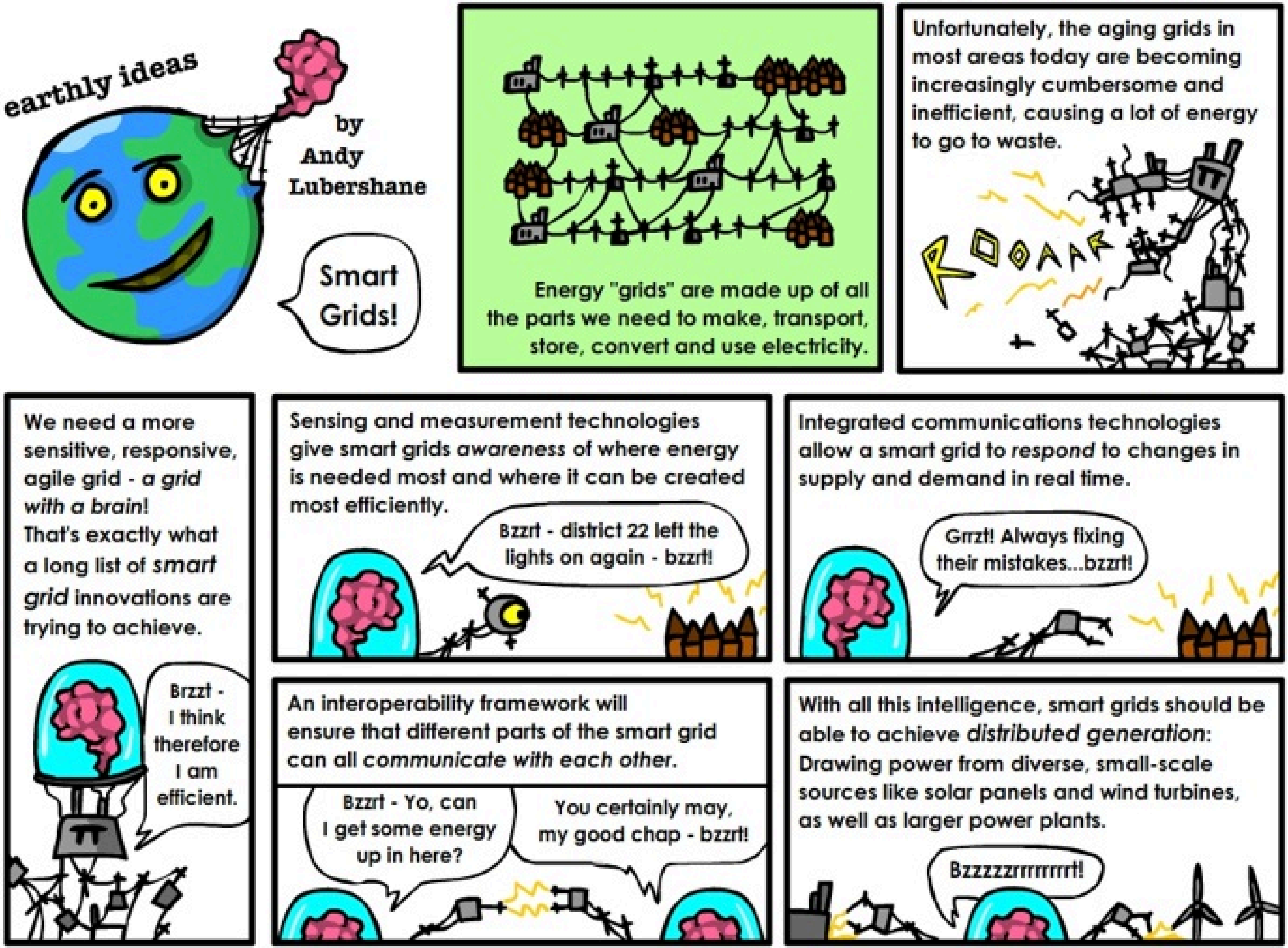
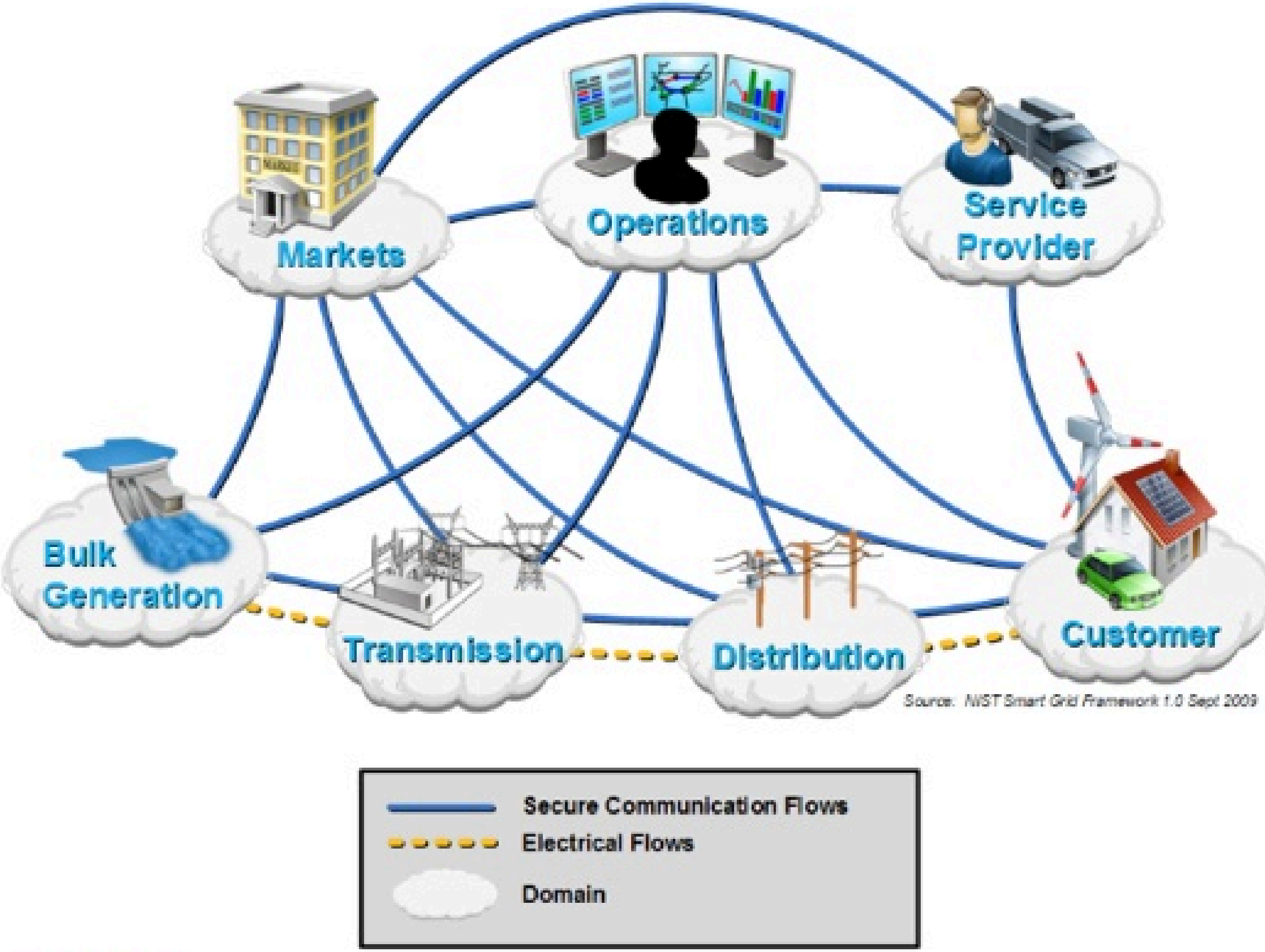

earthly ideas
by Andy Lubershane
Smart Grids!
Energy "grids" are made up of all the parts we need to make, transport, store, convert and use electricity.
Unfortunately, the aging grids in most areas today are becoming increasingly cumbersome and inefficient, causing a lot of energy to go to waste.
ROOAAR
We need a more sensitive, responsive, agile grid - *a grid with a brain*!
That's exactly what a long list of *smart grid* innovations are trying to achieve.
Brzzt - I think therefore I am efficient.
Sensing and measurement technologies give smart grids *awareness* of where energy is needed most and where it can be created most efficiently.
Bzzrt - district 22 left the lights on again - bzzrt!
Integrated communications technologies allow a smart grid to *respond* to changes in supply and demand in real time.
Grrzt! Always fixing their mistakes...bzzrt!
An interoperability framework will ensure that different parts of the smart grid can all *communicate with each other*.
Bzzrt - Yo, can I get some energy up in here?
You certainly may, my good chap - bzzrt!
With all this intelligence, smart grids should be able to achieve *distributed generation*: Drawing power from diverse, small-scale sources like solar panels and wind turbines, as well as larger power plants.
Bzzzzzrrrrrrrt!

VT Smart Grid Research Plans

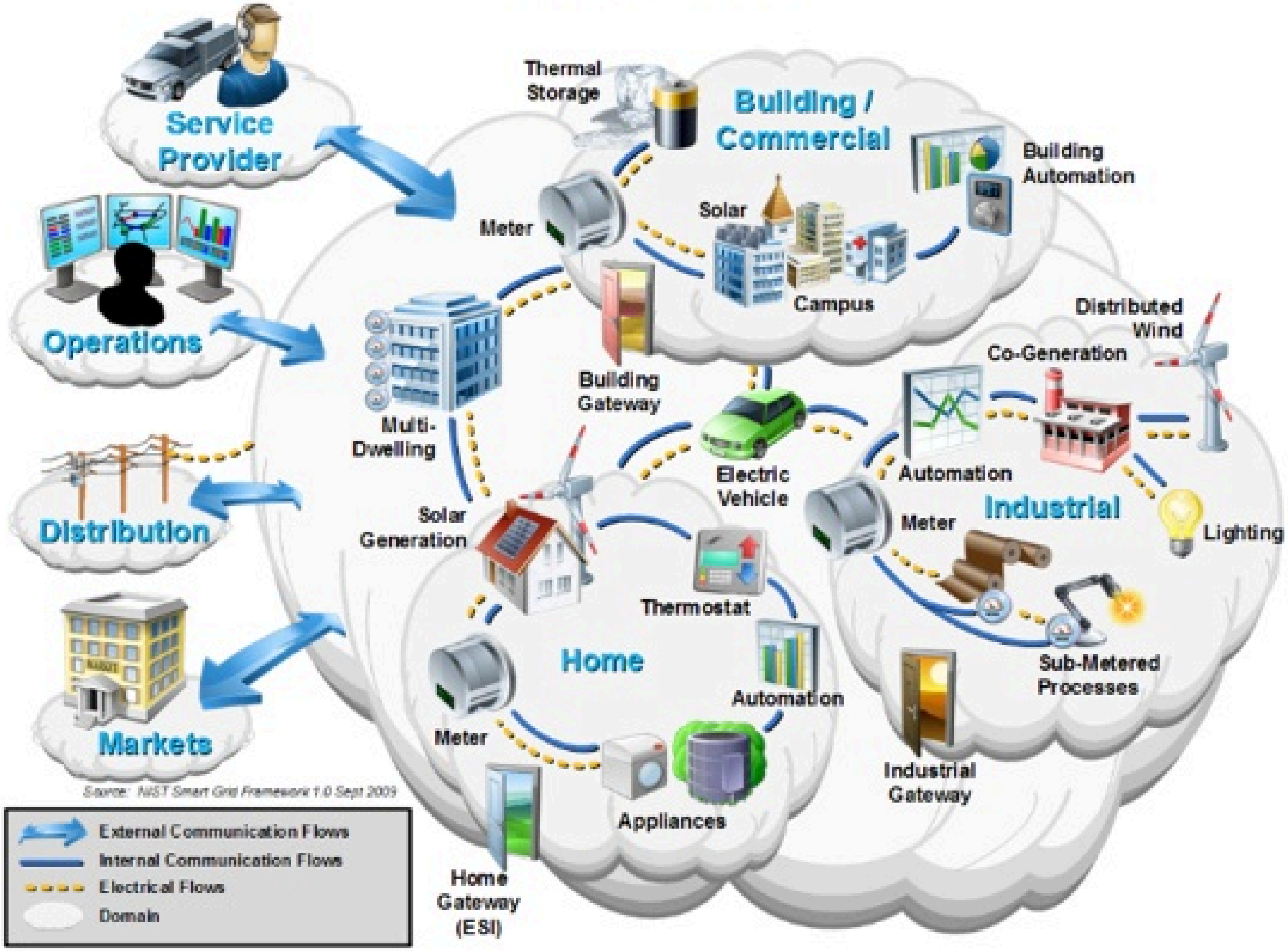
Ethan Goldman
Burlington, VT
March, 2011

Conceptual Model



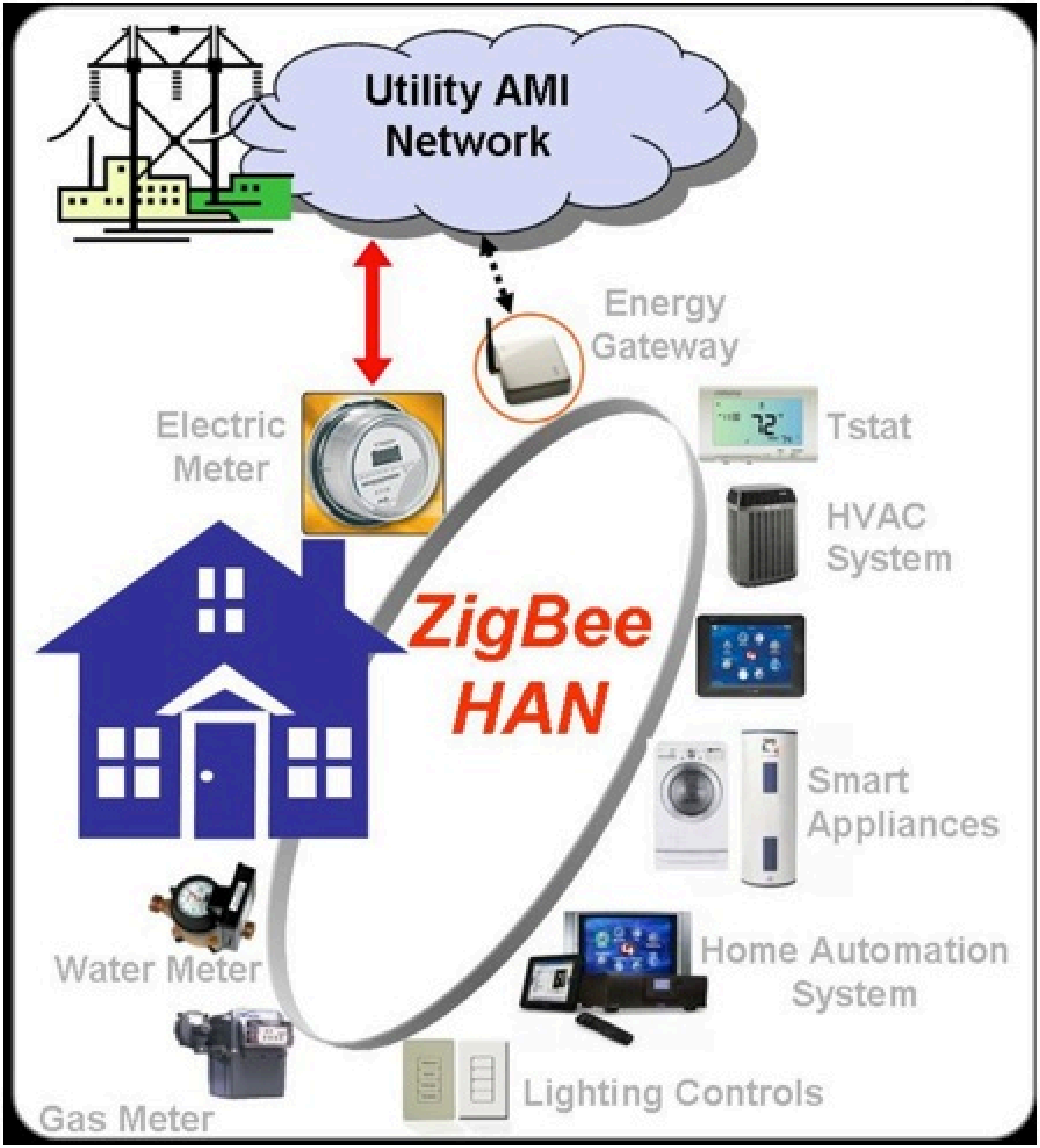
Source: NIST

Customer



Source: NIST

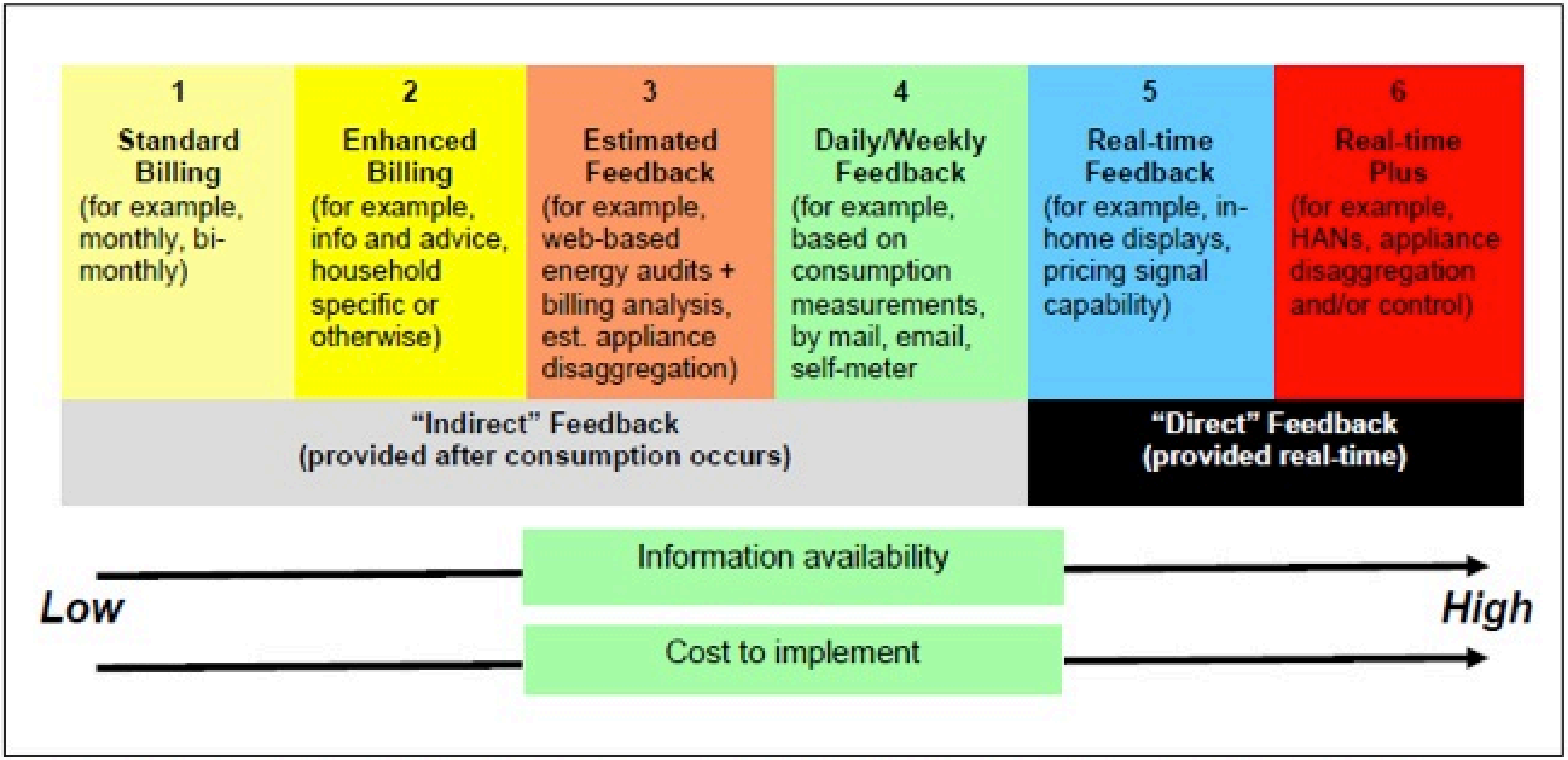
HAN



Utility AMI Network
Energy Gateway
Electric Meter
Tstat
HVAC System
ZigBee HAN
Smart Appliances
Home Automation System
Water Meter
Gas Meter
Lighting Controls

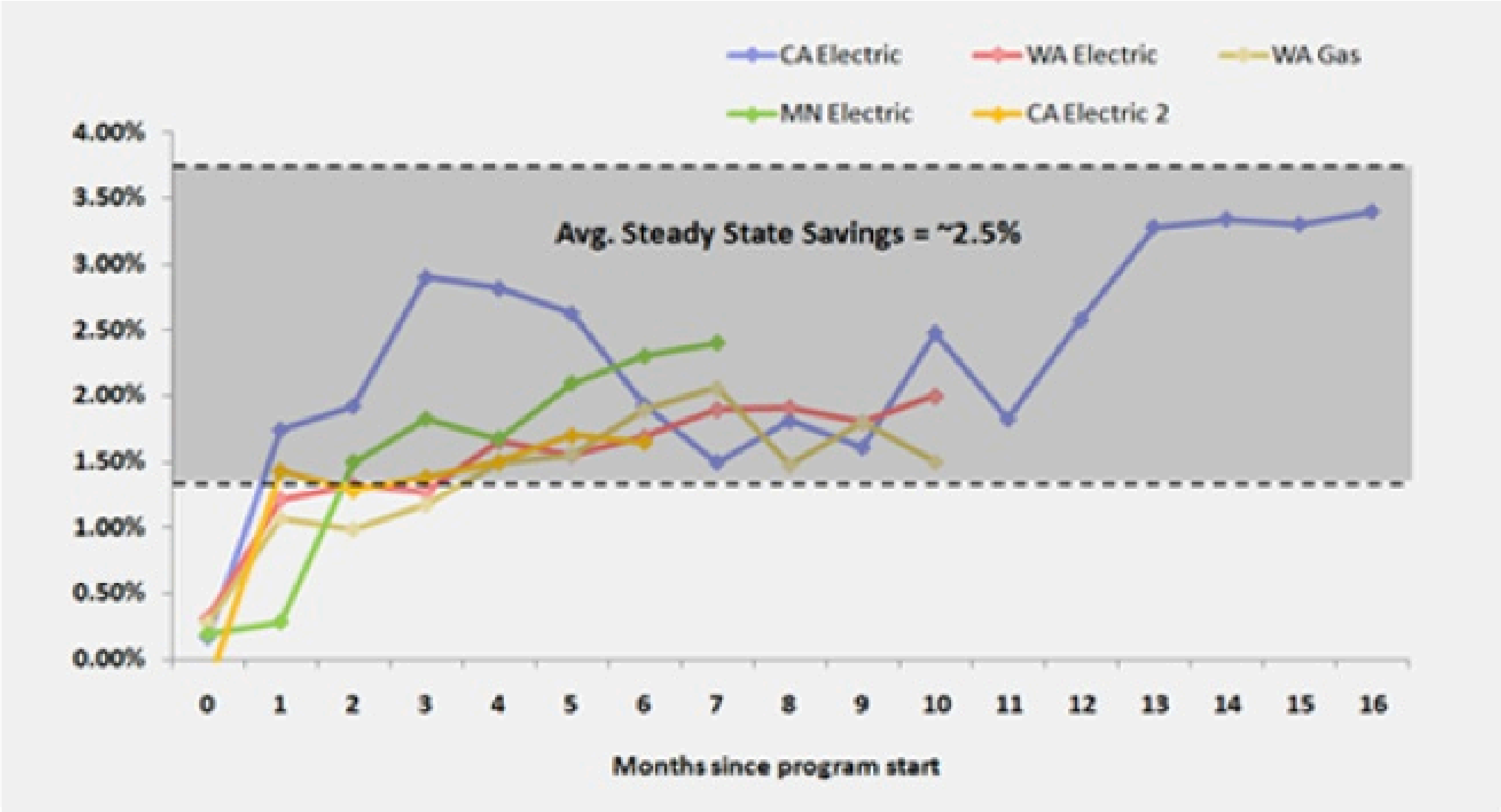
In-Home Displays

Feedback Delivery Mechanism Spectrum



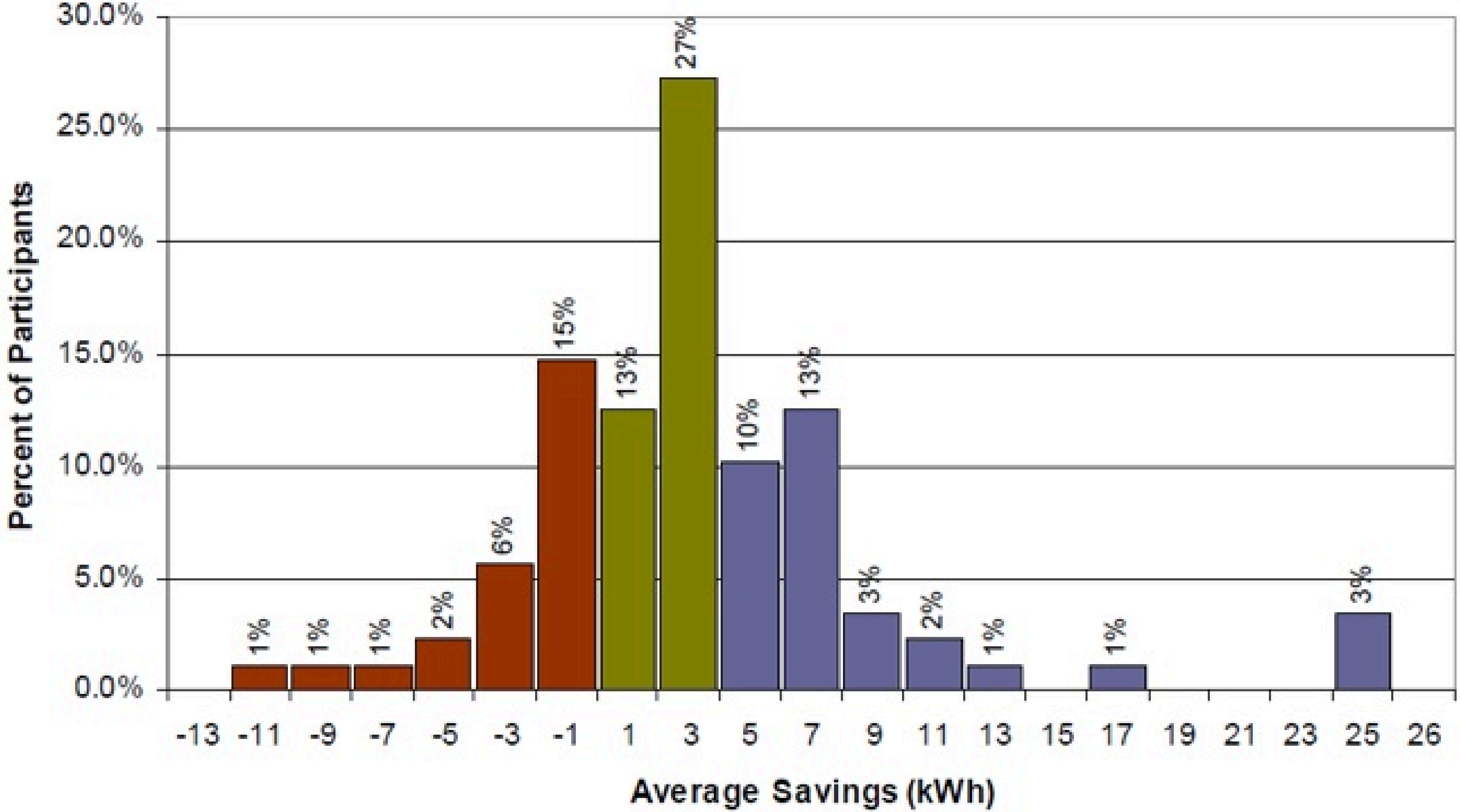
From *Residential Electricity Use Feedback: A Research Synthesis and Economic Framework; EPRI, 2009*

OPower


CA Electric
WA Electric
WA Gas
MN Electric
CA Electric 2
4.00%
3.50%
3.00%
2.50%
2.00%
1.50%
1.00%
0.50%
0.00%
Avg. Steady State Savings = ~2.5%
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Months since program start

GroundedPower (Tendril)

Figure 4-6. Distribution of Energy Savings for Program Participants



Survey of prior research

Table 1: Mechanisms of change in 'knowledge/ understanding/ motivation' framework that can be supported by smart meters.

Input	Mechanism in EDRP
Advice and information (knowledge)	On bills or online
	In conjunction with feedback
	Through community schemes
Feedback (understanding)	More frequent billing
	More accurate billing
	Additional information on bill, including graphs with historic feedback
	Real-time, on visual displays
Motivation	Information on potential cost savings through reducing bills
	Offering guaranteed cost savings or financial rewards for reduction / load-shifting
	Generating community engagement by offering rewards for combined performance

Source: Sarah Darby (2010), *Literature review for the Energy Demand Research Project*

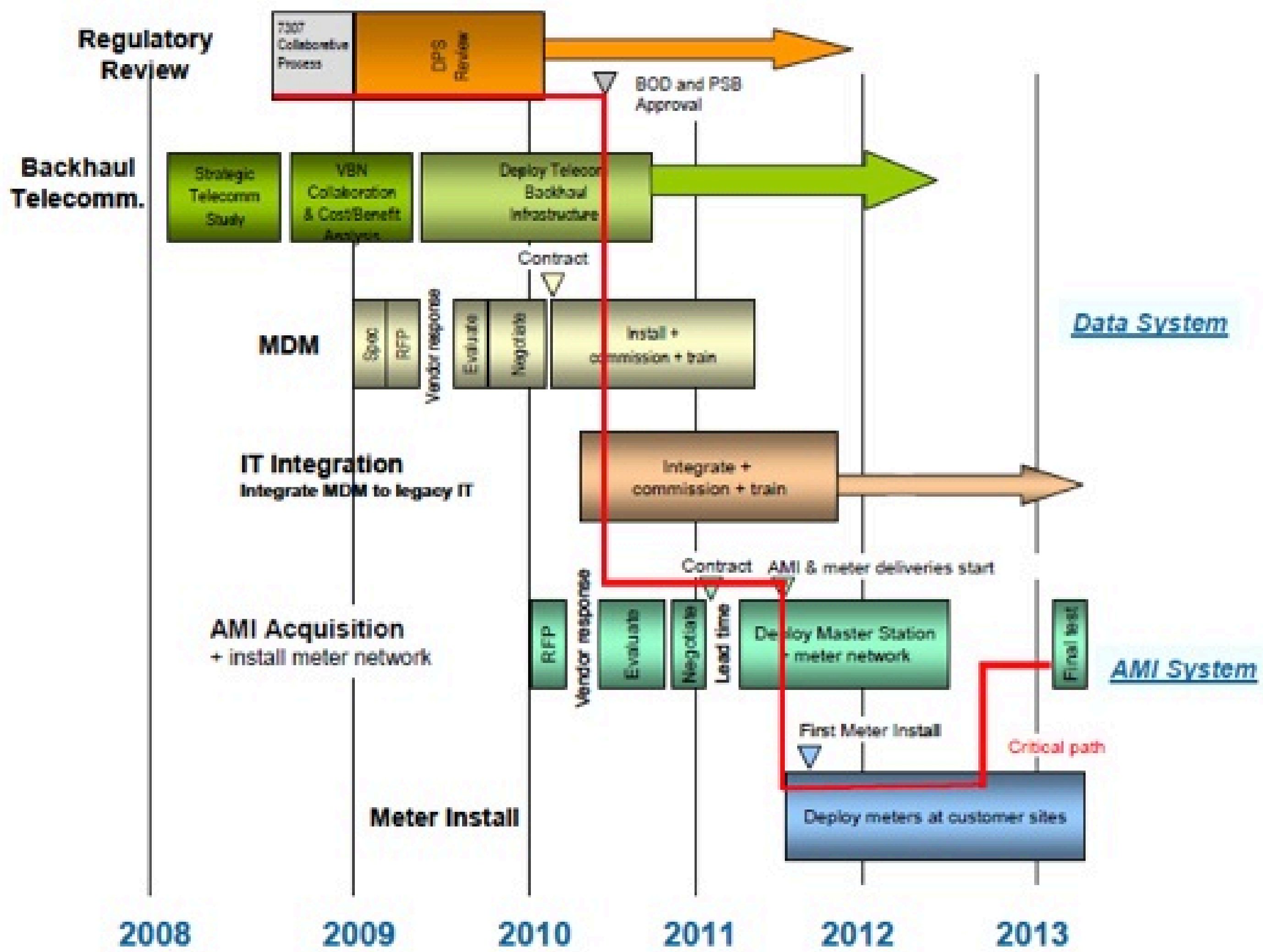
EPRI: Gaps in prior research

1. Uncertainty due to sample size, etc.
2. Specific delivery mechanisms
3. Persistence
4. Interactions with dynamic pricing
5. Differences between subpopulations

EPRI protocols

1. Defining Information Feedback Treatments
2. Determining Outcome Variables to be Measured
3. Delineating Customer Sub-segments of Interest
4. Defining the Experimental Design
5. Defining the Sampling Plan
6. Identifying the Recruitment Strategy
7. Identifying the Length of the Experiment
8. Identifying Data Requirements and Collection Methods
9. Meeting Minimum Data Requirements for Cross Utility Comparisons
10. Identifying Key Support Systems and Materials

Implementation Schedule (CVPS)



CBSP participants

- CVPS
- VEC / EVT (with more details)
- BED
- Rest of the country…
  - SMUD
  - First Energy
  - NV Energy
  - OGE
  - Lakeland Electric
  - Marblehead Electric
  - DTE Energy
  - MN Power

CVPS research

- Peak Time Rebate (PTR)
- Time of Use (TOU) rates
- Dynamically controlled hot water heaters
- Heat pump hot water heaters
- ~2,000 customers in control group
- ~1,800 customers in treatment group

VEC/EVT research

- Variable Peak Pricing (VPP)
- In-Home Displays (IHD)
- End-use monitoring & controls
- Proactive customer service
- ~5,000 customers in control group
- ~1,700 customers in treatment group

Stay tuned…

- Smart grid deployment
- Research results
- 3rd party integration