

Emerging Tech
Doing more with less

Power of Internet of Things and how to Power it

(Grid, Energy Harvesting and Energy Storage Systems)

Massoud Jourabchi
Northwest Power and Conservation Council

Oregon Association of Professional Energy Managers Forum
March 17 2016



What you would hear today

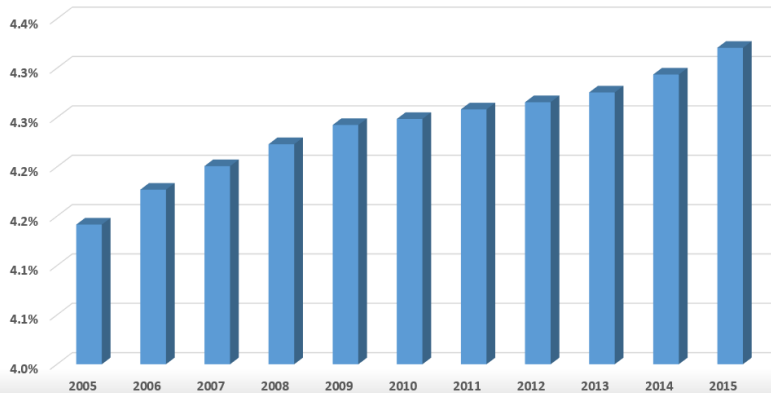
- Brief overview of recent electricity picture in the region
- Doing more with less
- Factors contributing to current demand
- Trends impacting future demand
 - Conservation and Demand Response
 - Federal Appliance Standards
 - Seasonal Temperature
 - Internet of Things

Factors Impacting to Demand for Electricity

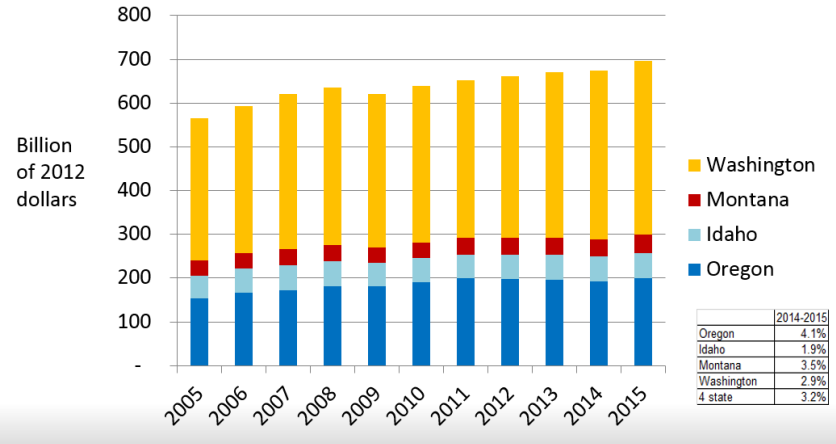
- Economy
- Building Codes and Appliance Standards
- Seasonal Change in temperature
- Behind-the-meter investments
 - Utility induced efficiency
 - Consumer induced efficiency
 - Roof-top-solar
 - Market Trends

**Regional population grew
from 12.3 in 2005 to 13.9 million in 2015
and expected to increase to 16 million by 2035**
(Region's share of national population increasing)

Regional Population as percent of nation

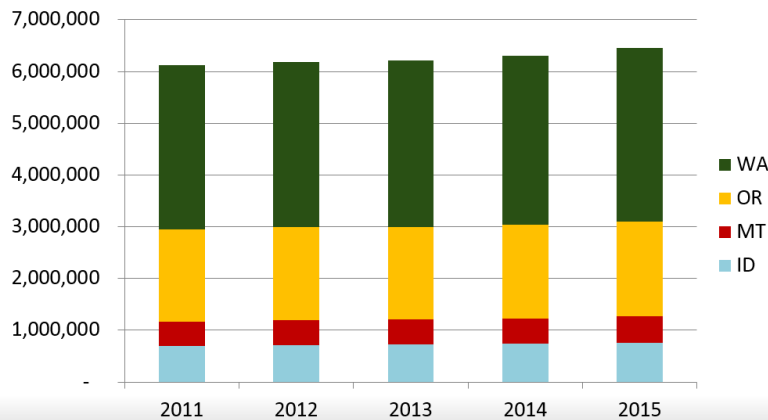


**Economy of region,
measured in Gross State Product,
grew faster than the nation**



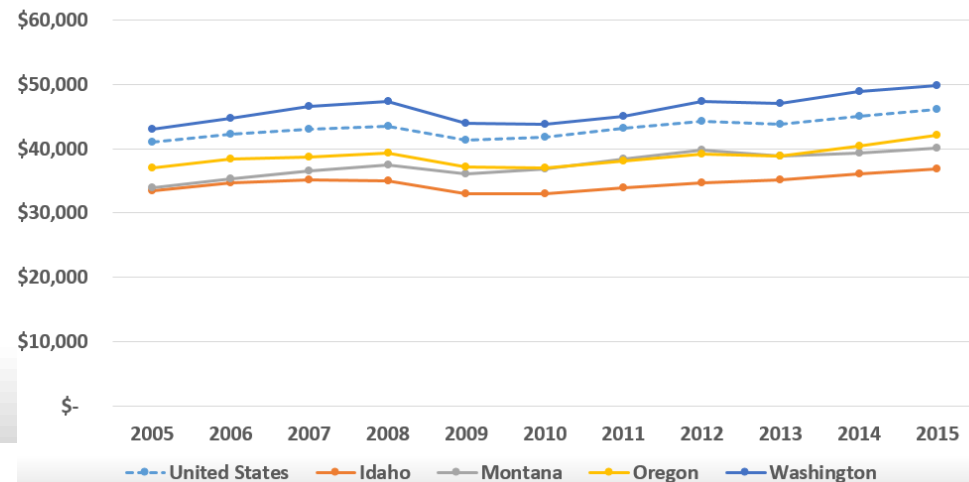
Employment Picture has Improved

(In the past 5 years employment was increased by over 363,000)



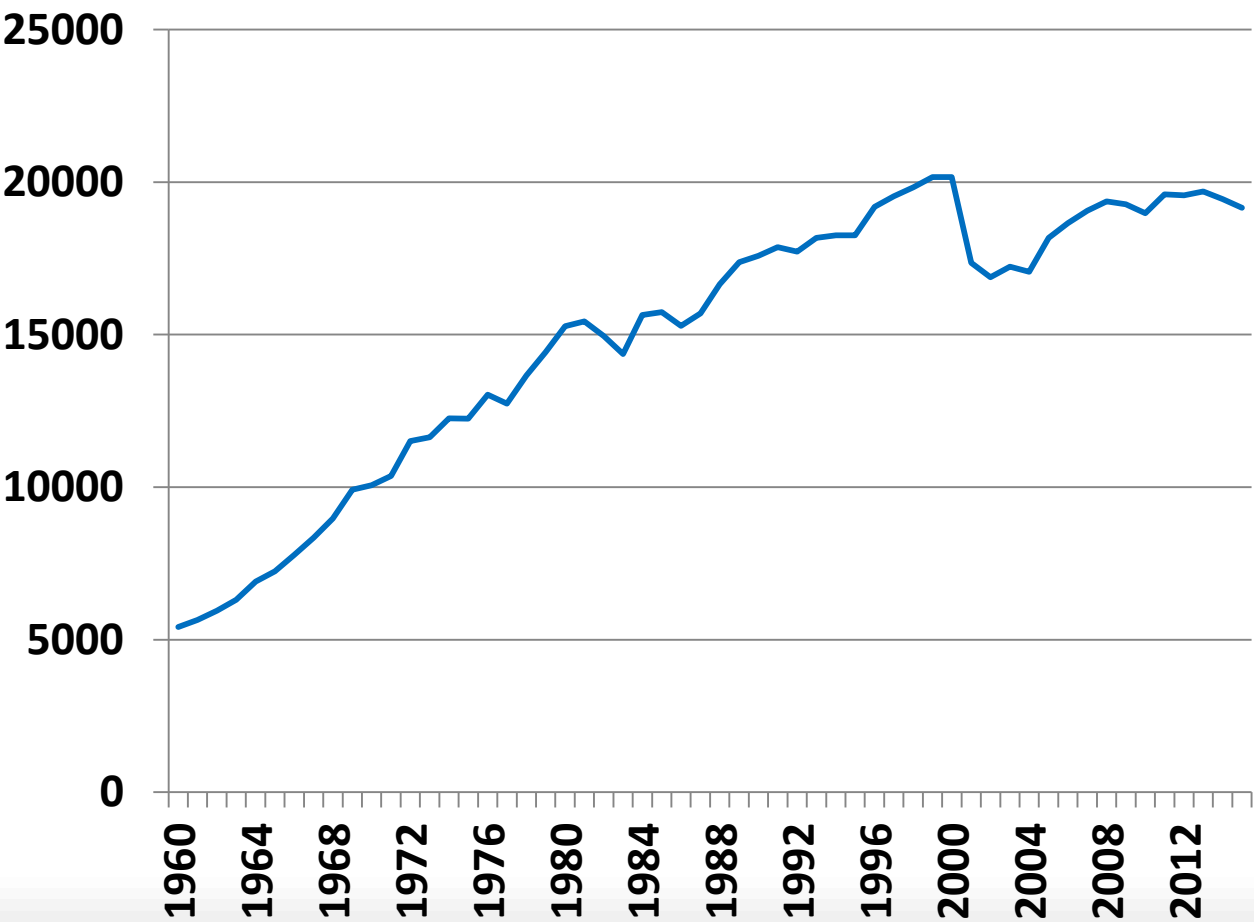
Regional Income Has Improved

Per Capita Income (2012 dollars)



NW regional Sales in the past decades

(aMW)



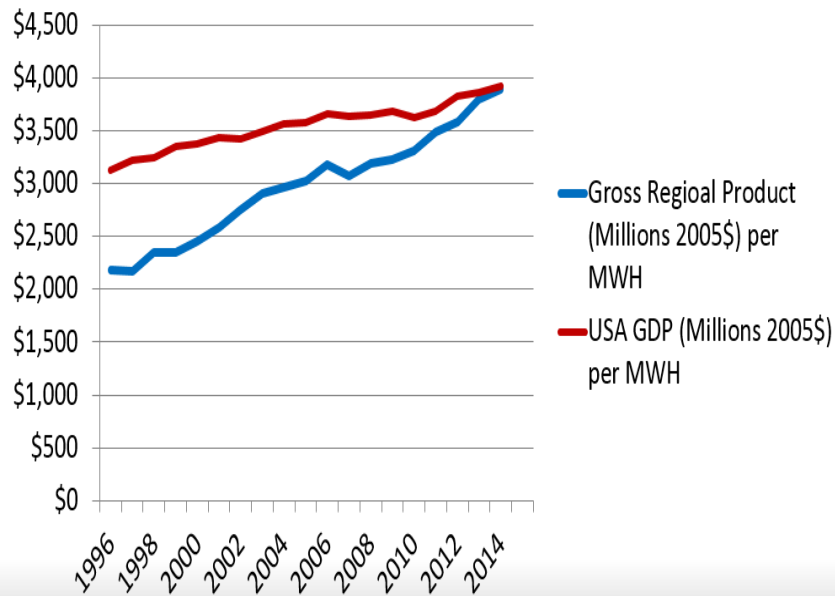
	Annual Growth Rate
1960s	7%
1970s	4%
1980s	1.6%
1990	1.4%
2001-2010	-0.4%
2010- 2015	0.2%
Future	?

2010-2015	Annual Growth Rate
Com.	0.65%
Res.	-0.30%
Ind. *	0.23%

* Excludes Aluminum

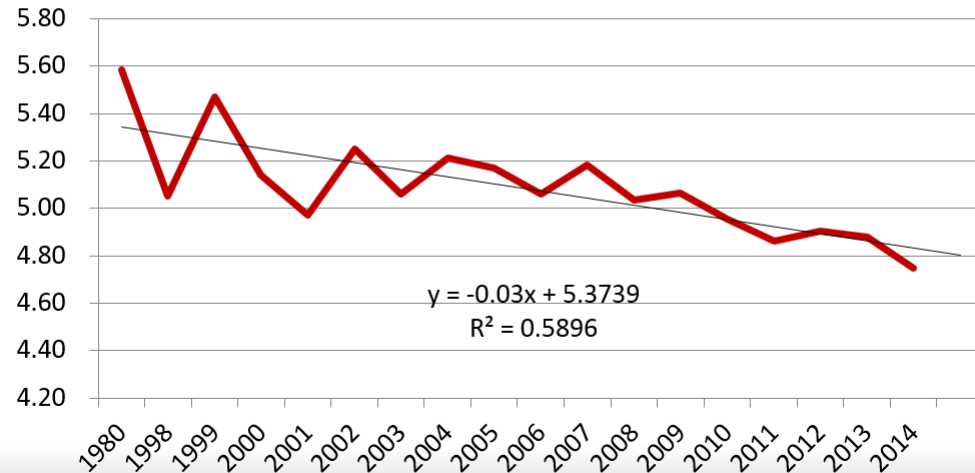
Doing More with Less Energy

\$2005 Dollars of Output per MWH of consumption



NW Residential Sector

Weather normalized MWH of consumption per capita



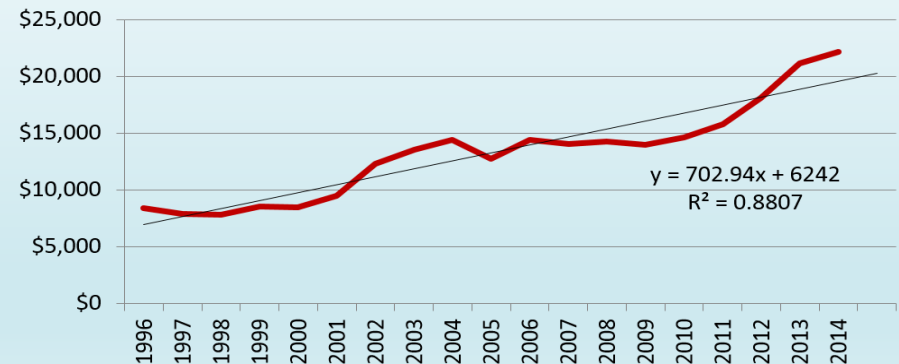
Commercial Sector

Dollars of Output from Commercial Sector per MWH of weather normalized consumption



Manufacturing* Sector

\$2005 Dollars of Output per MWH of weather normalized consumption



Forecast of Demand for Electricity

Projected growth in the region

■ Commercial floor space additions

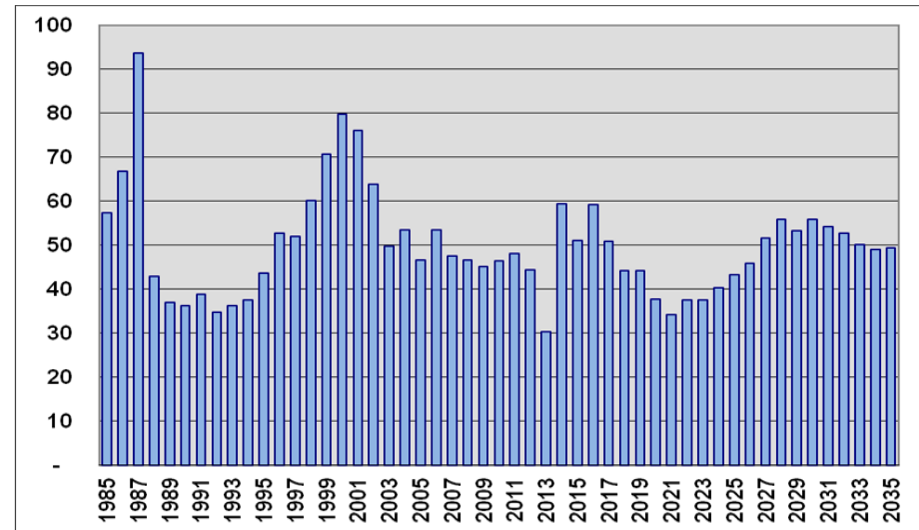
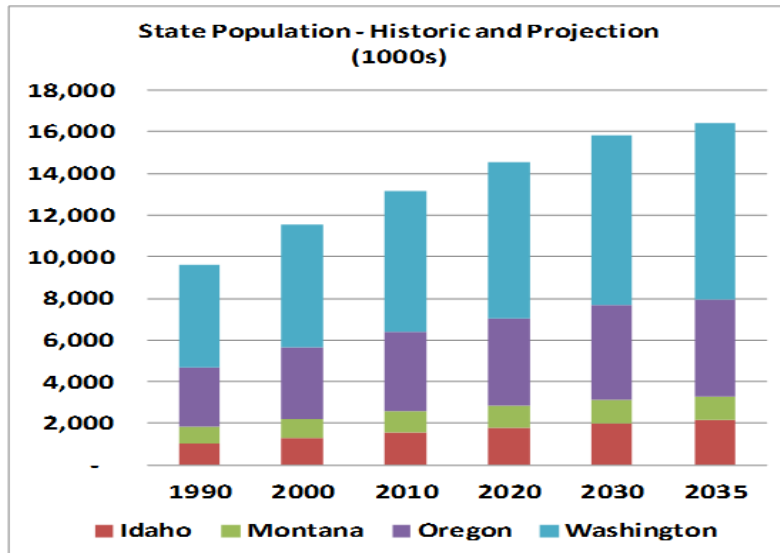
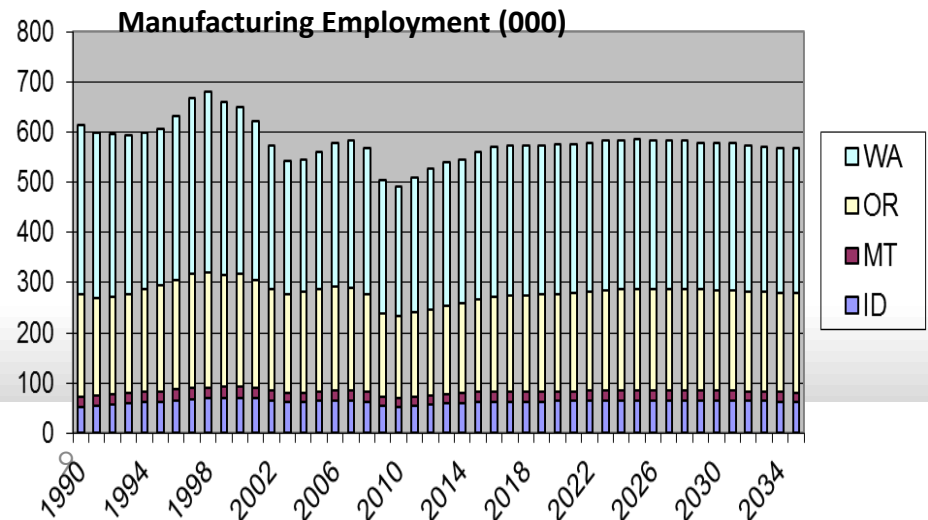
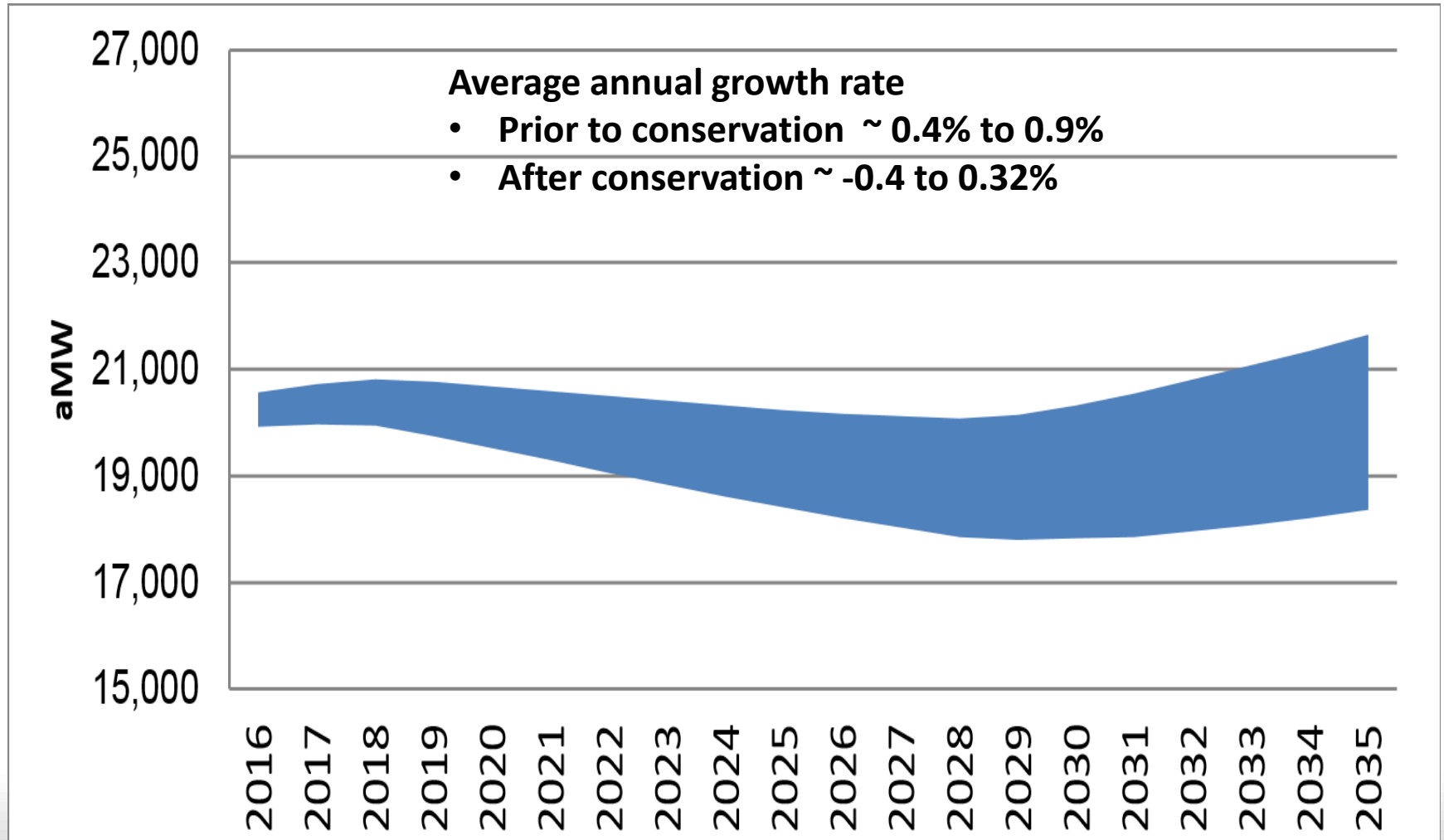


Table D - 7: Historic and forecast stock of residential units (1000s)

Regional Summary	1985	2007	2015	2020	2030	2035
Single Family	2,753	3,997	4,279	4,573	5,077	5,318
Multi Family	578	1,016	1,141	1,286	1,546	1,673
Manufactured homes	329	583	601	611	632	643

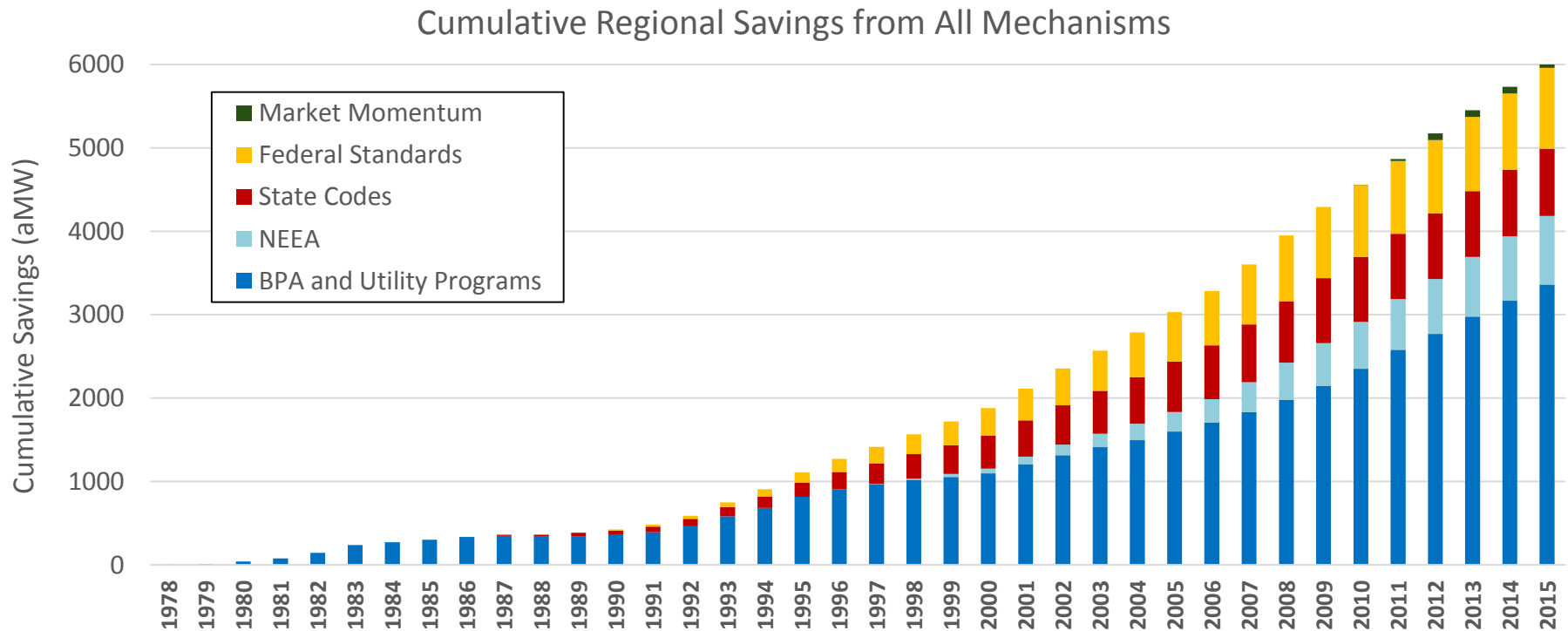


Range of Forecasted Loads net of Conservation



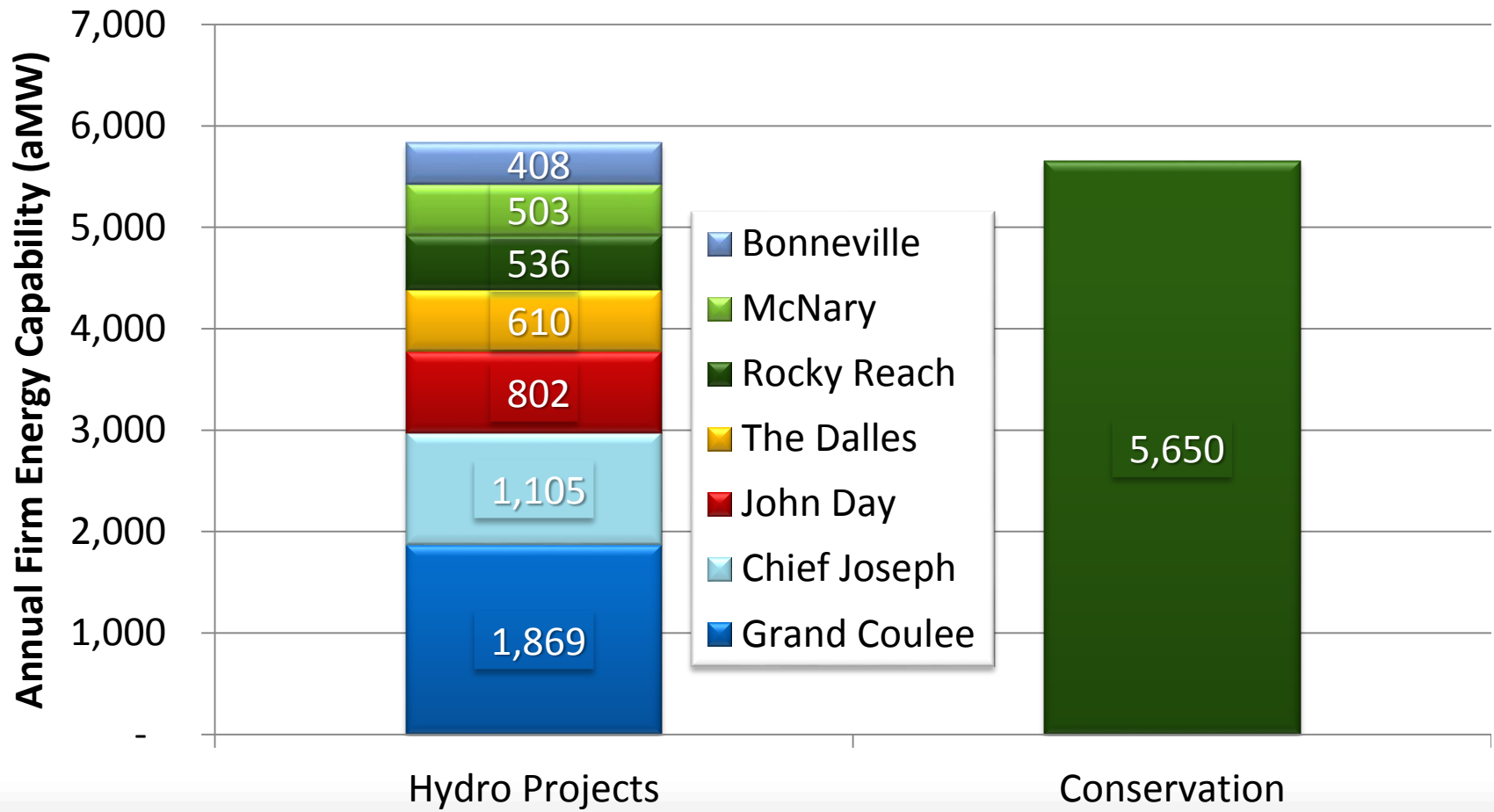
Investment in Energy Efficiency

Region has achieved almost 6,000 aMW of conservation, making it the second largest resource behind hydro

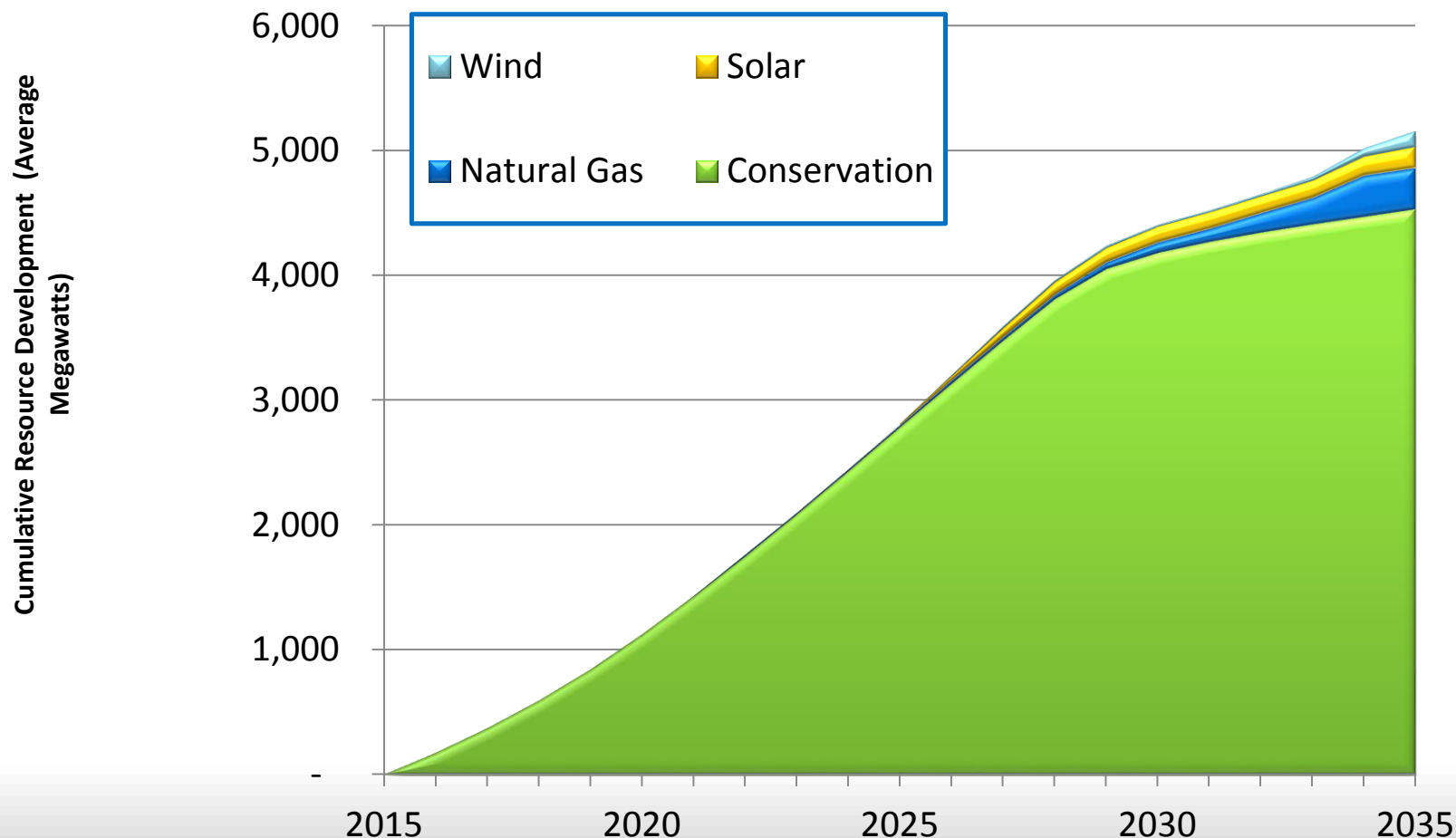


- Investment in Electricity Efficiency Has Met Nearly 55% of PNW Load Growth Since 1980
- Efficiency now generates equivalent of more than **17%** of regional mix of generation

Savings from Energy Efficiency Since 1978 Nearly Equal the Annual Firm Energy Output of the Seven Largest Hydro Projects in the Region

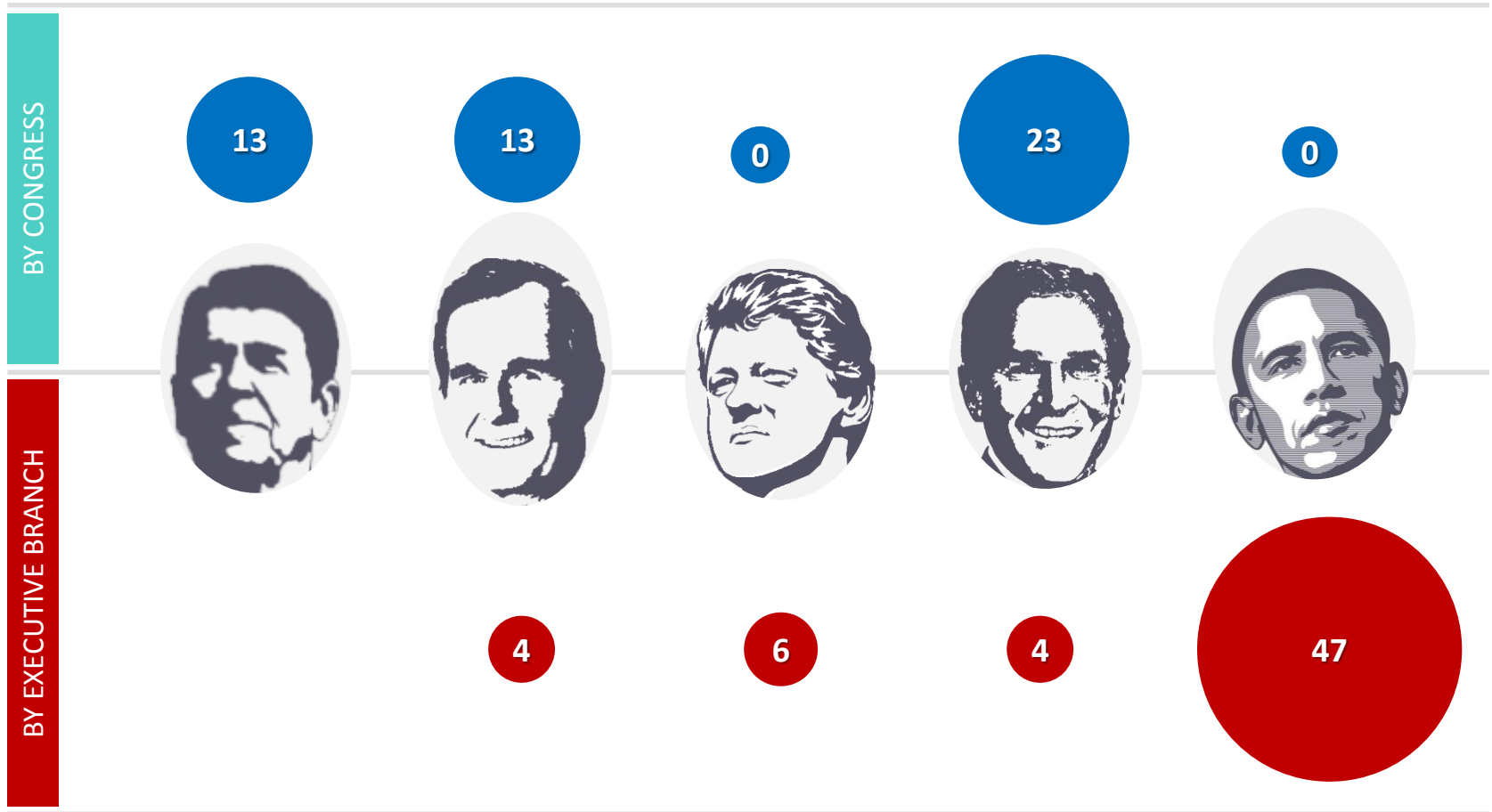


Conservation and Demand Response to Meet Nearly All Forecast Growth in Regional Energy and Capacity Needs



Impact of Future Federal Standards

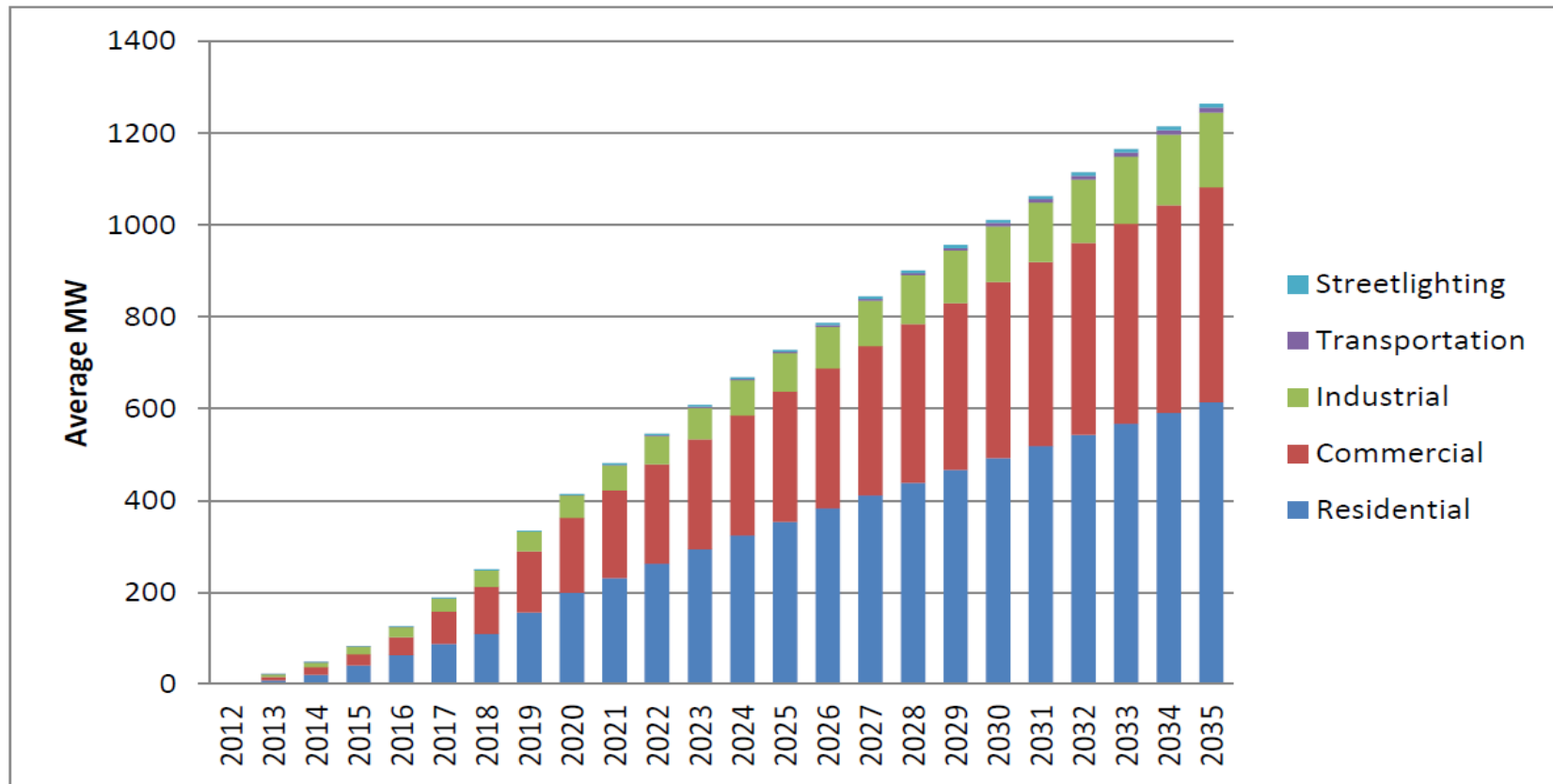
Standards adopted by administration



*As of January 3, 2017
Source: ASAP/ACEEE

Impact of standards since 2012

Figure F - 2: Year by Year Direct Impact of Federal Standards

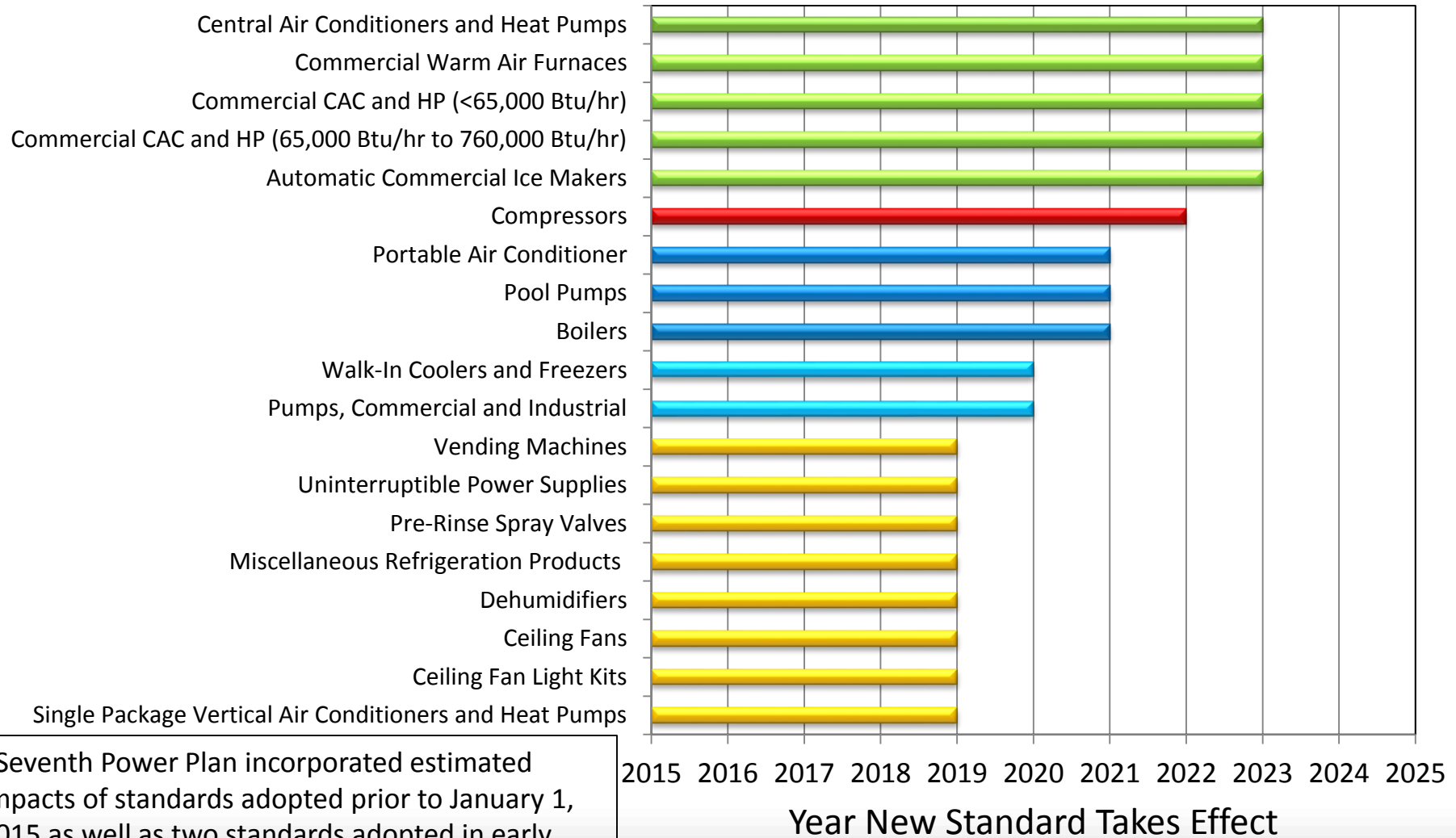


Standards have predominantly targeted demand for electricity

Residential sector ~ 80%

Commercial sector ~50% Industrial Sector ~20%

19 New Federal Efficiency Standards Issued Since 2015 Will Help Achieve the 7th Plan's Energy Efficiency Goals*

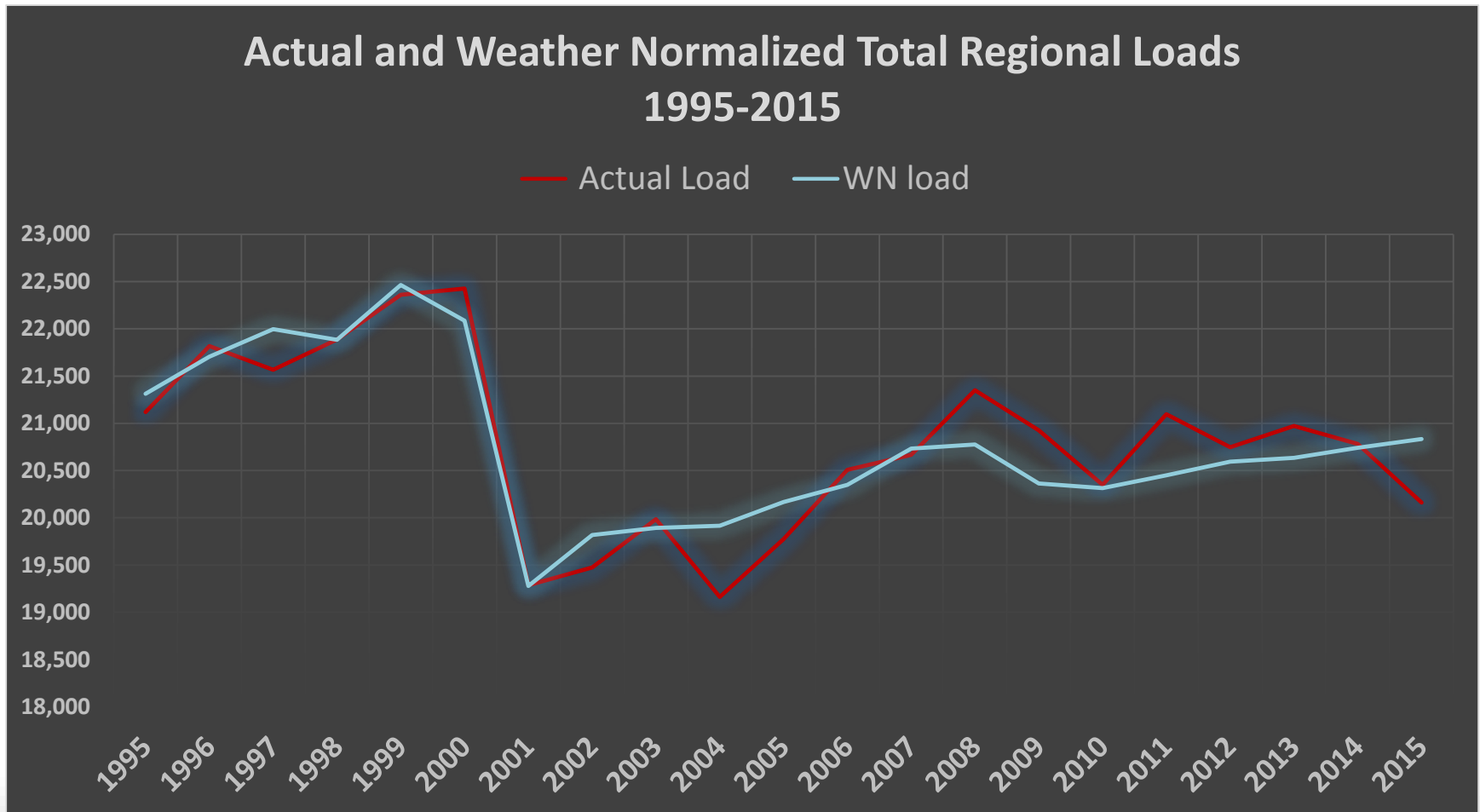


*Seventh Power Plan incorporated estimated impacts of standards adopted prior to January 1, 2015 as well as two standards adopted in early 2015

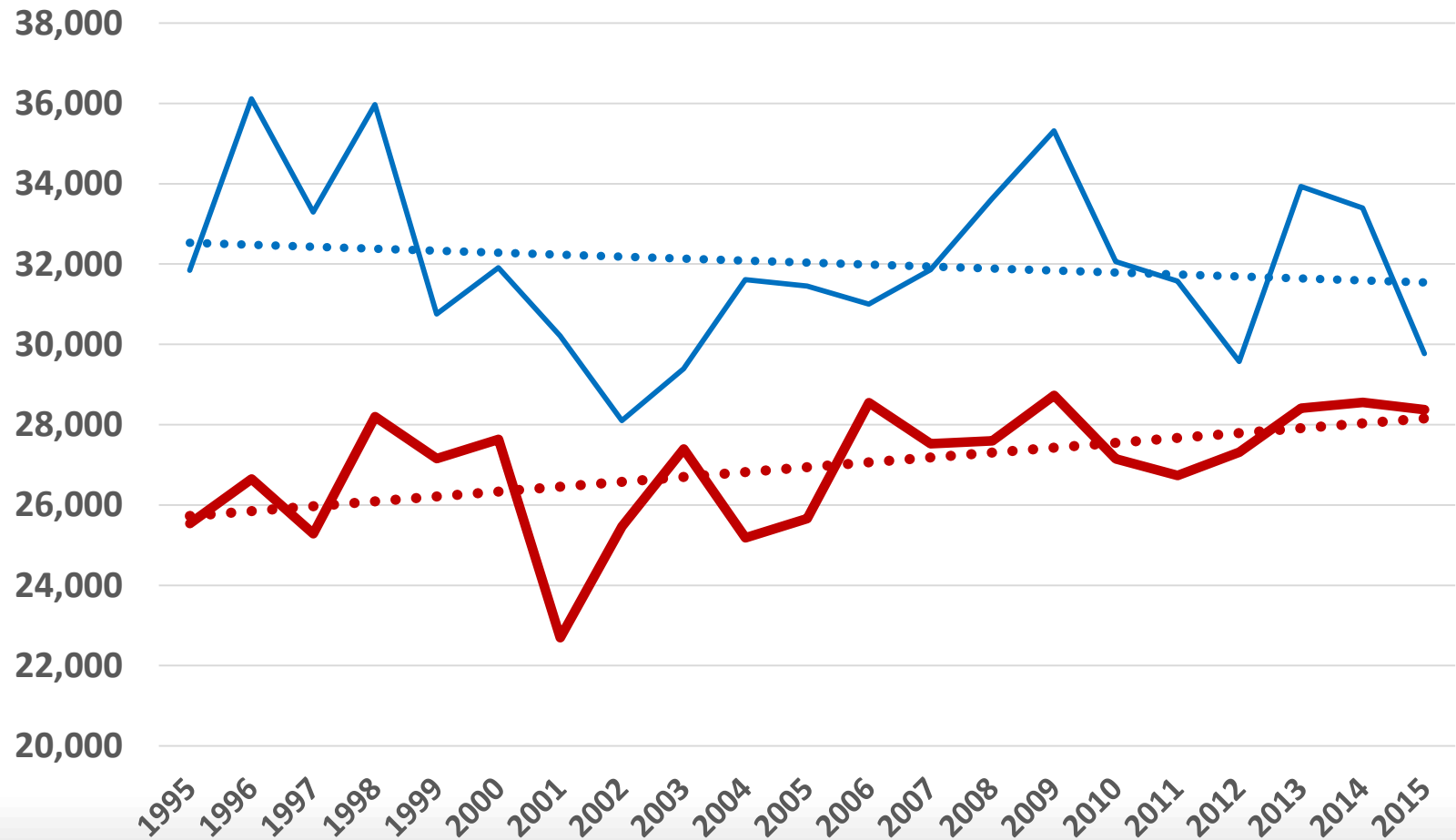
Impact of Temperature on Demand For Electricity

Increasingly weather is playing a larger role

Weather is playing a bigger role in demand for electricity



Difference between Winter and Summer Peak loads is Shrinking



Emerging Technologies

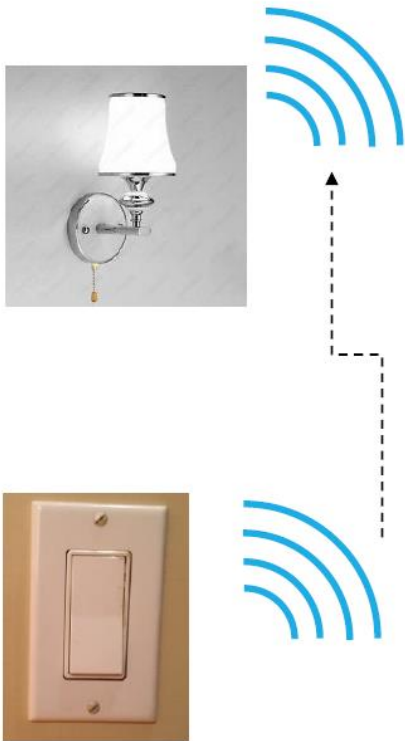
Internet of Things (IoT)

- What is it?
- Where it is applied?
- How it can be powered
 - Grid
 - Energy Harvesting
 - Energy Storage

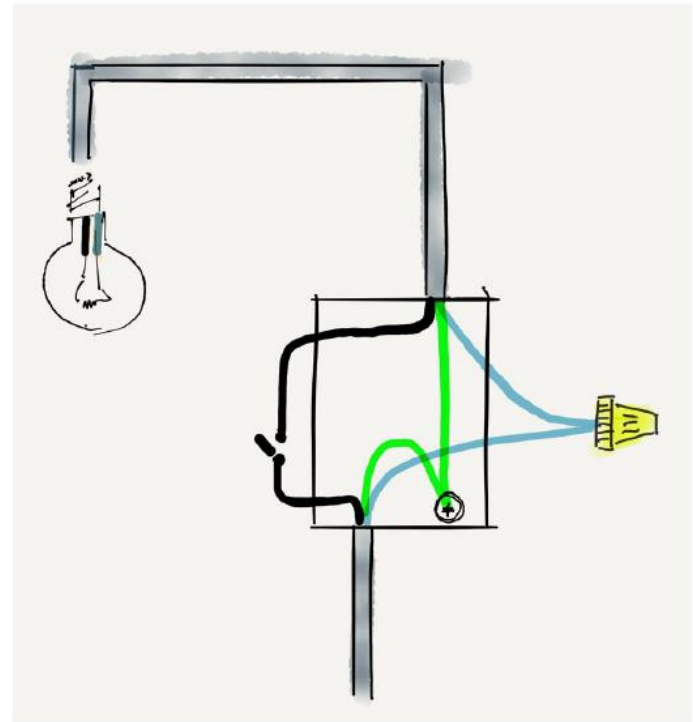
What is IoT?

(How to light up a room)

IoT



Traditional



Reach of IoT

- Residential sector
- Commercial sector
- Manufacturing sector
- Transportation sector
- Utility sector
- Agriculture
- Conservation and environmental recovery monitoring

IoT at Home

Can smart homes monitor and adapt to
our breathing and heart rates?

Personal
Health



Baby Sleep



Elderly
Health



87% of elderly
want to age in
place

Apnea test @home



Adapt Lighting and Music to
Mood



PROFESSIONAL
EDUCATION

The Internet of Things: Roadmap to a Connected World

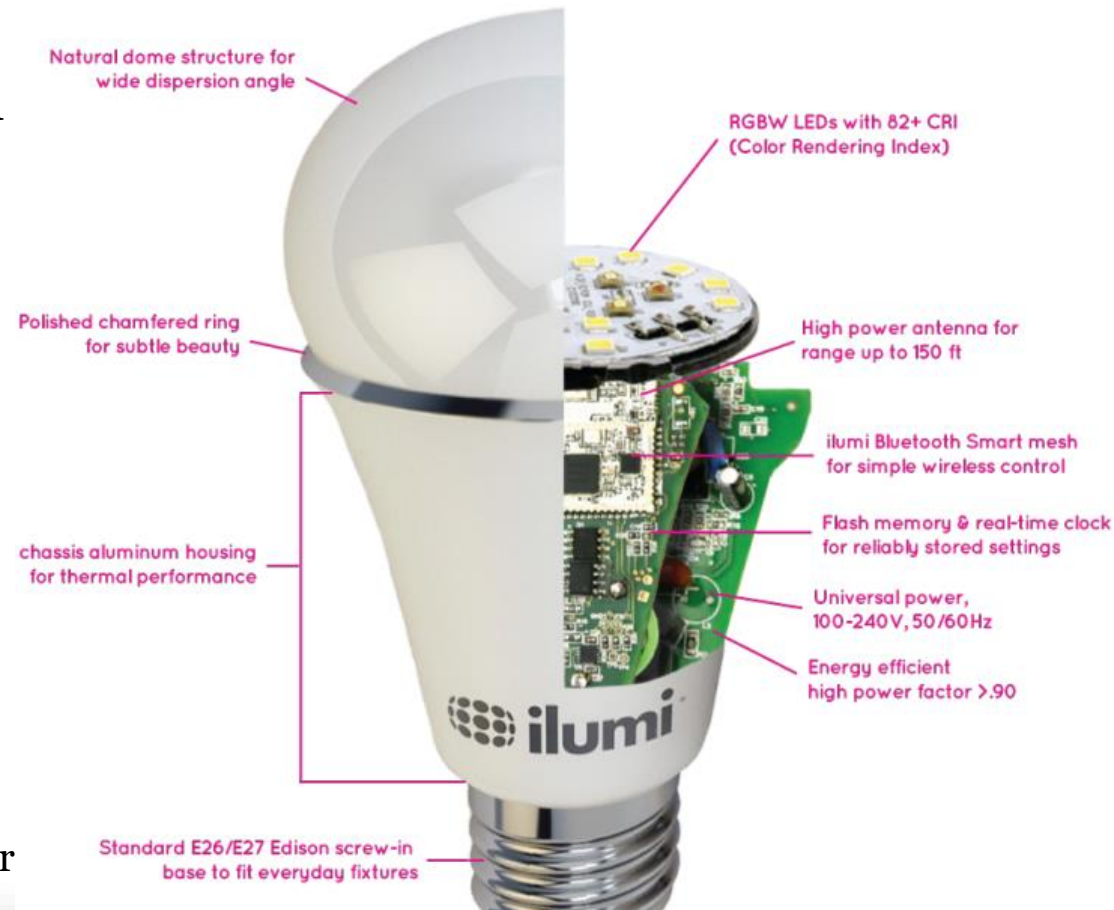
© 2016 Massachusetts Institute of Technology



Smart Lighting

(going beyond lighting)

- Smart, Solid-State Lighting (SSL) that can be controlled and networked allowing a central control/utility to turn on or off, adjust brightness, change color and color temperature via other connected devices.
- The network which SSLs are integrated into can have other uses:
 - Asset management including location and type
 - Time-of-use metering
 - Video monitoring for security and other analytics
 - Chemical and radiation detection for public safety

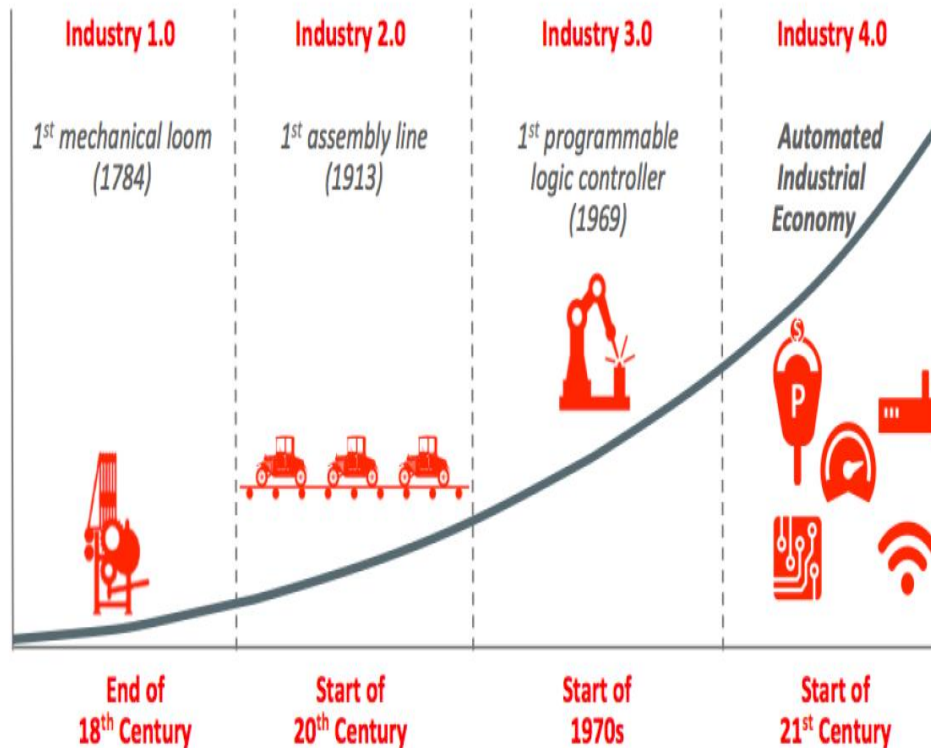


ABI research

IoT in Businesses

- Office buildings
 - Individually optimized lighting and HVAC
 - Security, monitoring indoor air quality
 - Employee monitoring
 - Communication
- Retail establishments
 - Individual shopper discounting
 - Inventory tracking and ordering
 - Monitor store traffic, hot spots, customer behavior
- Medical facilities
 - Fall detection
 - Patient monitoring and recovery.

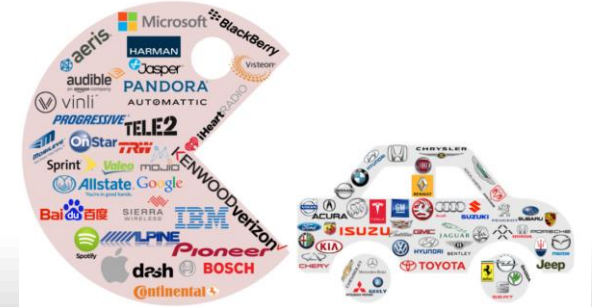
Industrial Applications



- Integrated Production monitoring
- Predictive analytics and maintenance
- Asset Tracking
- Control Room Consolidation
- Autonomous Robots
- Additive Manufacturing
- Augmented Reality

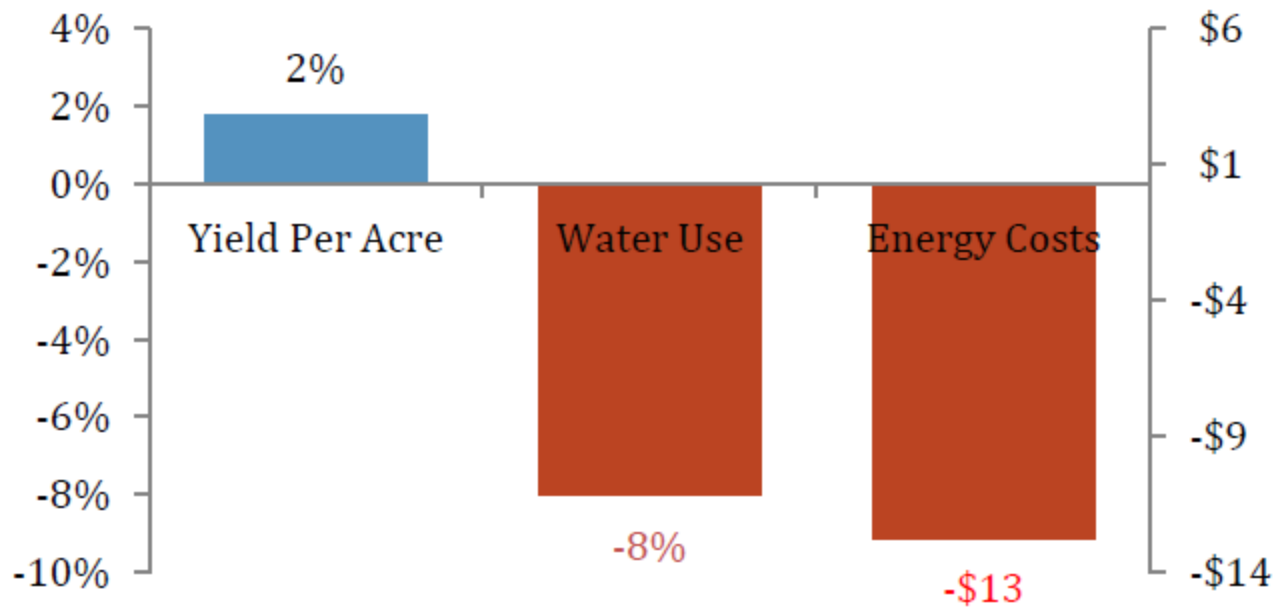
IoT in transportation

- Continued connectivity
- Car services (Lyft, Uber)
- Autonomous driving cars and buses
- Parking space identification
- Best route selection
- Over the air software updates (Tesla)
- Usage-based auto-insurance
- Predictive analytics



IoT in Agriculture

Trial Benefits Of An OnFarm Connected Farming System



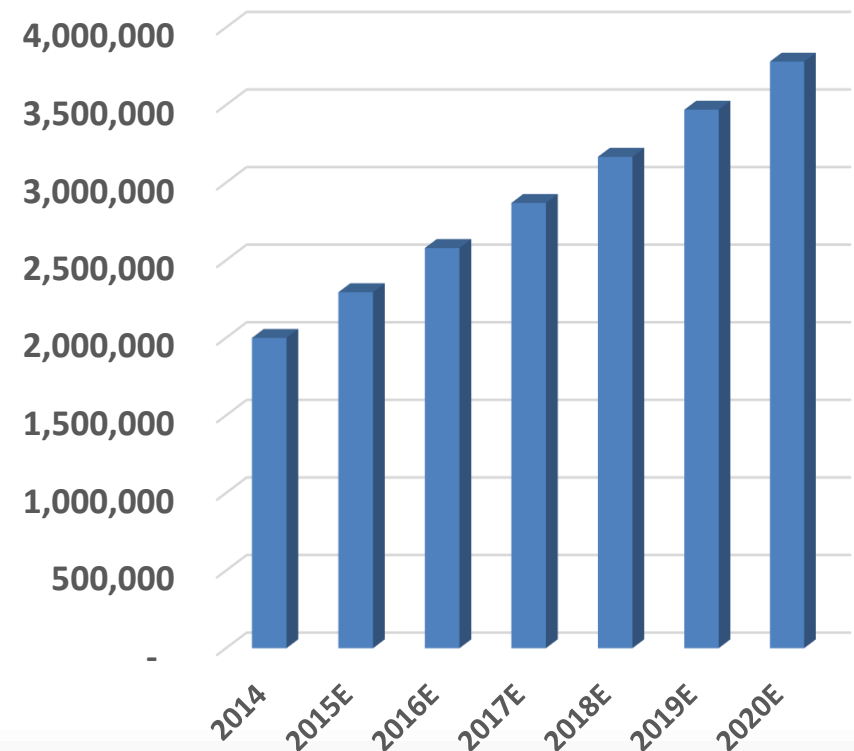
Source: OnFarm, Michigan Farm News, 2015

Electric Utilities and Smart Meters

Some of the benefits :

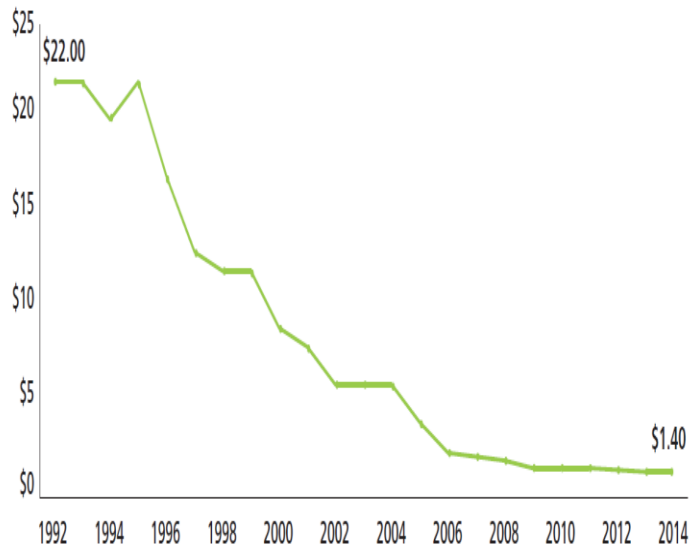
- Providing real-time billing and usage information
- Allowing the power company to remotely turn on and off power
- Power-failure notifications
- Preventing energy theft
- Reducing the number of workers needed to check meters
- EPRI study indicates that the US could reduce electricity use by more than 4% by 2030 through the use of smart meters and the implementation of smart energy grids.
- Savings of \$20.4 billion, according to the study.

NW – Number of Advanced/Smart Meters



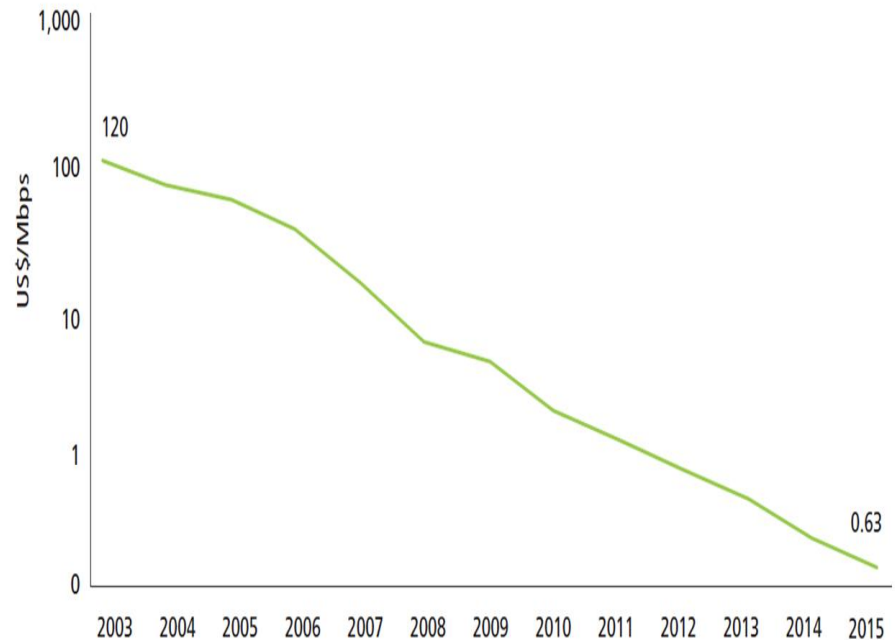
Costs Declining

Figure 5. Sensors prices on the decline over the last 25 years



Source: Rob Lineback, IC Insights Inc. "The market for next-generation microsystems: More than MEMS!," http://itac.ca/uploads/events/executorum2010/rob_lineback_10-6-10-2.ppt, June 10, 2010, accessed January 28, 2015; Lee Simpson and Robert Lamb, *IoT: Looking at sensors*, Jeffries Equity Research, February 20, 2014, p. 4.

Figure 9. Internet transit prices in the United States



Note: Transit prices are plotted on a logarithmic scale.

Source: DrPeering.net, <http://drpeering.net/white-papers/Internet-Transit-Pricing-Historical-And-Projected.php>, accessed January 21, 2015.

Energy Sources for IoT

- Main energy sources
 - Grid provided
 - Energy Storage
 - Large stationary batteries
 - Small batteries
 - Energy Harvesting

Standby Power Consumption

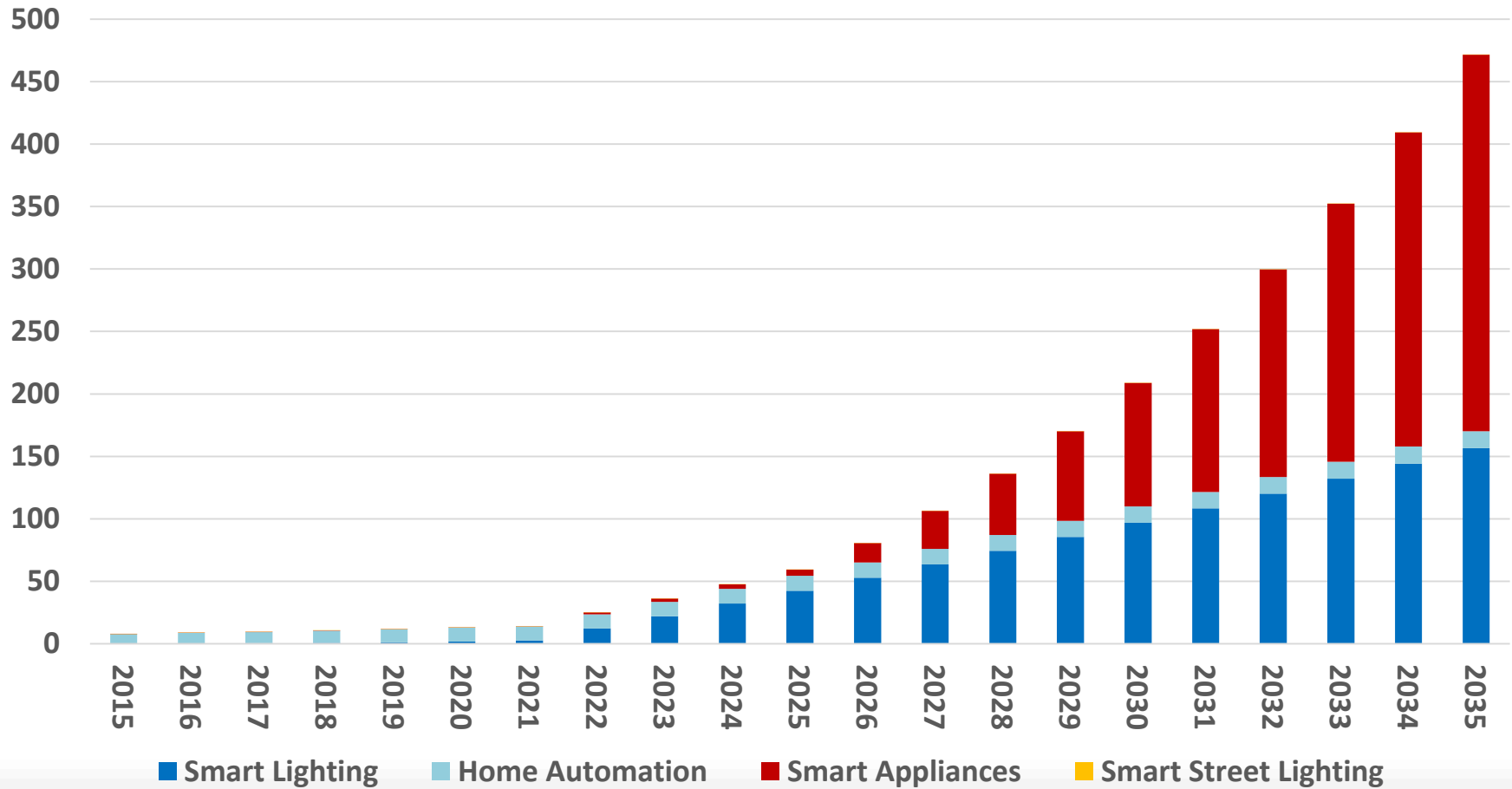
Category	Device	Average Standby Power [W]
Smart Lighting	Smart LED Bulbs	1.0
	Gateways	1.6
Home Automation	Gateways	1.7
	IP Camera	2.2
	Mains Connected Sensors	0.6
	Mains Connected Actuators	1.0
Smart Appliances	Appliances	0.4
	Gateway	1.6
Smart Street Lighting	Luminaires	0.4
	Master Luminaire	2.0
Smart Roads	Roadside Units	8.0
	IP Camera	4.0

Source: IEA 4E EDNA report, Energy efficiency of the internet of things, technology and energy assessment report . April 2016

Estimated IoT Standby Demand for Electricity In the Northwest (aMW)

Without and With technological improvements

(with tech. improvements by 2035 IoT standby demand may be as low as 80 aMW)



Large Scale Batteries would be operating in all areas



Energy Harvesting



Batteries to Power IoT

Estimated global number and energy used to manufacture small conventional rechargeable and disposable batteries

Figure 18: Estimates for worldwide annual battery consumption related to IoT

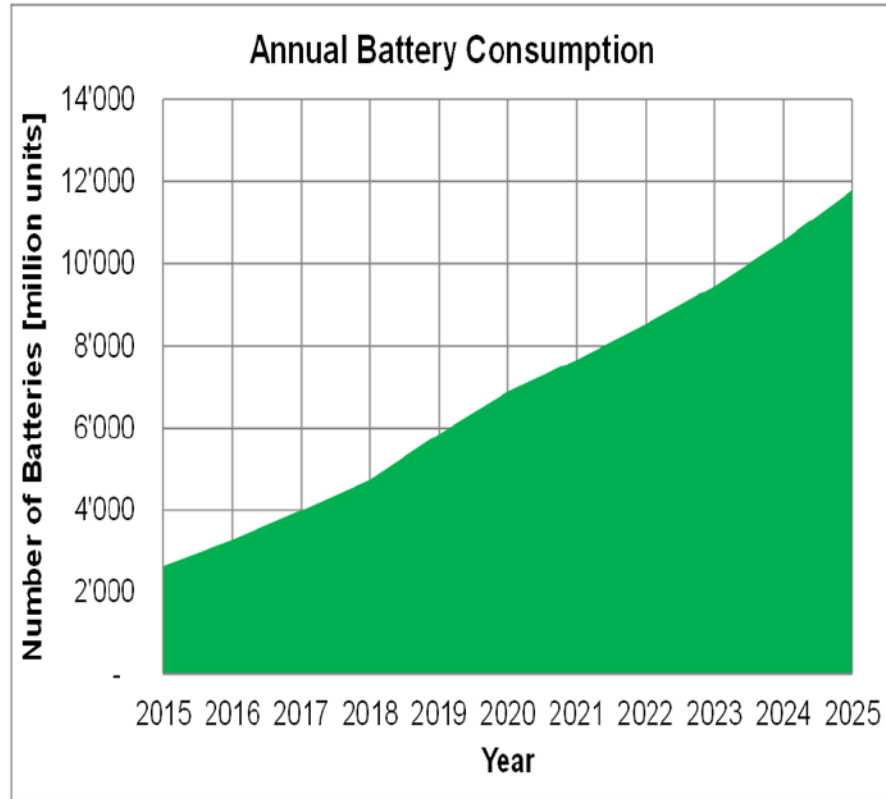
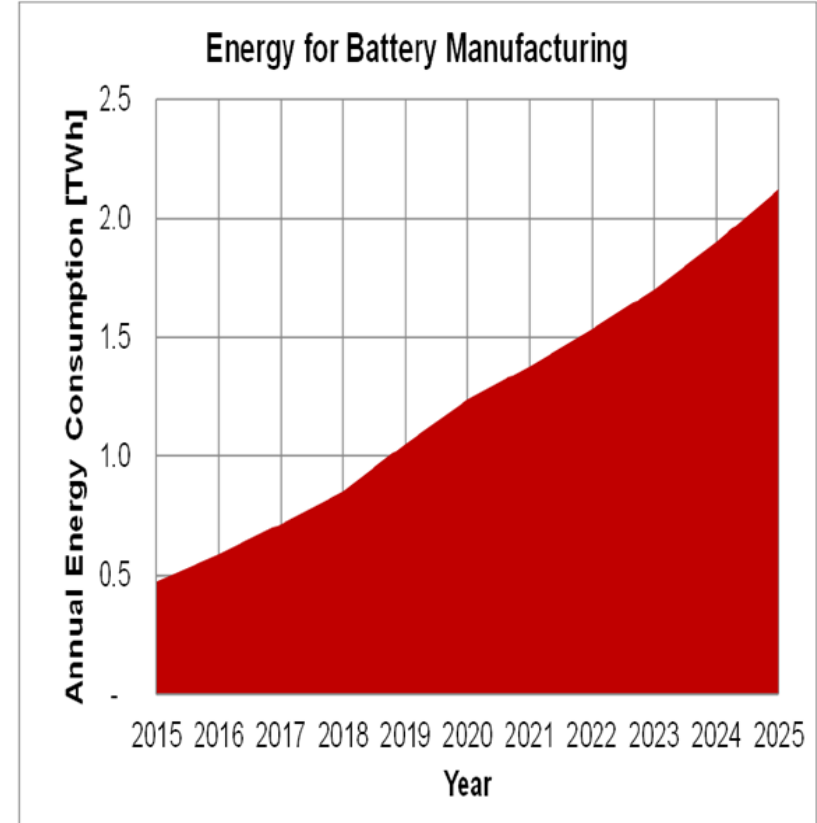


Figure 19: Estimates for worldwide energy consumption for IoT battery manufacturing



IEA 4E EDNA report, Energy efficiency of the internet of things, technology and energy assessment report (April 2016).

Net energy effects of IoT is not clear

- Increase in consumption due to standby loss ~ 859 kWh/year (as of 2015)
 - Adjusted for NW lighting saturation, ~ 750 kWh/year

Potential Change in Enduse Demand in Residential

	Low	High
Smart Thermostats	1-4%	1-4%
Smart Lighting		
Baseline (mix)	3%	7%
Baseline (LED)	-1%	-2%
Smart Plugs	2%	5%

Source: Smart Technologies and Connected Products: Early Adopter Toys or Gateways to Energy Savings? Navigant Consulting Inc. 2016 ACEEE Summer Study on Energy Efficiency in buildings

Summary

- Economy , Employment and Incomes are growing.
- Electrical loads are stable because of investments in efficiency.
- New emerging technologies can increase demand in electricity in some sectors while overall they increase efficiency of the economy.
-
- IoT technologies present improved productivity in the economy.
- Concern regarding IoT:
 - Security, privacy and lack of common standards
 - User needs to be aware when integrating more and more connected equipment into their business operations and decision making.

On behalf of NWPPCC , I would like to thank you all for being on the front-line and a force behind increased efficiency in the northwest economy.