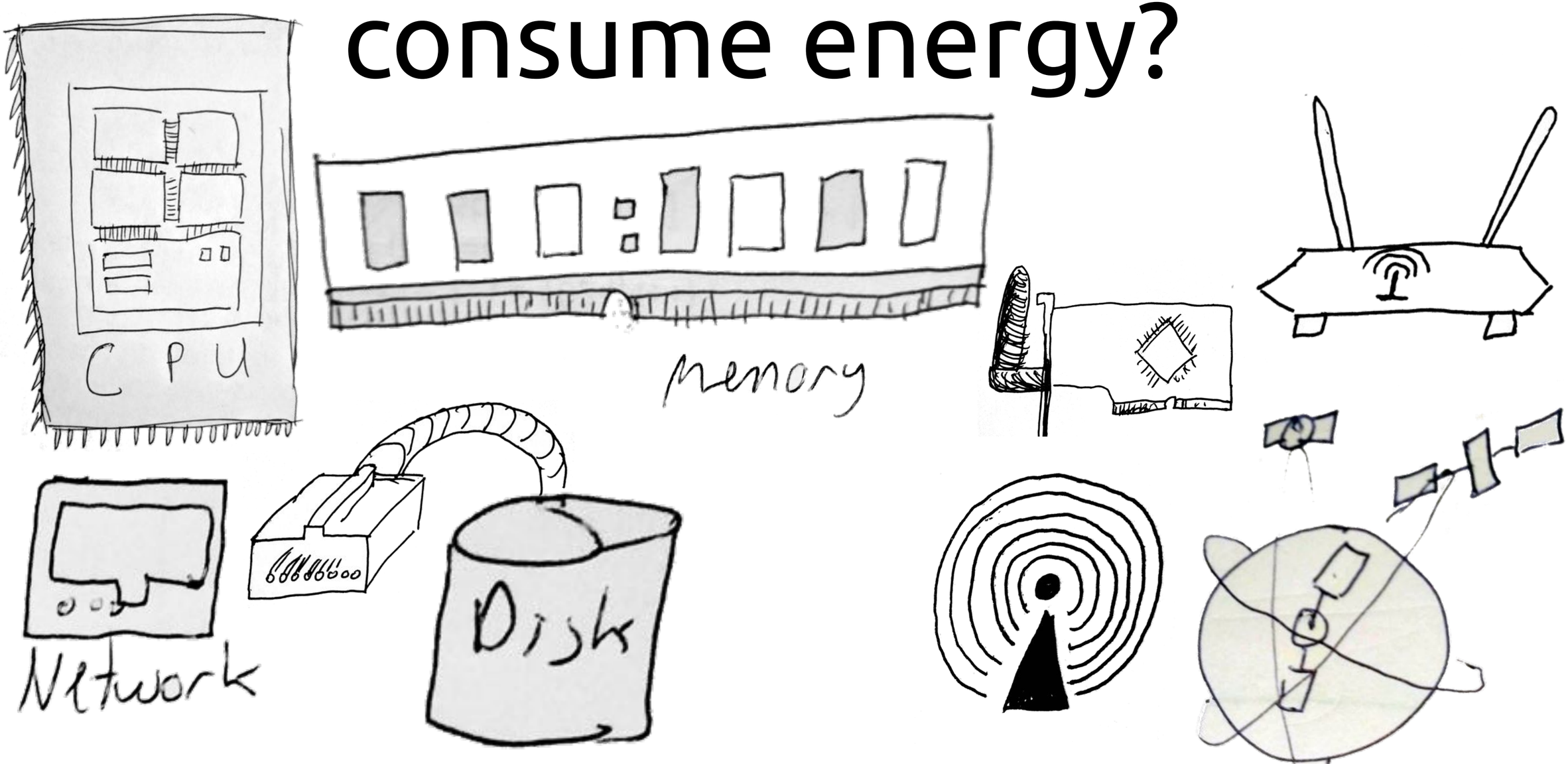


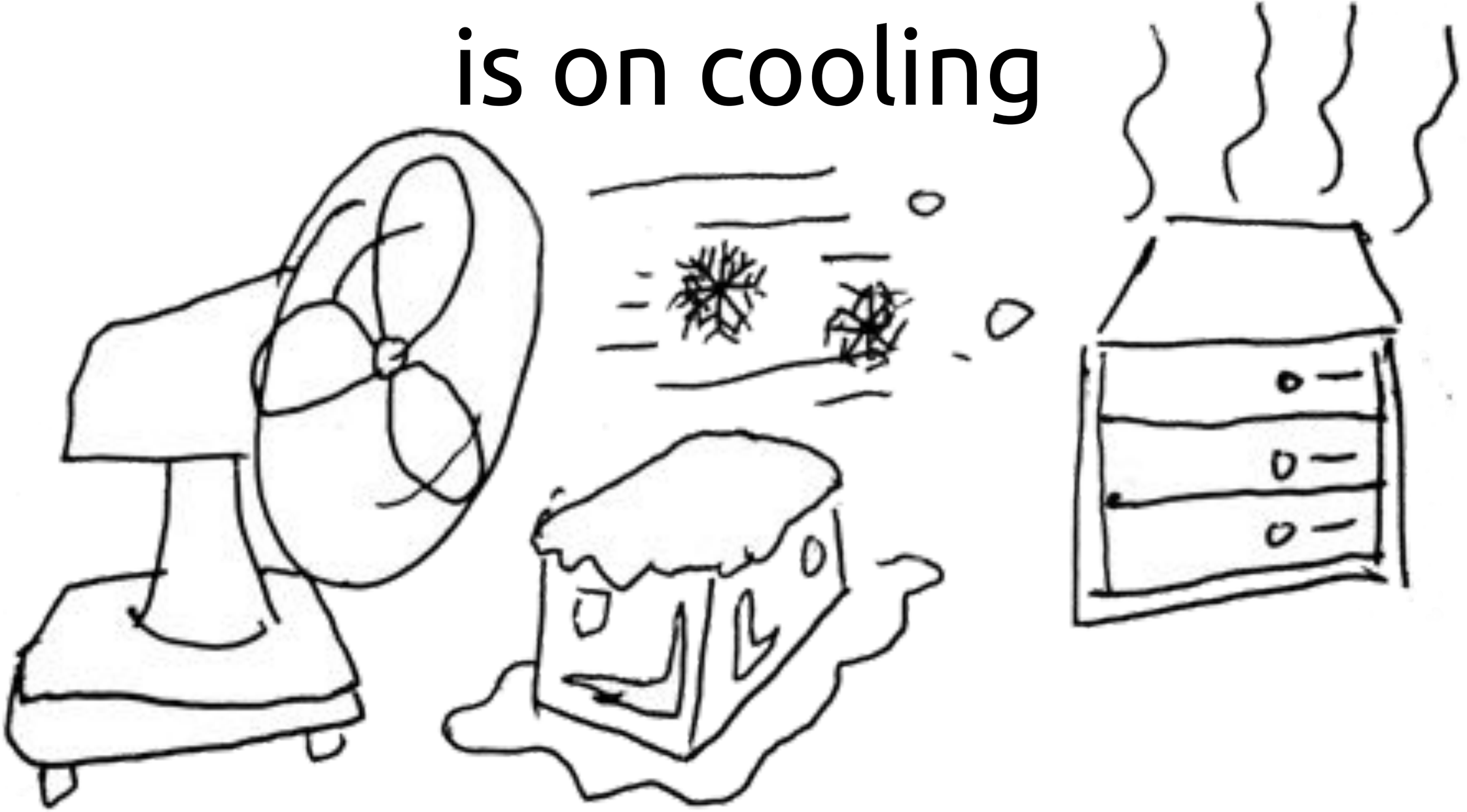


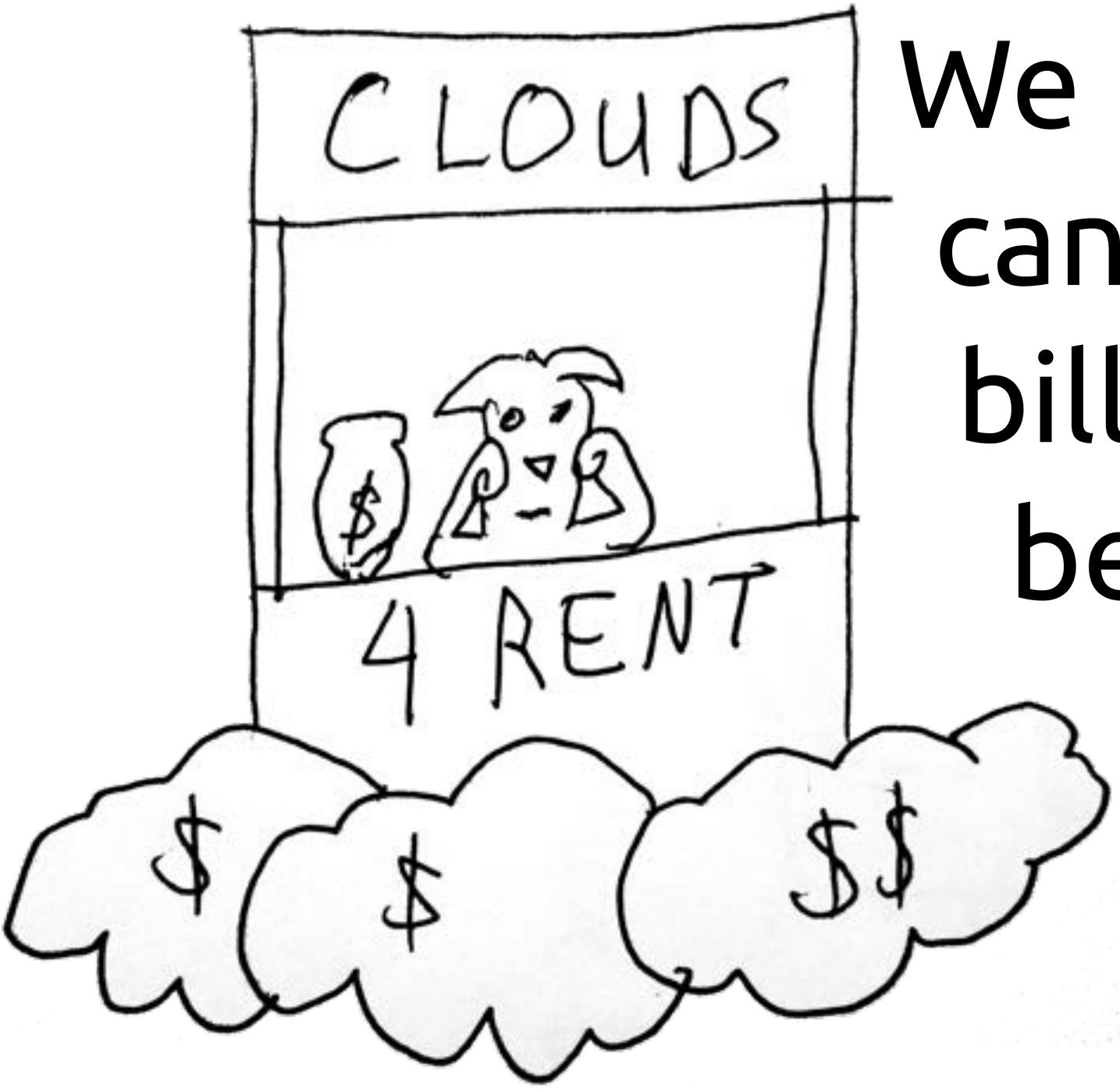

Coal
60c
CPU

How do computers consume energy?



Song et al.[7]: 40% of energy spent is on cooling





We bill for what we can measure. If we bill for energy it'll be an estimate!

Will customers revolt?

AWS Service Charges	$6,225.43
▸ API Gateway	$128.36
▸ CloudFront	$0.03
▸ CloudTrail	$0.00
▸ CloudWatch	$284.68
▸ Config	$55.48
▸ Data Pipeline	$2.31
▸ Data Transfer	$191.91
▸ DynamoDB	$0.00
▸ EC2 Container Registry (ECR)	$0.02
▸ EC2 Container Service	$0.75
▸ Elastic Compute Cloud	$2,523.37
▸ ElastiCache	$68.30
▸ Elasticsearch Service	$140.98
▸ Glue	$0.00
▸ GuardDuty	$11.80
▸ IoT	$0.05
▸ Key Management Service	$3.86
▸ Kinesis	$94.83
▸ Kinesis Analytics	$39.60
▸ Kinesis Firehose	$1.01
▸ Lambda	$12.87
▸ Redshift	$954.14
▸ Registrar	$24.00

▾ Elastic Compute Cloud		$2,523.37
▾ **US West (Oregon)**		**$2,523.37**
Amazon Elastic Compute Cloud LoadBalancing:Network		$12.93
$0.006 per used Network load balancer capacity unit-hour (or partial hour)	0.001 LCU-Hrs	$0.01
$0.0225 per Network LoadBalancer-hour (or partial hour)	574 Hrs	$12.92
Amazon Elastic Compute Cloud NatGateway		$352.63
$0.045 per GB Data Processed by NAT Gateways	948.230 GB	$42.67
$0.045 per NAT Gateway Hour	6,886 Hrs	$309.96
Amazon Elastic Compute Cloud running Linux/UNIX		$1,158.59
$0.0116 per On Demand Linux t2.micro Instance Hour	5,662.581 Hrs	$65.69
$0.020 per On Demand Linux t1.micro Instance Hour	574 Hrs	$11.48
$0.023 per On Demand Linux t2.small Instance Hour	25,805.650 Hrs	$593.53
$0.0464 per On Demand Linux t2.medium Instance Hour	4,010.367 Hrs	$186.08
$0.067 per On Demand Linux m3.medium Instance Hour	574 Hrs	$38.46
$0.0928 per On Demand Linux t2.large Instance Hour	574 Hrs	$53.27
$0.1 per On Demand Linux c4.large Instance Hour	1,148 Hrs	$114.80
$0.166 per On Demand Linux r3.large Instance Hour	574 Hrs	$95.28
Amazon Elastic Compute Cloud running Red Hat Enterprise Linux		$129.72
$0.226 per On Demand RHEL r3.large Instance Hour	574 Hrs	$129.72
Amazon Elastic Compute Cloud running Windows		$110.57
$0.0644 per On Demand Windows t2.medium Instance Hour	1,717 Hrs	$110.57
EBS		$239.01
$0.05 per 1 million I/O requests - US West (Oregon)	9,301,186 IOs	$0.47
$0.05 per GB-month of Magnetic provisioned storage - US West (Oregon)	276.245 GB-Mo	$13.81
$0.05 per GB-Month of snapshot data stored - US West (Oregon)	1,039.281 GB-Mo	$51.96
$0.10 per GB-month of General Purpose SSD (gp2) provisioned storage - US West (Oregon)	1,727.726 GB-Mo	$172.77

We care! But unless our customers ask for it we won't prioritize it!

Vendor

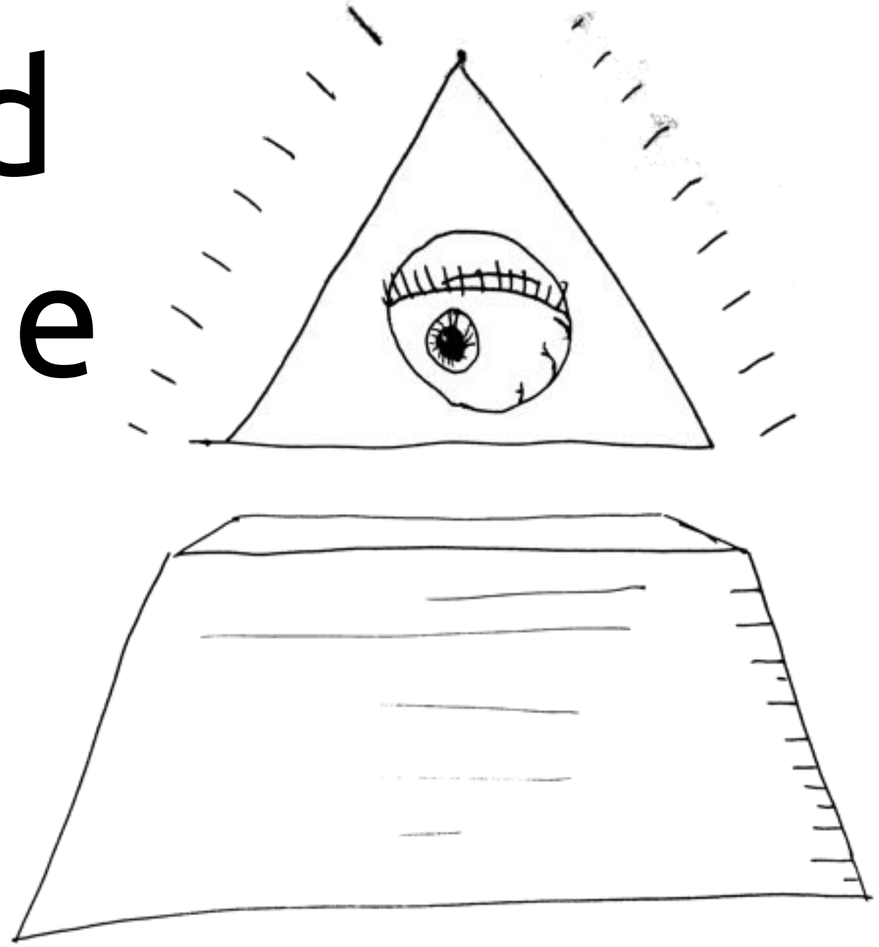
I care! But I lack feedback and incentive to act on it!

Customer

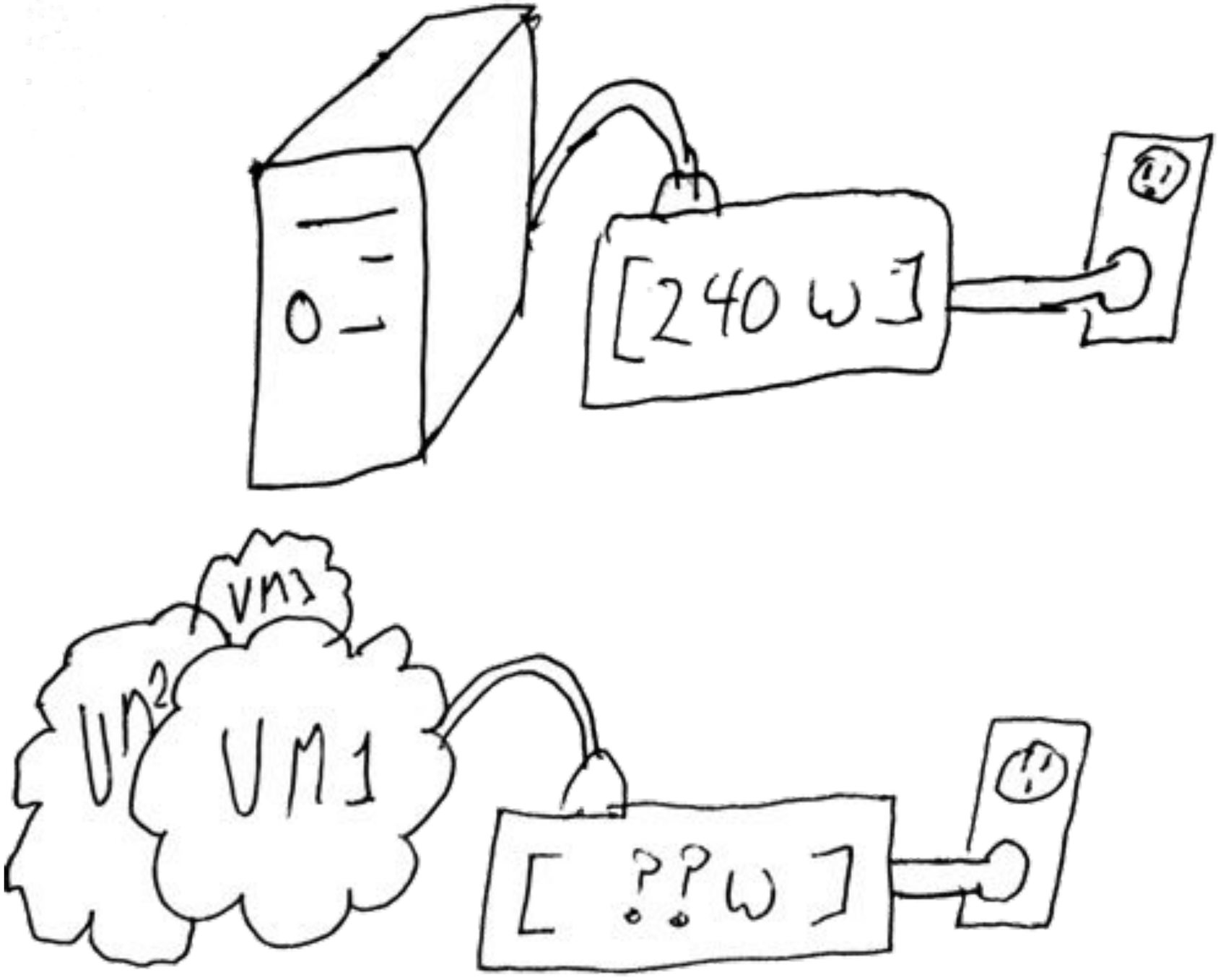
I care! But I lack feedback and incentive to act on it!

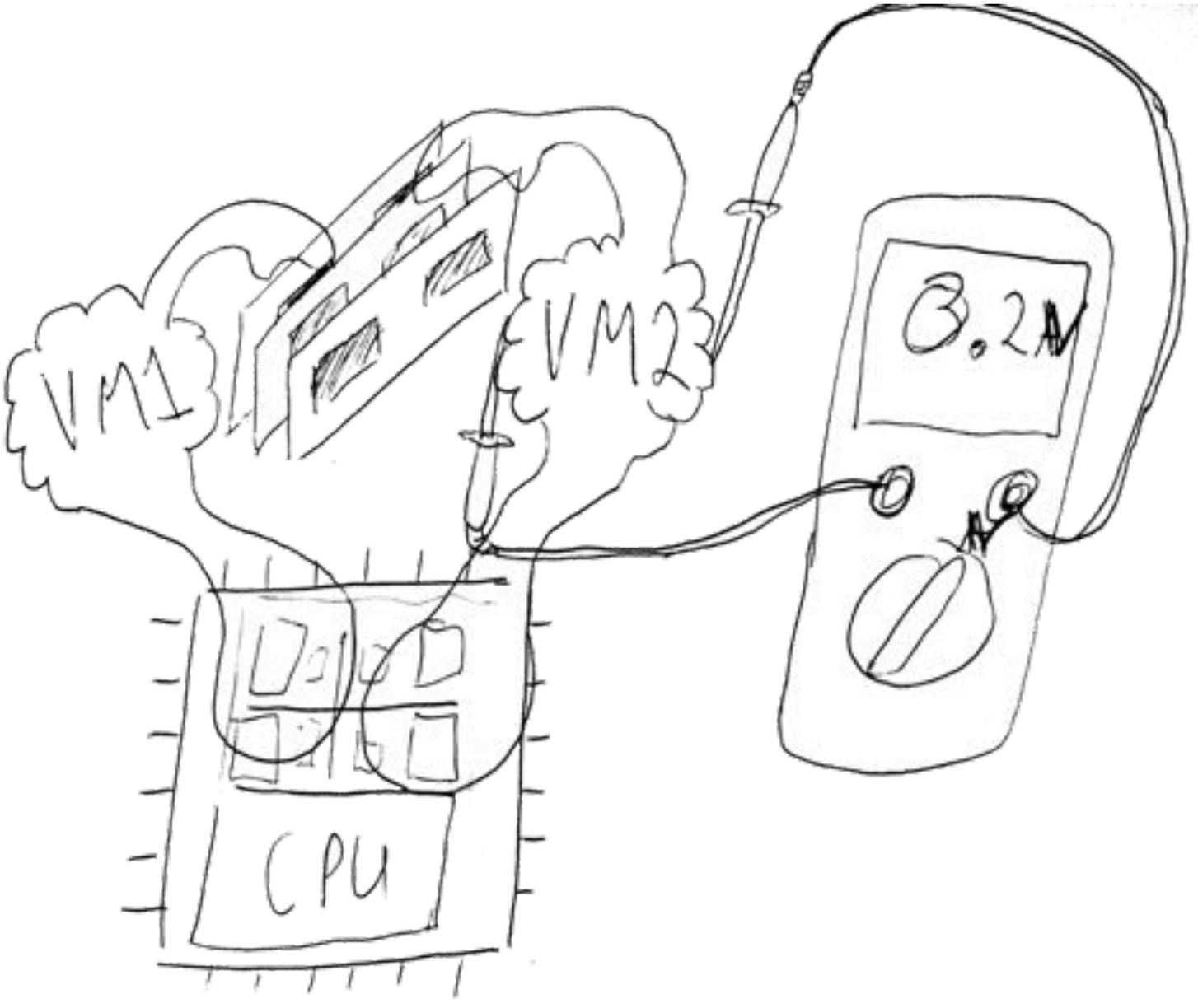
Customer

I could arrange that

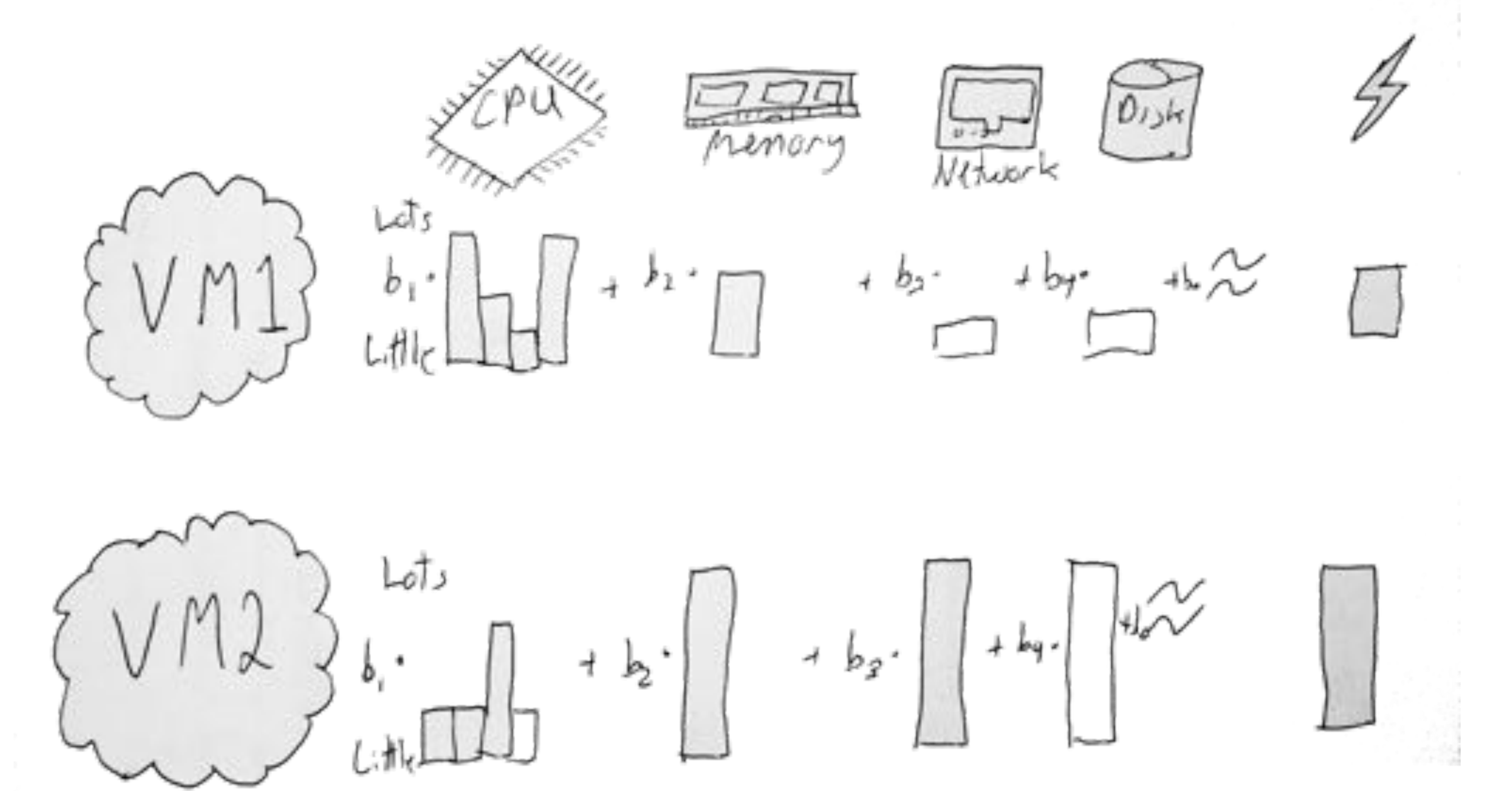


Government


[240 W]
VM2
VM1
VM1
[??W]



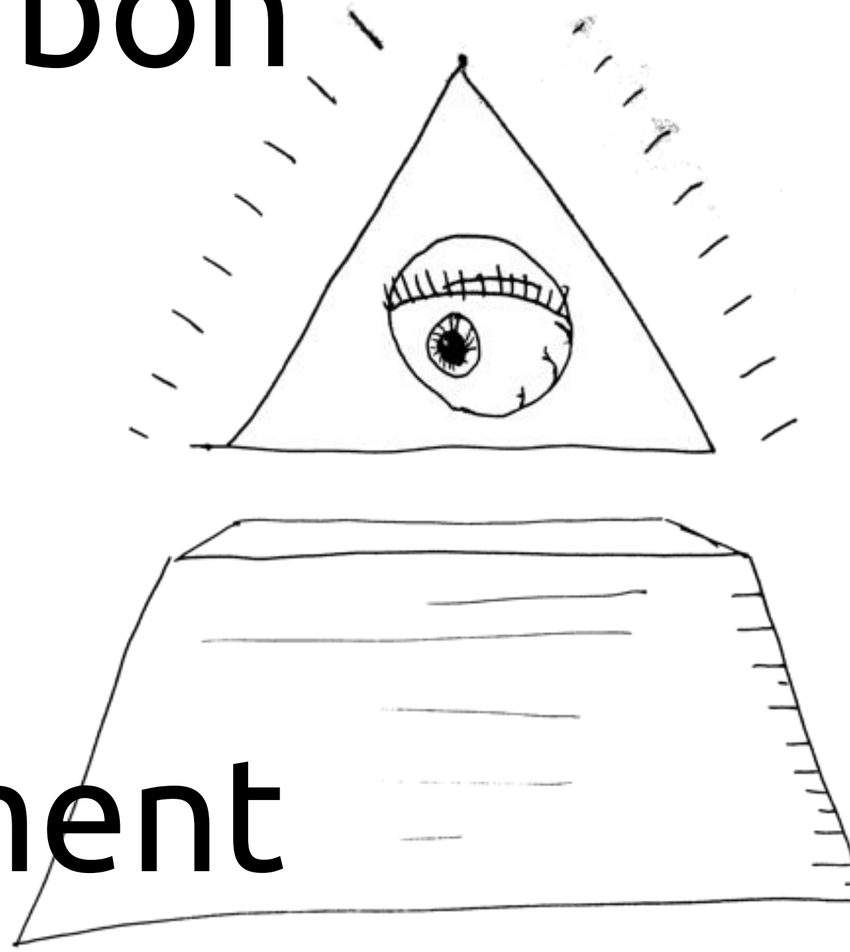
Hard to Measure Virtual Objects:


CPU
Memory
Network
Disk
VM1
Lots
$b_1 \cdot$
Little
$+ b_2 \cdot$
$+ b_3 \cdot$
$+ b_4 \cdot$
$+ b_n \cdot$
VM2
Lots
$b_1 \cdot$
Little
$+ b_2 \cdot$
$+ b_3 \cdot$
$+ b_4 \cdot$
$+ b_n \cdot$

I won't pay for modelled energy!

Customer

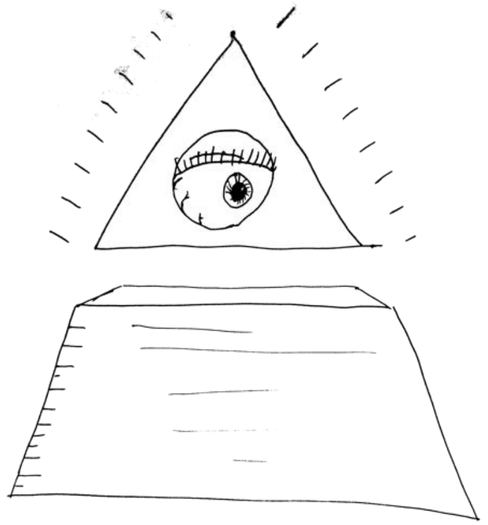
I've still managed to levy carbon taxes w/o direct measurement



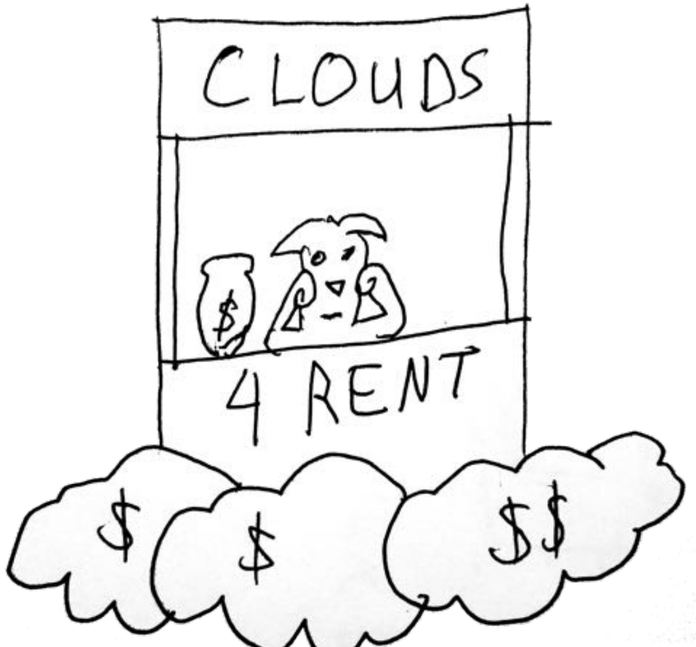
Government

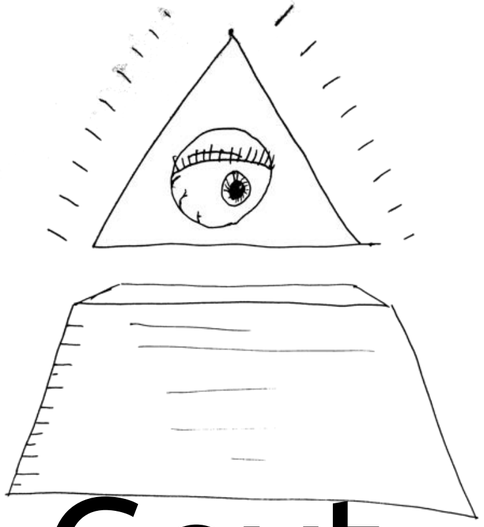
Sustainability: The next NFR

With taxation and incentives I can make Cloud Providers, Vendors, and Customers care about sustainability

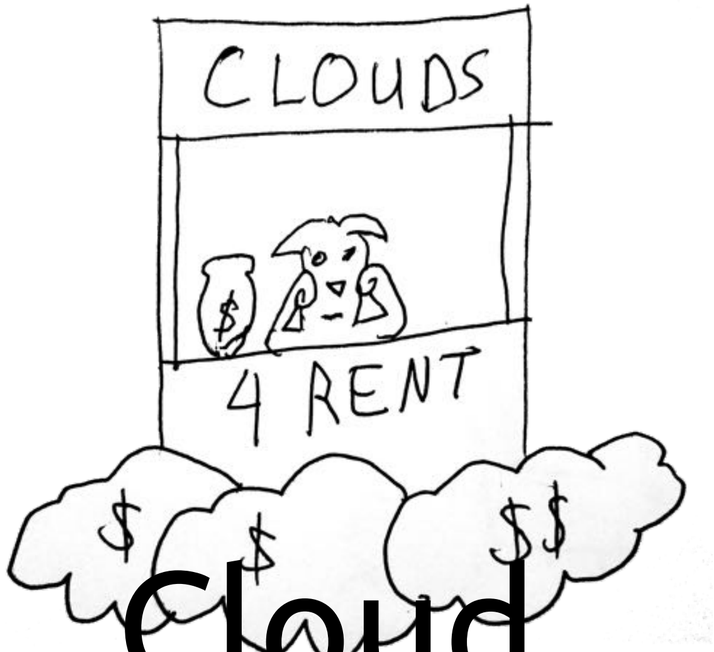


By billing the vendor I can make both the vendor and customer responsible.





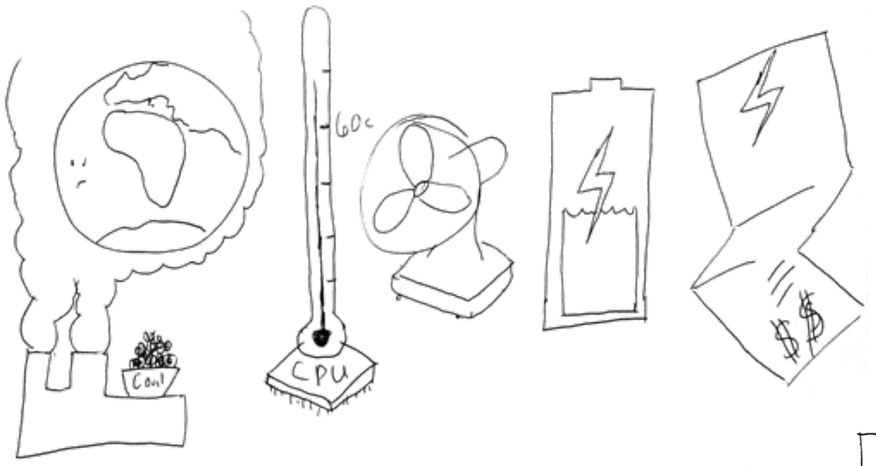
Govt.

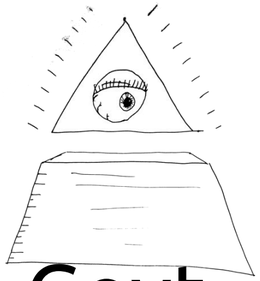


Cloud

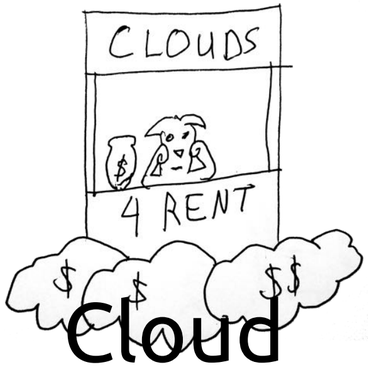
Vendor

Customer

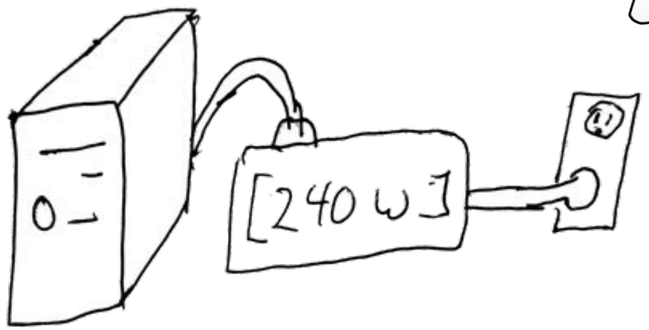
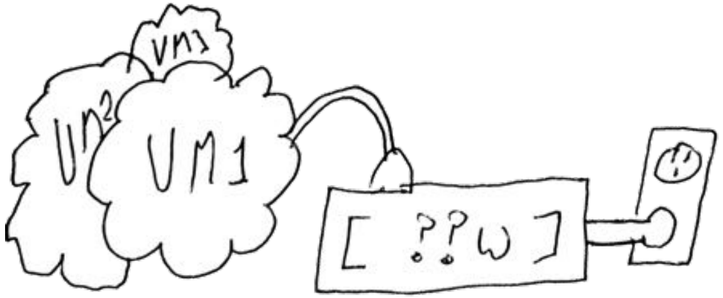
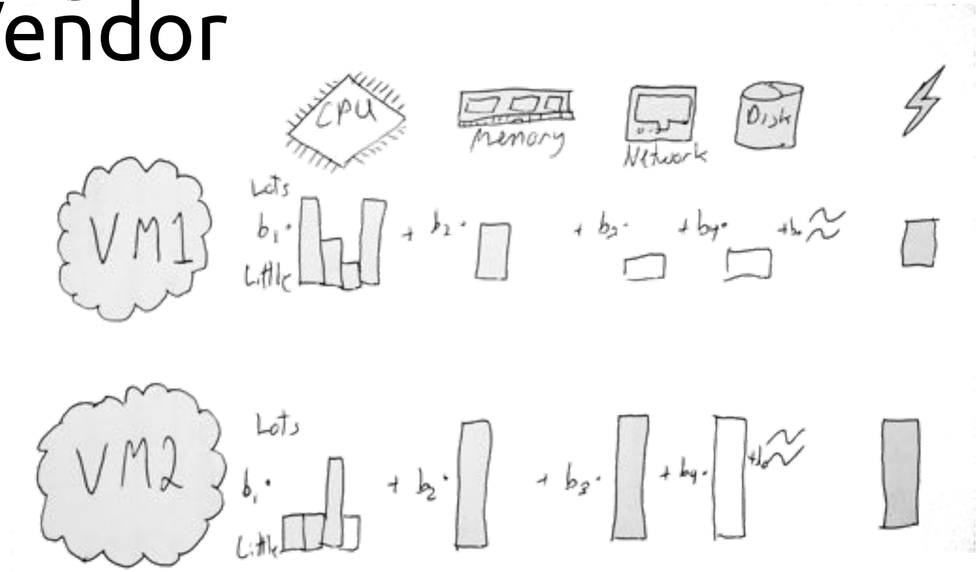




Govt.



Cloud

Vendor

Customer