



Energy Technologies Area

Lawrence Berkeley National Laboratory

Energy Efficiency Modeling

Making EE more Visible

Stephane de la Rue du Can
Berkeley Lab

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ENERGY EFFICIENCY FOR A SUSTAINABLE DEVELOPMENT

Global Recognition of Energy Efficiency as a Pillar of Sustainable Development



The 3 Pillars for Achieving Sustainable Energy Development

- **ENERGY ACCESS:** By 2030, ensure universal access to affordable, reliable and modern energy services
- **RENEWABLE ENERGY:** By 2030, increase substantially the share of renewable energy in the global energy mix
- **ENERGY EFFICIENCY:** By 2030, double the global rate of improvement in energy efficiency

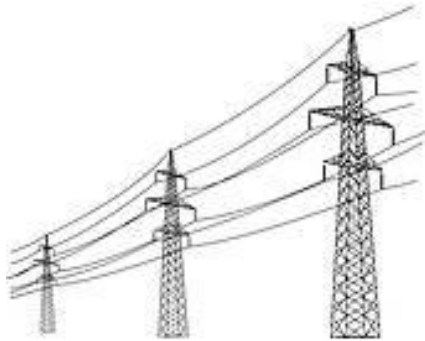
How Do We Make Energy Efficiency More Visible

- Energy Efficiency cannot be directly measured
 - How do we make Energy Efficiency more Visible to us and to others?



The Importance of Data and Analytics Methods

- Data and Analytic Methods are what lines and poles are to Energy Access investment.
 - Data and Analytic Methods are the backbone of Energy Efficiency goals



ENERGY EFFICIENCY POLICY

Regulations

Standards and Labeling

Building Codes

Transport fuel standards

Industry EMS

Market Based Incentives

Utility EE DSM programs

ESCOs

Financial Schemes

Tax Incentives

Research and Development

Technology Roadmap

Prioritization Tools

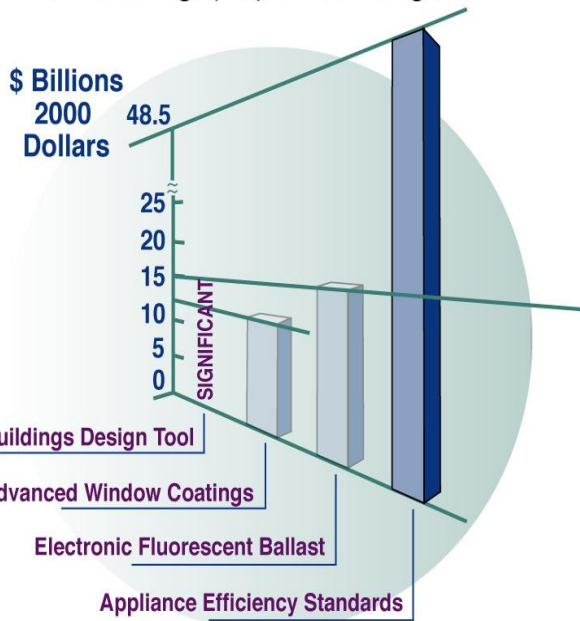
Energy Savings Methods

Pilot Programs

US STANDARDS AND LABELING PROGRAM

Estimate of Economic Benefits

Lifetime Savings (Net) for Technologies*



- EE standards is the largest source of Economic Benefits from all USDOE Energy Efficiency programs
- **Today** 60 categories of appliances and equipment are included
 - As a result, American consumers saved \$63 billion on their utility bills in 2015 alone, representing ~\$500 per household
 - By 2030, cumulative operating cost savings from all standards in effect since 1987 will reach nearly \$2 trillion

BERKELEY LAB'S APPLIANCE STANDARDS GROUP

Appliance Standards Projects

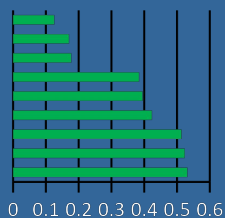


- Home Appliances
- Space-Conditioning and Water Heating
- Transformers and Motors
- Lighting Systems
- Consumer Electronics
- Test Procedures Development

Research Support for Standards Rulemakings

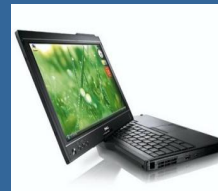
Economic Research

Learning Rates



- Life cycle cost of the product
- Markups and Discount Rates
- Purchase Price Elasticity

Technical and Field Research



- Product Prototyping (Max Tech)
- Field Monitoring
- Consumer Surveys
- Full Fuel Cycle

Source: LBNL Standard Group

METHODS AND ANALYSIS

Engineering Analysis

determines specific gains and costs of efficiency options for MEPS levels

Economic Analyses

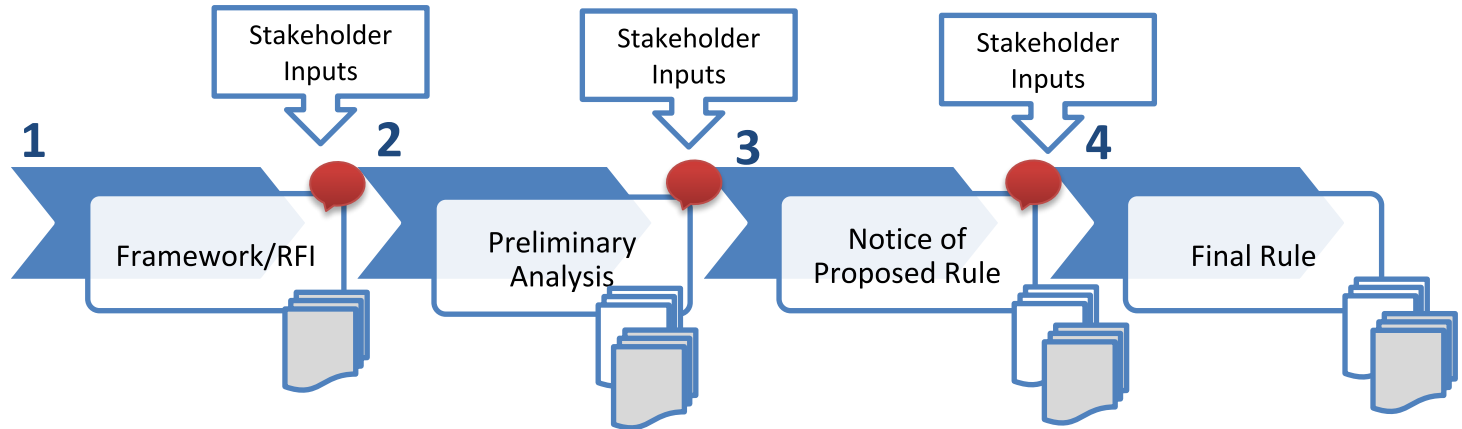
looks at historical and projected costs and benefits to consumers, manufacturers, utility companies, and the country

Environmental impacts

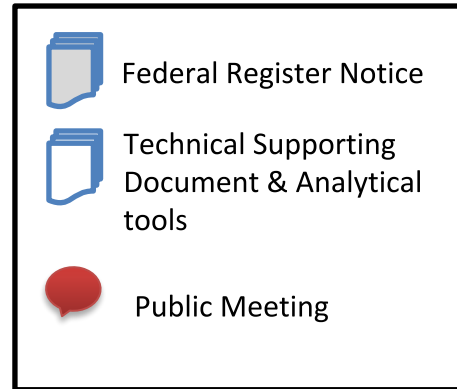
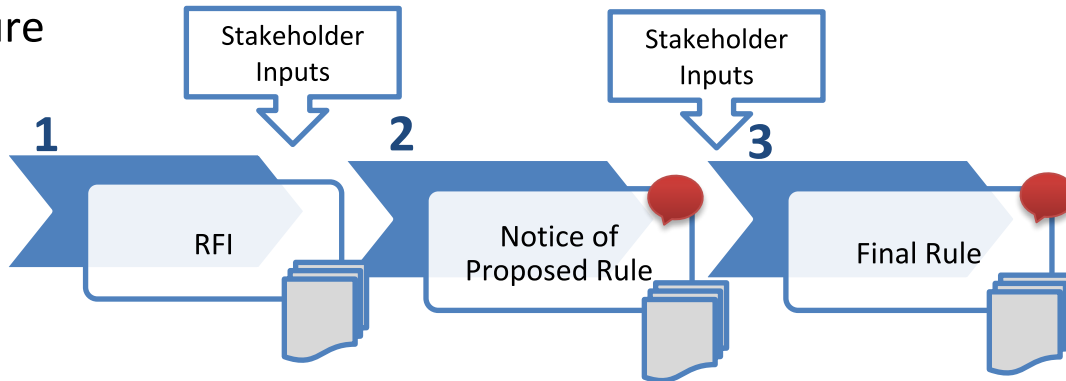
evaluates specific environmental impacts using underlying data on existing stock and forecasted future sales

Typical Standards Rulemaking Process

Energy
Conservation
Standards



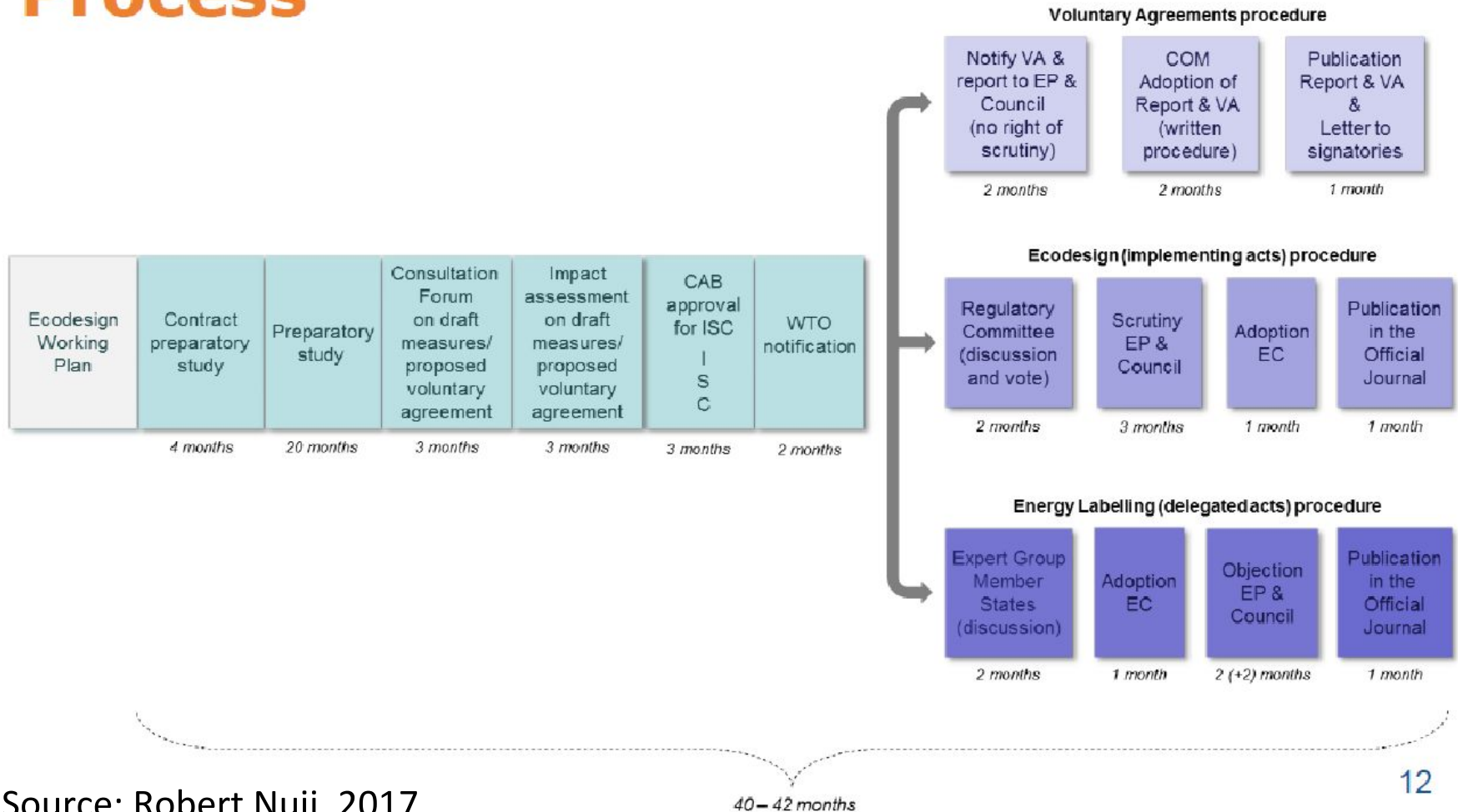
Test procedure



Note: DOE can also undertake a negotiated rulemaking or receive a consensus agreement, in which case there could be deviations from the typical process to expedite.

EU ECO-DESIGN PROGRAM

Process



Source: Robert Nuij, 2017

LBL's KEY TOOLS

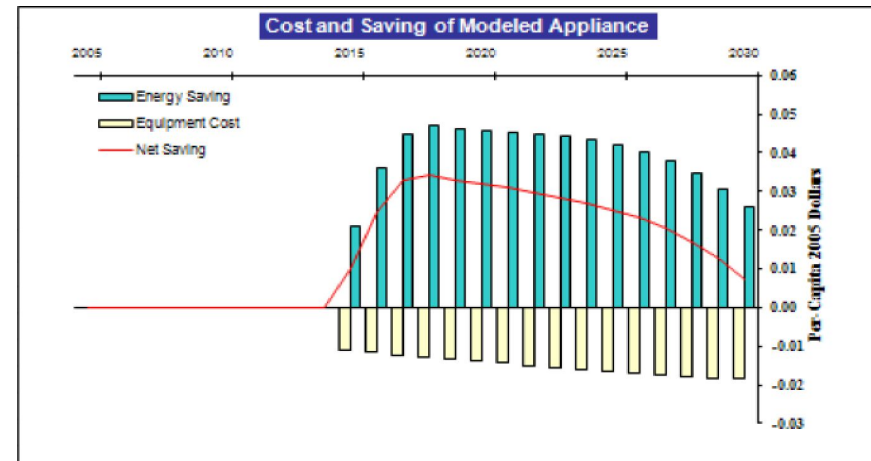
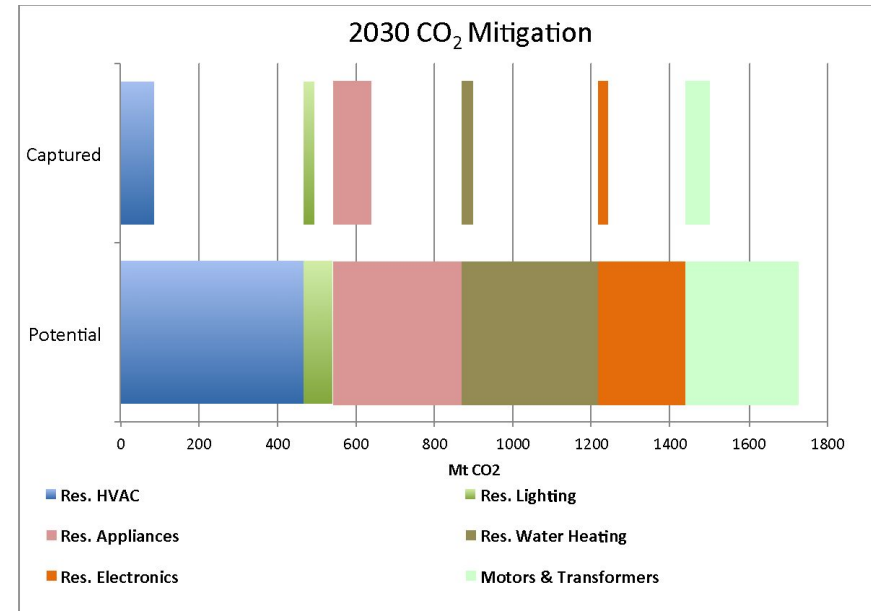
BUENAS: Bottom-Up ENergy Analysis System

- Stock turnover model coupled with a technology database
- Prioritization tool
- Tracking Energy Savings impacts

PAMS: Policy Analysis Modeling System

- Single Product Model
- Models MEPS
- Deeper Analysis of the Consumer Net Benefits

SEAD Countries Achievements



OVERVIEW OF CHINA'S STANDARDS AND LABELING (S&L) PROGRAMS

- China's mandatory standards and labeling programs have grown rapidly in recent years, with government's increasing focus on reducing energy and CO₂/GDP
- Large-scale efficient product subsidies and incentive programs were also introduced over the last few years, boosting the market adoption of efficient products

1999: Voluntary endorsement label

2014: Voluntary Energy Efficiency Top Runner: 3 pilot products

1989: Minimum Energy Performance Standards (MEPS) limit energy use for equipment
Now: covers over 64 products



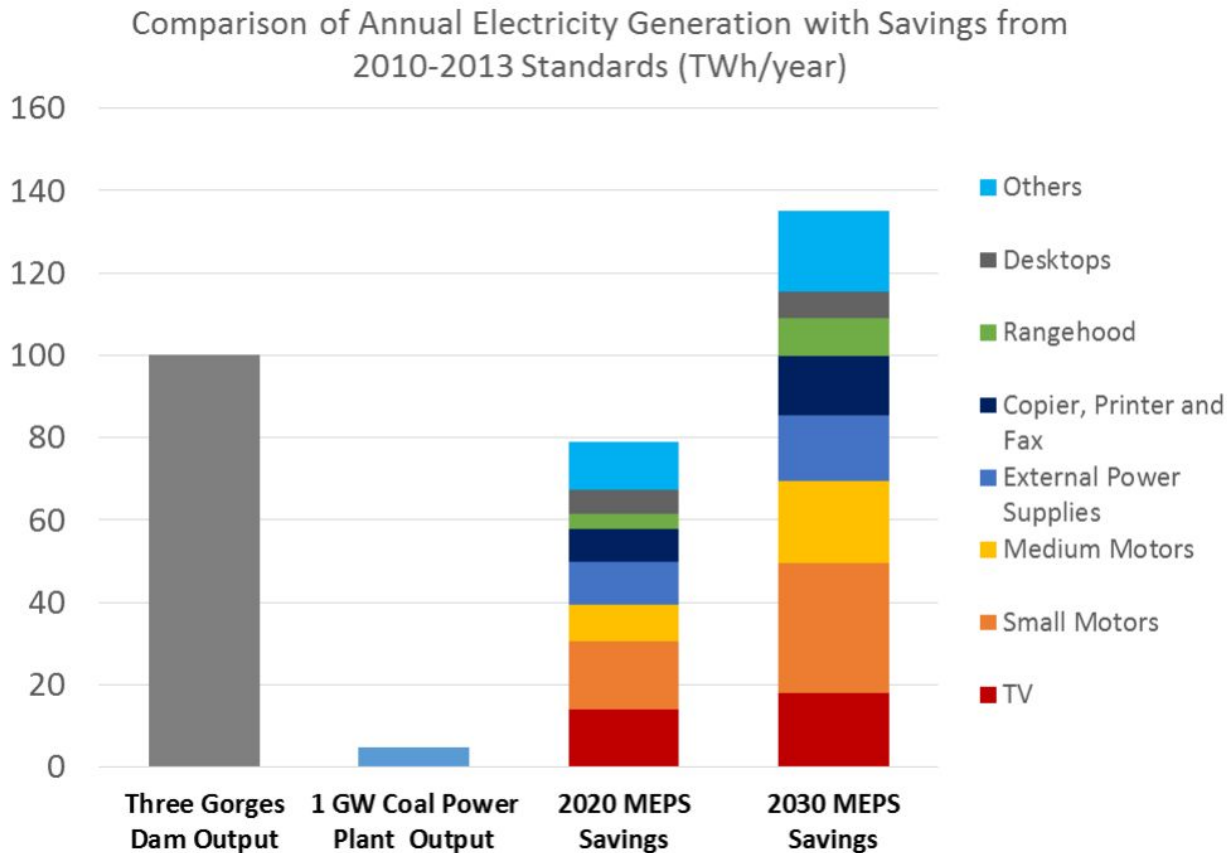
Now: covers 64 products

2005: Mandatory China energy information label
Now: covers 33 products



2016: redesigned China Energy Label

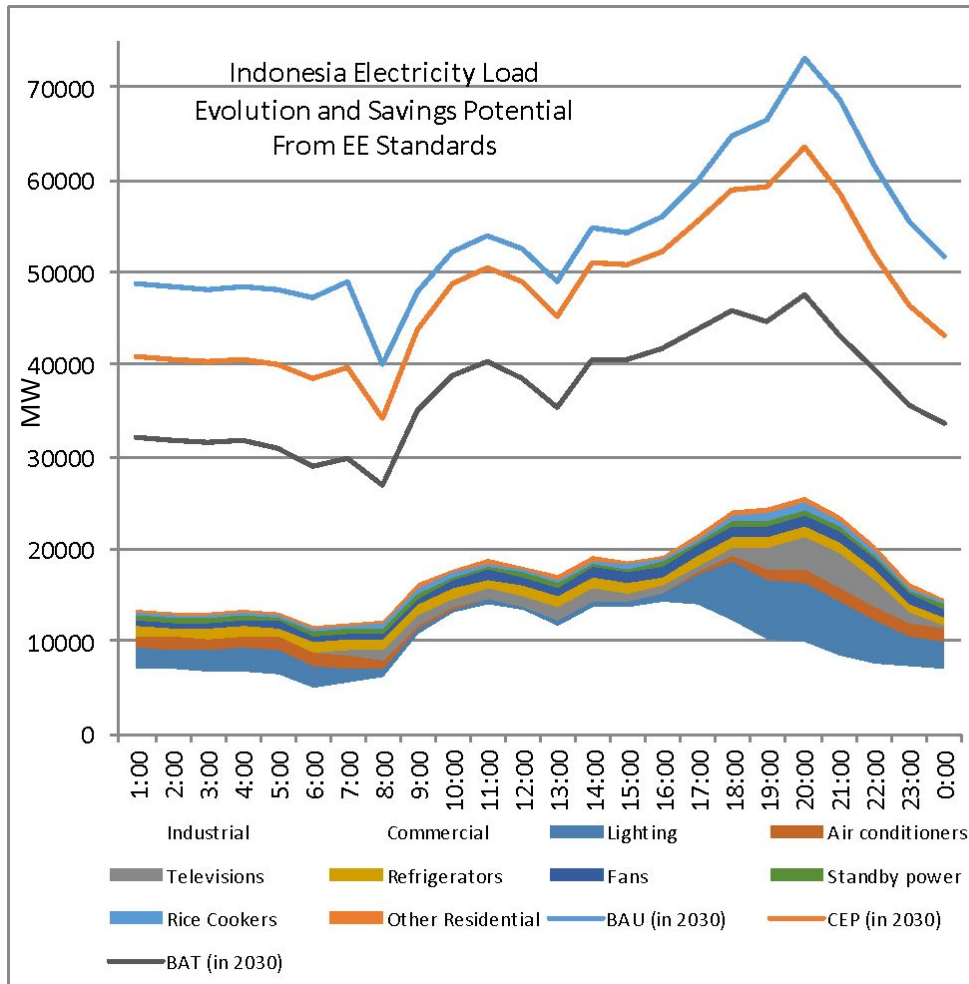
CHINA: PROGRESS TRACKING AND PROGRAM EVALUATION



- Evaluated 23 revised and new product MEPS adopted from 2010 – 2013
- Incorporates latest **actual sales and market-average baseline efficiency** data in collaboration with CNIS
- Incorporates **usage data** from a recent 2012 residential household energy consumption survey

Source: Khanna et al., *Prospective Evaluation of the Energy and CO2 Emissions Impact of China's 2010 – 2013 Efficiency Standards for Products* (LBNL, 2016)

INDONESIA: EE DOUBLES RETURNS ON EE INVESTMENT



Indonesia needs 50GW of capacity by 2030, and will spend \$80 bn to get first 35GW by 2020 (mostly thermal), followed by another 35GW by 2030.

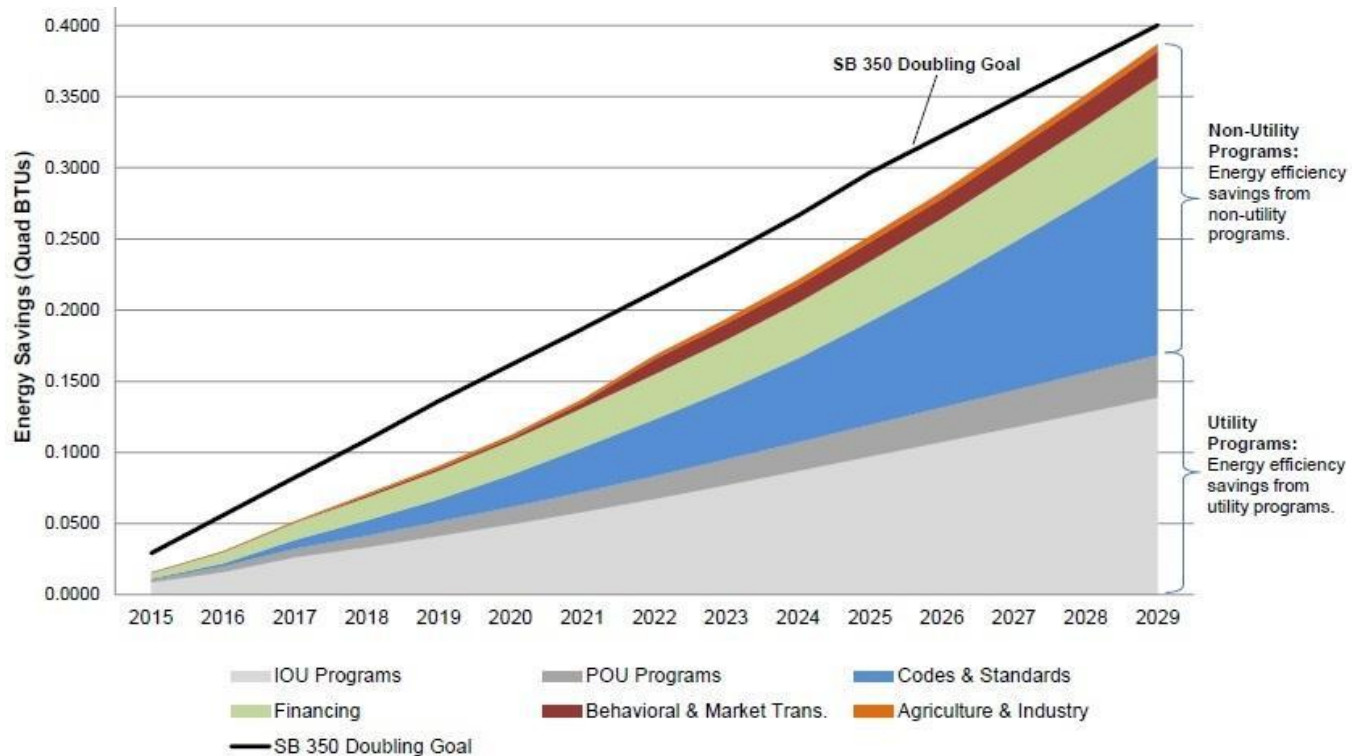
We find 10-25 GW from EE policy by 2030, thus covering up to half of capacity needs. Main barrier is technical capacity. Needed investment less than \$1 billion.

EE policy should be fully integrated into any power sector projects, renewable or otherwise

Source: Karali et al 2015 (LBNL)

CALIFORNIA ELECTRICITY AND NATURAL GAS SAVINGS PROJECTIONS

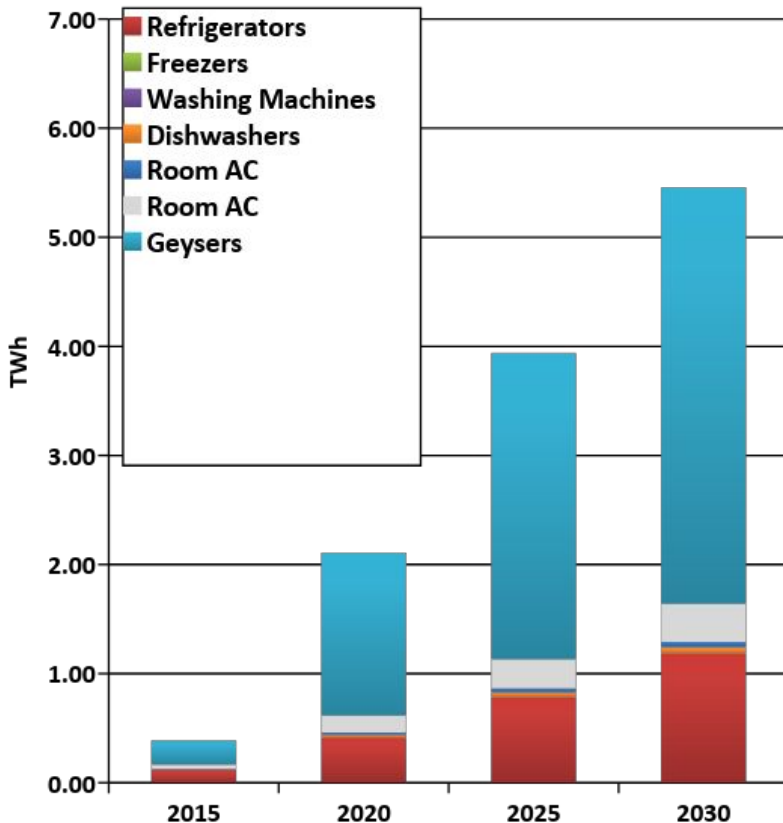
Senate Bill 350: sets a target to reduce California's 2030 GHG reduction by 40% below 1990 levels. To achieve this target, the bill requires the state to **double** statewide energy efficiency savings in electricity and natural gas end uses by 2030.



Source: CEC, 2017 Integrated Energy Policy Report

LBNL PAST COLLABORATION

Energy Savings



- **Energy Savings Estimates -**
Using [BUENAS](#), LBNL provided estimates of energy savings potentials for each appliance type covered by the program.
- **Baseline Study -** LBNL introduced new techniques to collect data through "web crawling" in order to establish the efficiency baseline of South Africa's appliance market.
- **Technical Cost-Benefit Analysis for Water Heaters:** - Working with Stellenbosch University and local consultants, LBNL conducted a cost-benefit analysis of electric water heaters, leading to a revised standard saving 3.8 TWh in 2030.
- **Incentive program assessment -**
LBNL organized a stakeholder workshop on international best practices for incentives

MULTIPLE BENEFITS OF SOUTH AFRICA'S S&L PROGRAM



12 billion Rand of annual energy bill savings



Avoiding emissions of the following atmospheric pollutants:

- 2,000 tons of Particulate emissions
- 50,000 tons of SO_x emissions
- 24,000 tons of NO_x emissions



Water Savings of 8 billion of litres



Reduction of 6 Million ton of CO₂ emissions

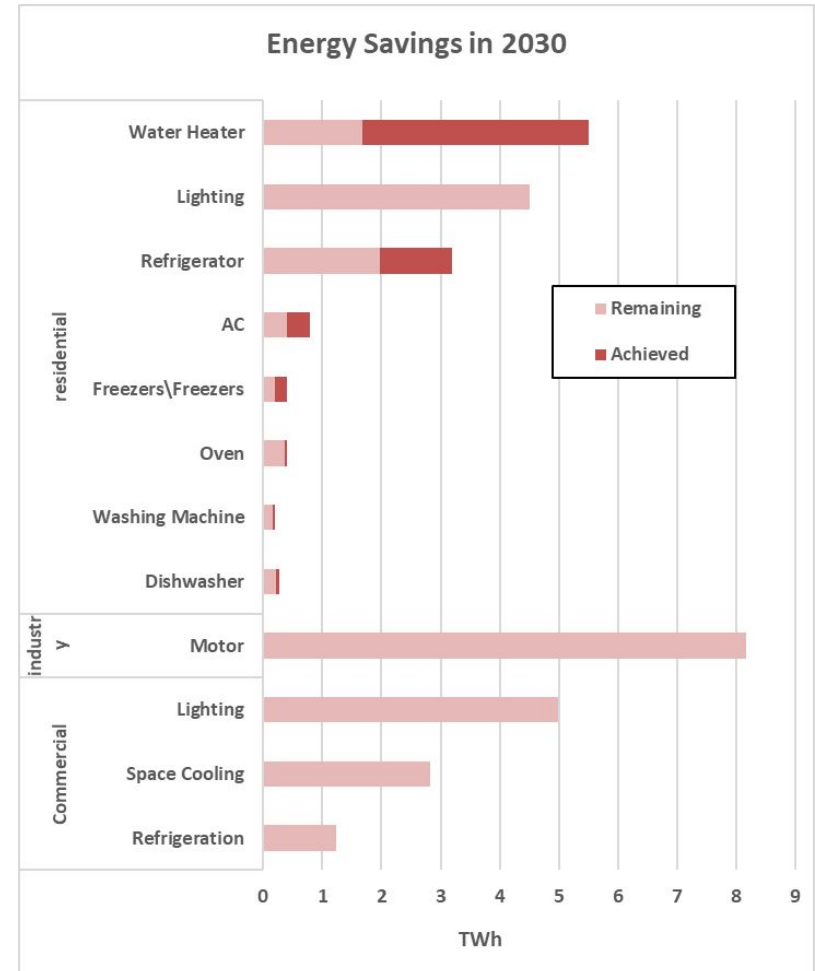


Avoiding costly investment in the construction of a Power Plant of 800 MW

PROJECT OVERVIEW

Work with DOE on the expansion of the S&L program to help achieve greater energy savings

- Create, co-jointly with DOE and SANEDI, a country version of BUENAS
- Expand the current version to include non-residential end-use technologies with more recent and more South Africa specific data
- Build sustainable local capacity for understanding the role of standards in a comprehensive energy planning process



Thanks!



Extra Slides

Energy Efficiency Program Benefits

ECONOMIC IMPROVEMENT

- Consumer's bill Savings
- Increased competitiveness
- Encourage innovation
- Job creation

ENVIRONMENTAL PROTECTION

- Pollution reduction (SO₂, NO_x, PM)
- Fight climate change (CO₂ avoided)
- Water savings

ENERGY SECURITY

- Electricity reliability

Job Creation

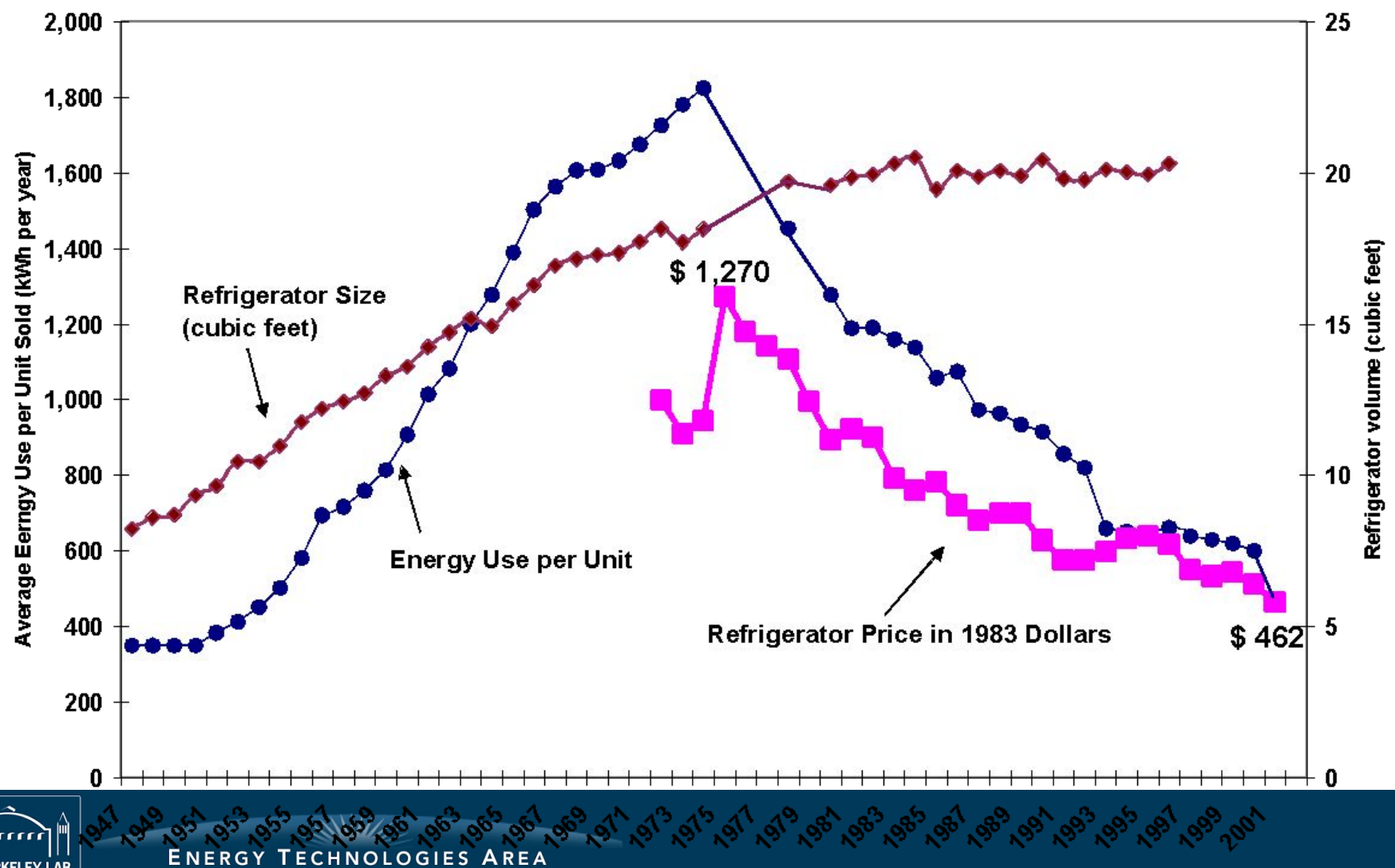
- ACEEE uses an input–output model of the US economy to estimate the job creation impacts of existing national appliance standards.
- The net economic benefits from all existing standards resulted in nearly 300,000 net added jobs in 2016.
- As the net economic savings grow, the number of related jobs will grow as well, reaching more than 550,000 in 2030.

APPROXIMATE BUDGETS FOR S&L PROGRAMS

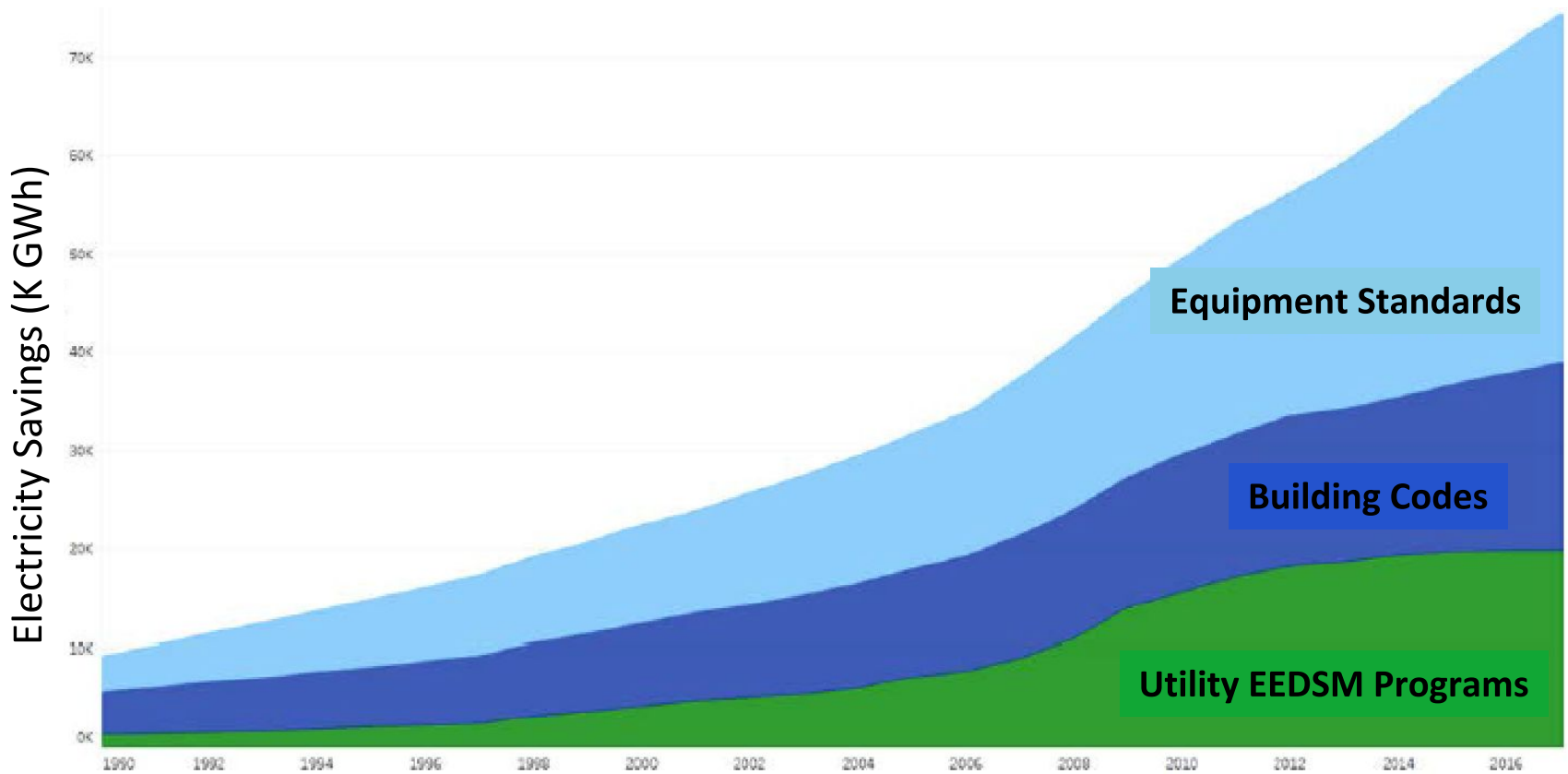
	Approximate Budget	Funding Sources	Staff Resources
US	~ USD \$35M/year	National Budget via Federal Government	~ 100 employees total (including contractors)
Australia	~ AUD \$10M (USD \$9.2M)/year	75% from Commonwealth government, 25% from states and territories	~ 40 full-time equivalent staff
UK	~ £3.3M/year (USD \$5.1M)	National government	Unknown
China	NA	Allocation from national budget	~ 30 full-time equivalent staff

Real Prices dropped while efficiency increased

United States Refrigerator Use v. Time



California Electricity Savings from Energy Efficiency Programs

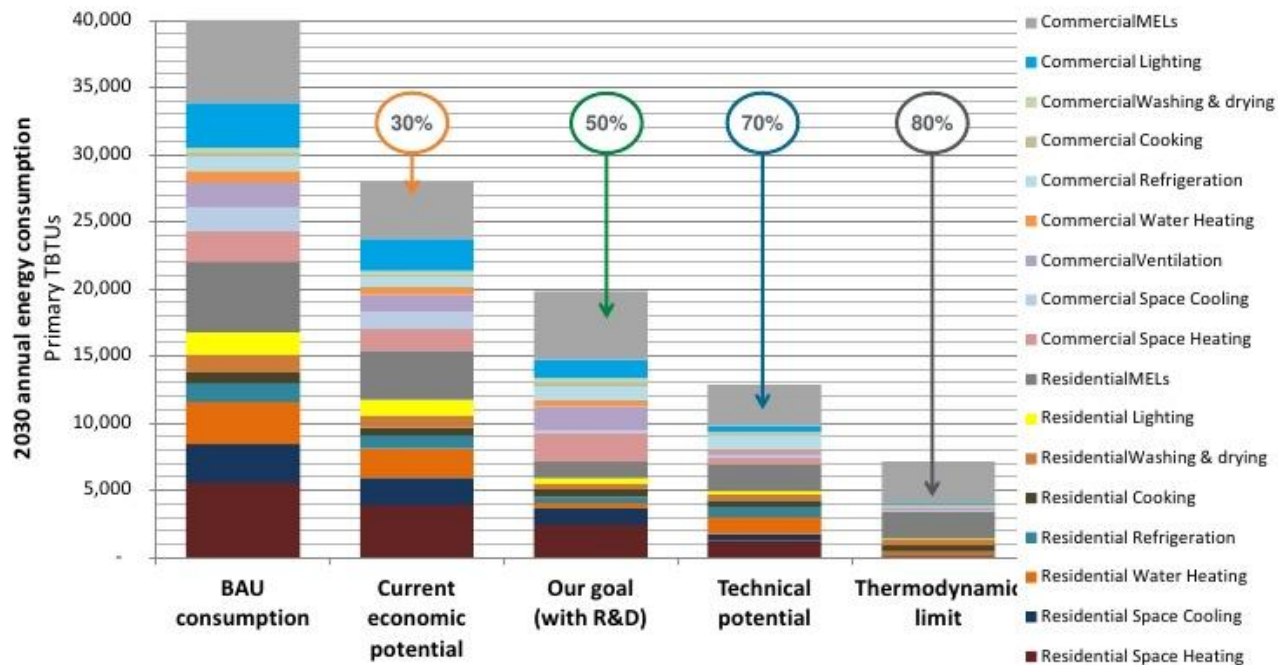


US DOE Program

DOE Building Technologies Program (BTP) Pursues an Overarching Goal

U.S. DEPARTMENT OF
ENERGY | Energy Efficiency &
Renewable Energy

Reduce Building-Related Energy Use 50% by 2030

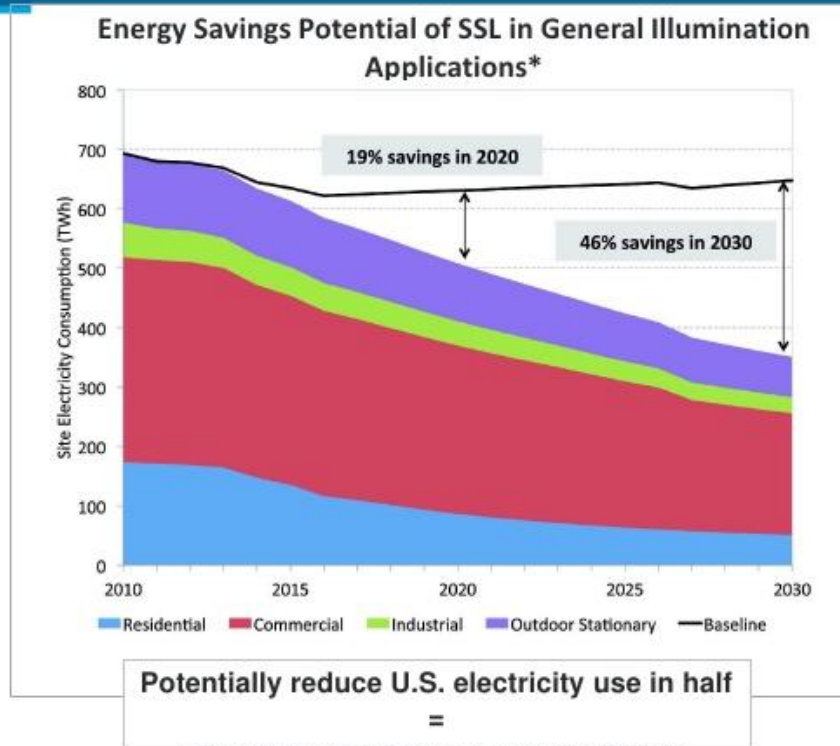


Source: BTP Prioritization tool, NAS, McKinsey

6 | Building Technologies Program

buildings.energy.gov

Major Impacts of New Technologies: SSL applications will cut lighting energy use by 46%



*DOE Report "Energy Savings Potential of Solid-State Lighting in General Illumination Applications" January 2010