

# Cost-effectiveness of energy efficiency programs

## comparative analysis of efficiency programs

University of Geneva

Hae-In Cho, Alisa Freyre, Meinrad Burer, Martin Patel

Prof. Martin Patel

Chair for Energy Efficiency

University of Geneva

Institute for Environmental Sciences (ISE)

and Department F.-A. Forel for environmental and aquatic sciences (DEFSE)

Boulevard Carl-Vogt 66, 1205 Geneva, Switzerland

Tel +41 (0) 22 379 0658 - Mobile +41 (0) 789 679 033 - [martin.patel@unige.ch](mailto:martin.patel@unige.ch)

# Introduction

## United States

**1970s**



- 2006 and 2015, annual utility spending on efficiency increased from 1.6 billion USD to 6.3 billion USD (ACEEE utility scorecard, 2017)
- In 2015, a limited number of utilities had savings higher than 3% of sales (ACEEE utility scorecard, 2017)
- California, \$90 billion in utility bill savings (NRDC, 2015)

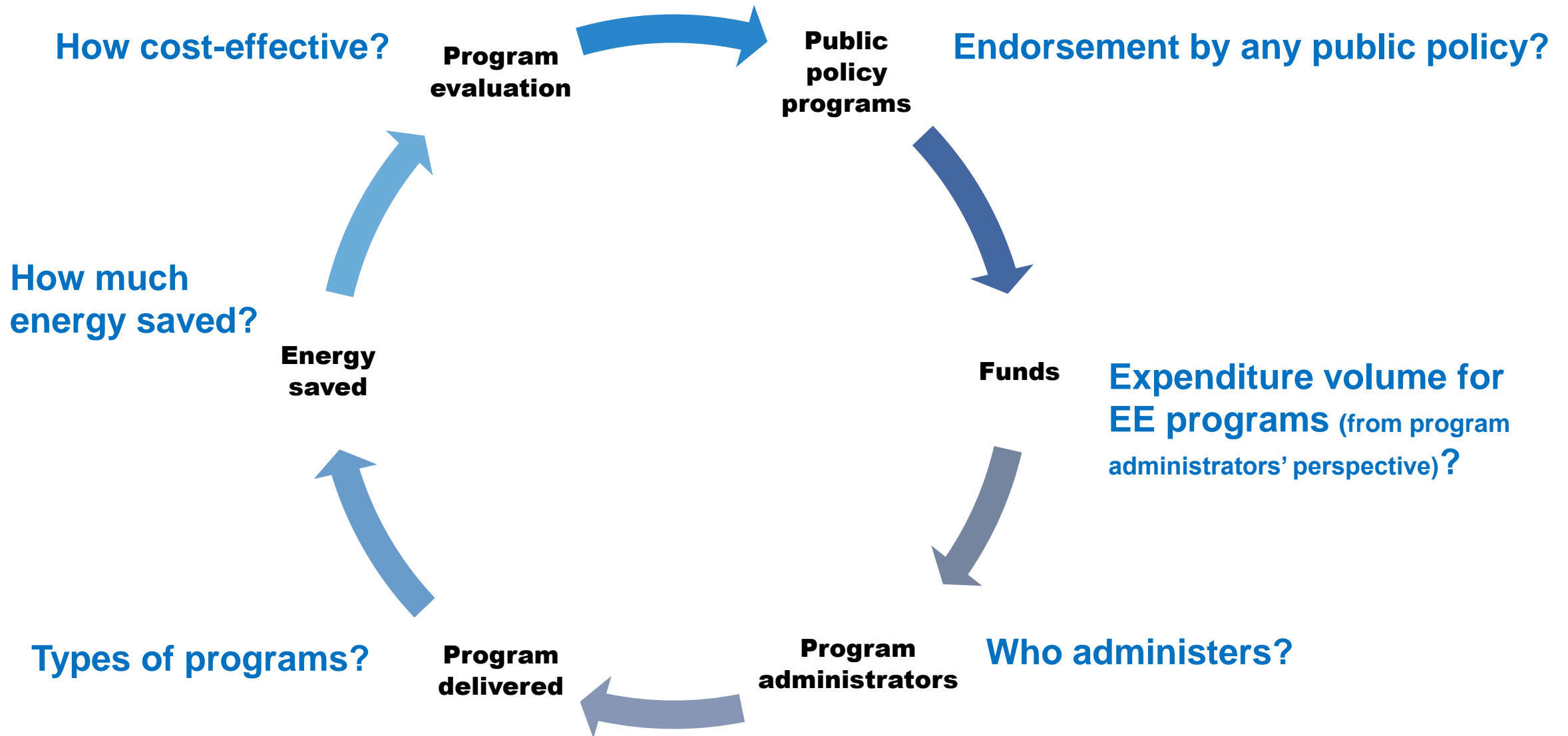
## Switzerland

**2009**



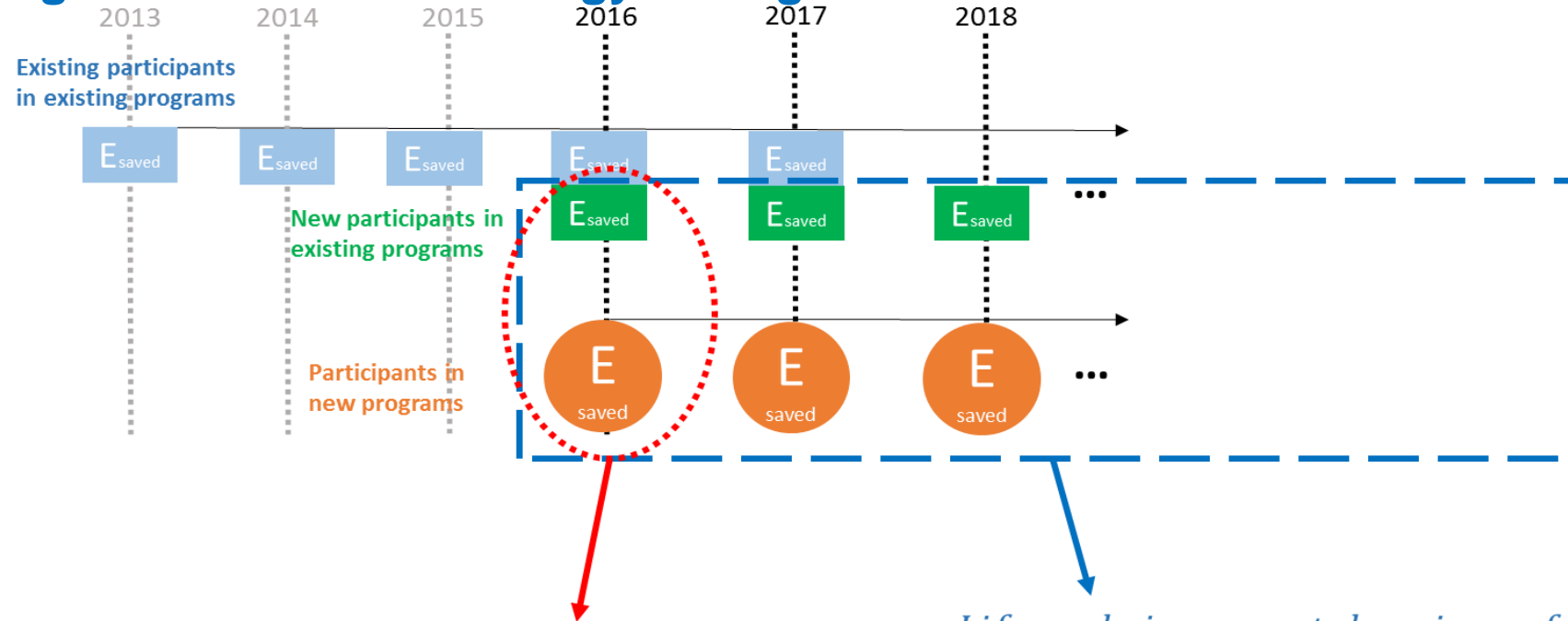
- Utility-run energy efficiency programs recently launched in a few cities

# Introduction



# Methodology

## 1. Annual gross incremental energy savings



$$\text{Annual gross incremental energy savings} = \frac{\text{Life cycle incremental savings of program portfolio}}{\text{Weighted average life time of program portfolio}}$$

## 2. Program administrator cost

- Program administration cost
- Financial incentives

## 3. Levelized program administrator cost of saved energy

$$\frac{\text{Capital Recovery Factor} \times \text{Total Program Administrator Costs}}{\text{Annual Gross Energy Savings (in kWh)}}$$

Where;

$$\text{Capital Recovery Factor} = [r \times (1+r)^d] / [(1+r)^d - 1]$$

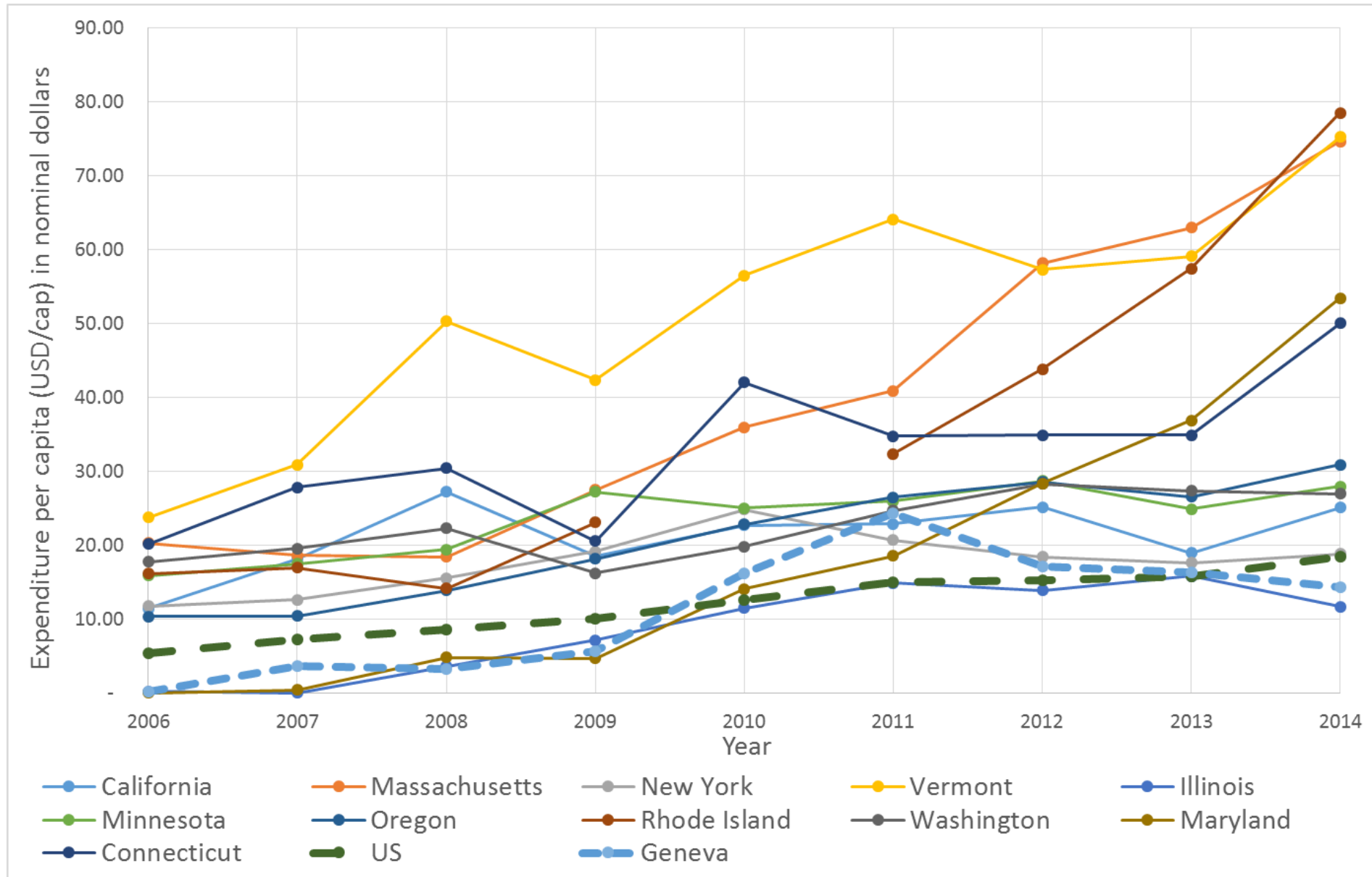
r: discount rate (5%)

d: weighted average life of the portfolio

# Results



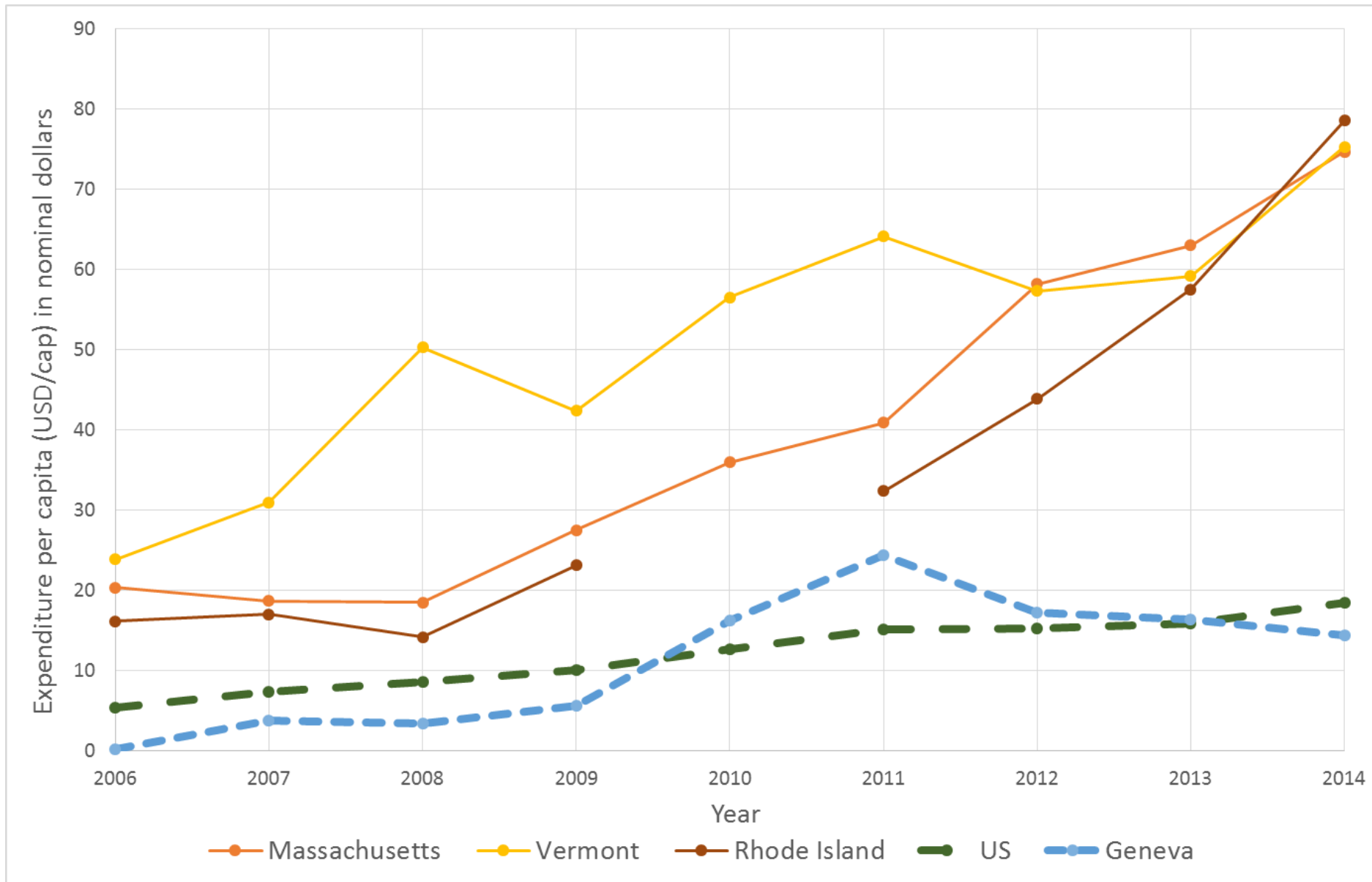
## Expenditure volume for EE programs (3 US states vs. Geneva)



# Results



## Expenditure volume for EE programs (11 US states vs Geneva)



# Results

## Endorsement by any public policy?

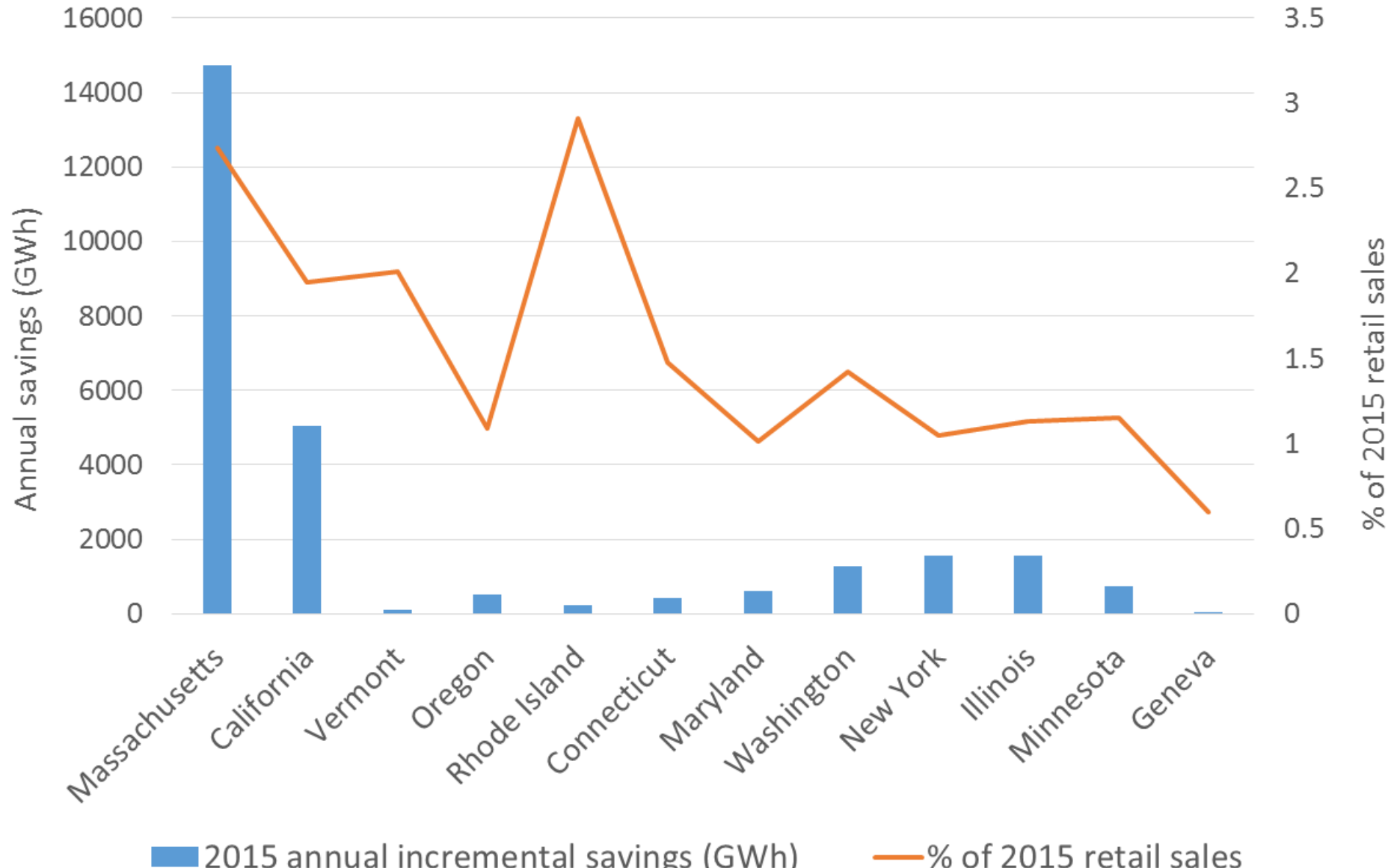
Table 1 Status of public policy adoption and achievement (source: ACEEE 2016 scorecard, ACEEE EERS policy brief)

states	EERS	'All cost effective' mandates (in 2015)	Approx. annual electricity savings target (2014-2020)*	Actual achievement in 2015*	Spending per cap in 2015 (USD)
California	Y	Y	1.2	1.95	35.21
Connecticut	Y	Y	1.5	1.48	48.43
Illinois	Y	N	0.7	1.13	22.27
Massachusetts	Y	Y	2.9	2.74	82.11
Maryland	Y	N	2.0	1.01	46.08
Minnesota	Y	N	1.5	1.15	27.59
New York	Y	N	0.7	1.05	18.98
Oregon	Y	N	1.3	1.09	35.47
Rhode Island	Y	Y	2.6	2.91	78.48
Vermont	Y	Y	2.1	2.01	86.90
Washington	Y	Y	1.5	1.42	35.83

# Results



## How much energy saved?



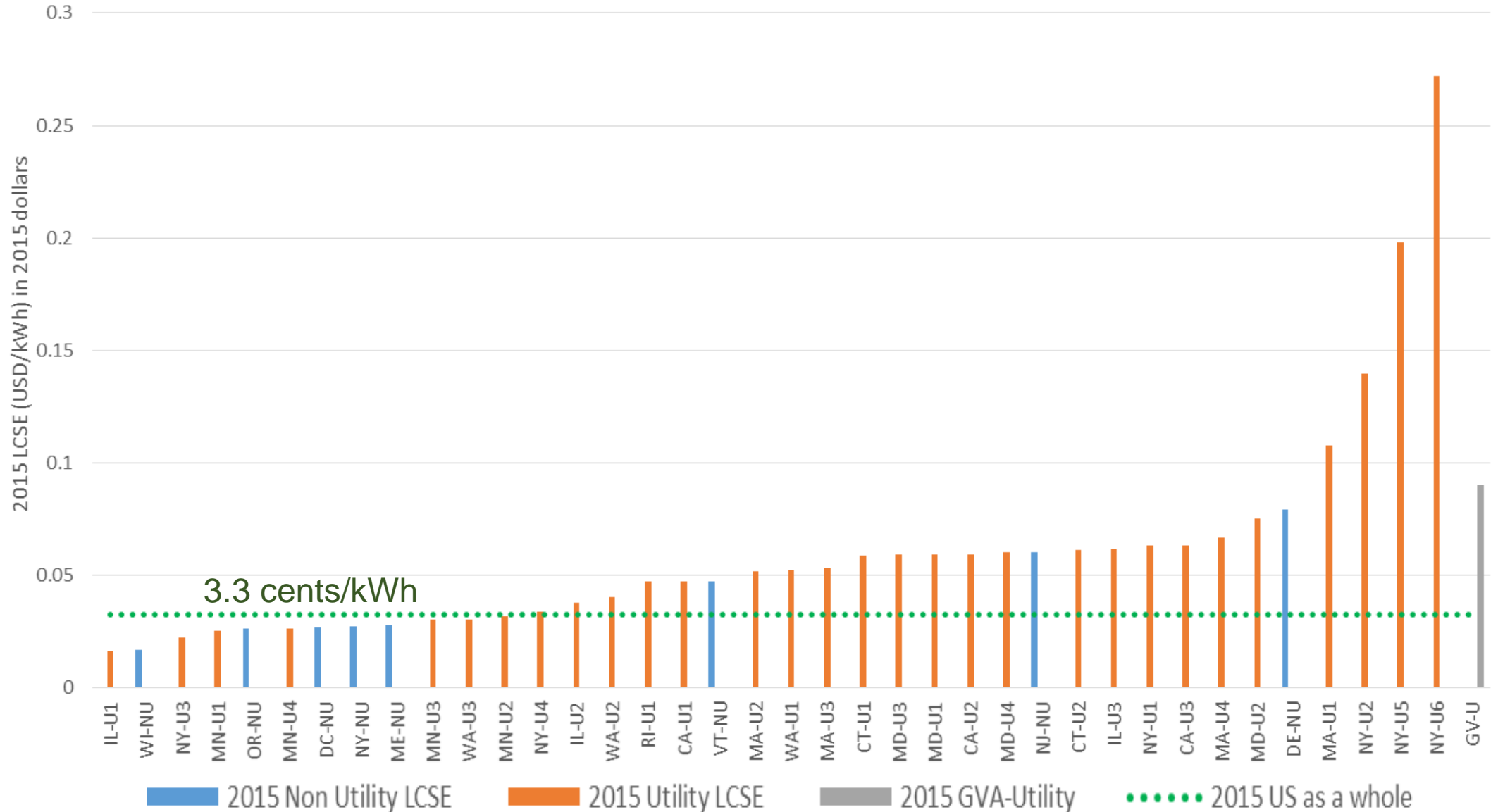
### \*Energy savings per capita

	kWh/cap
Massachusetts	2.17
California	0.13
Vermont	0.18
Oregon	0.13
Rhode Island	0.21
Connecticut	0.12
Maryland	0.10
Washington	0.18
New York	0.18
Illinois	0.12
Minnesota	0.16
Geneva	0.09



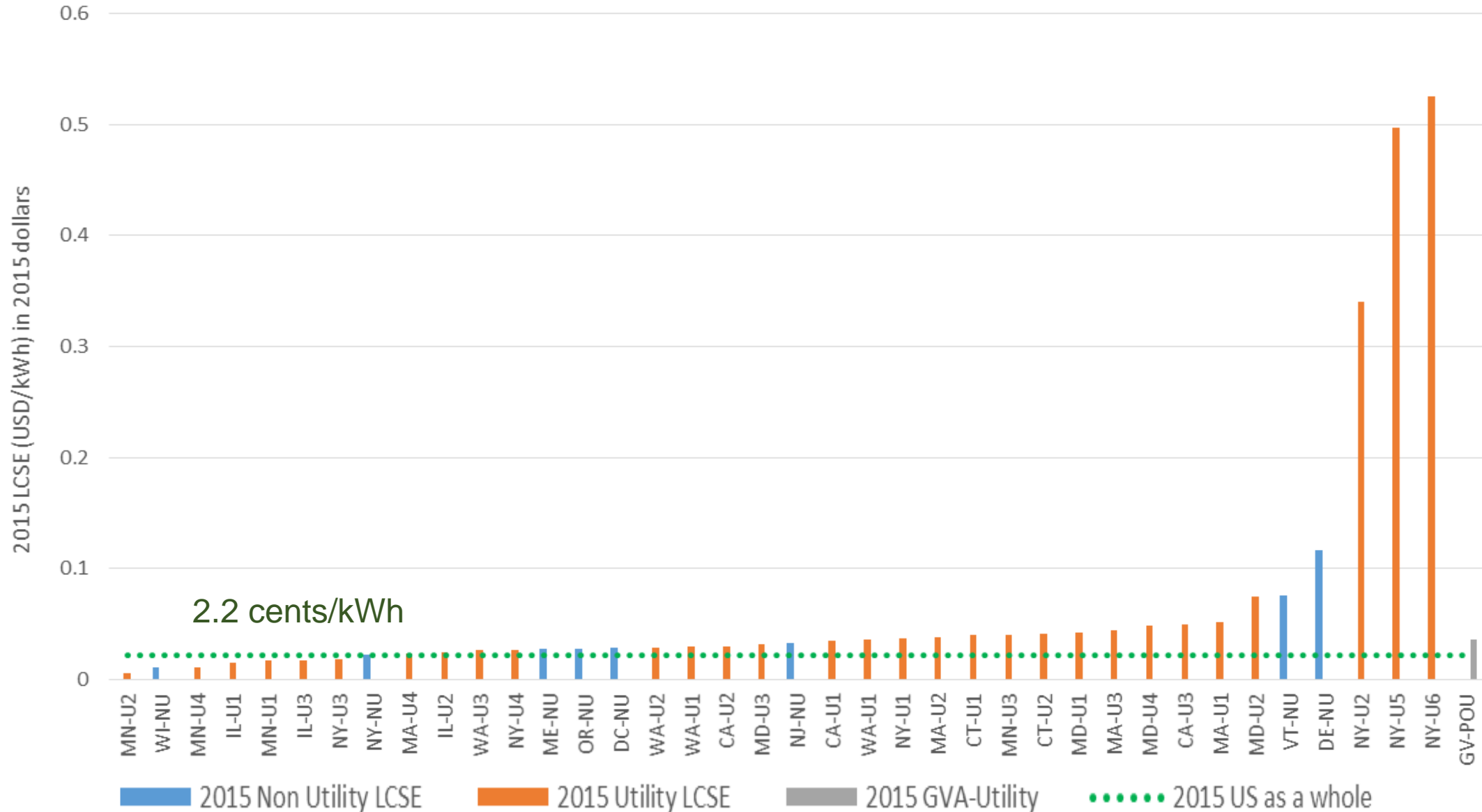
# Results

## How cost-effective? – LCSE (USD/kWh) in residential sector (2015)



# Results

## How cost-effective? – LCSE (USD/kWh) in commercial and industrial sector (2015)

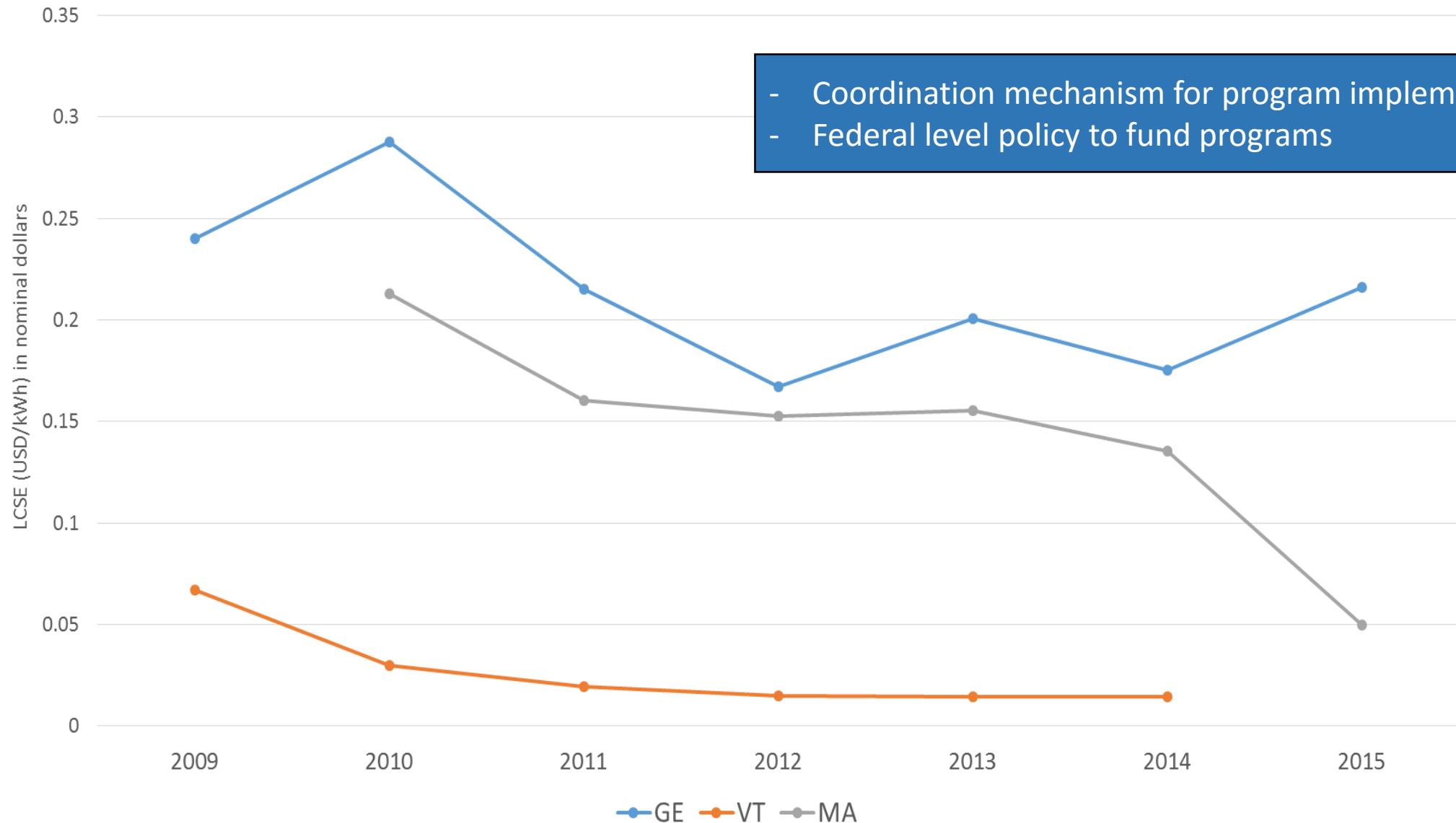


## Types of programs and their cost effectiveness (LCSE, USD/kWh)

		2013	2014	2015
<b>Residential</b>	Eco-Sociales	0.200	0.175	0.216
	Communs d'immeubles	0.044	0.054	0.053
	Chaleur renouvelable	0.275	0.067	0.084
	Ménages et indépendants	0.286	-	-
<b>Commercial &amp; Industrial</b>	Négawatt	0.080	0.058	0.031
	Optiwatt	0.232	0.115	0.045
<b>total</b>		0.080	0.079	0.050

# Results

## Low-income programs – Cost-effectiveness



# **Conclusion**

- **Policy context is decisive for utility-operated energy efficiency programs**

Typical procedure:

- Set the savings target
  - investigate all cost-effective energy efficient measures
  - ensure cost-recovery
  - earmark certain amounts of funds for specific programs
- **States with higher ambition tend to invest more.**
  - **Collaboration with other parties, economies of scale and learning allow to improve the cost effectiveness of programs.**



supplementary

# Results

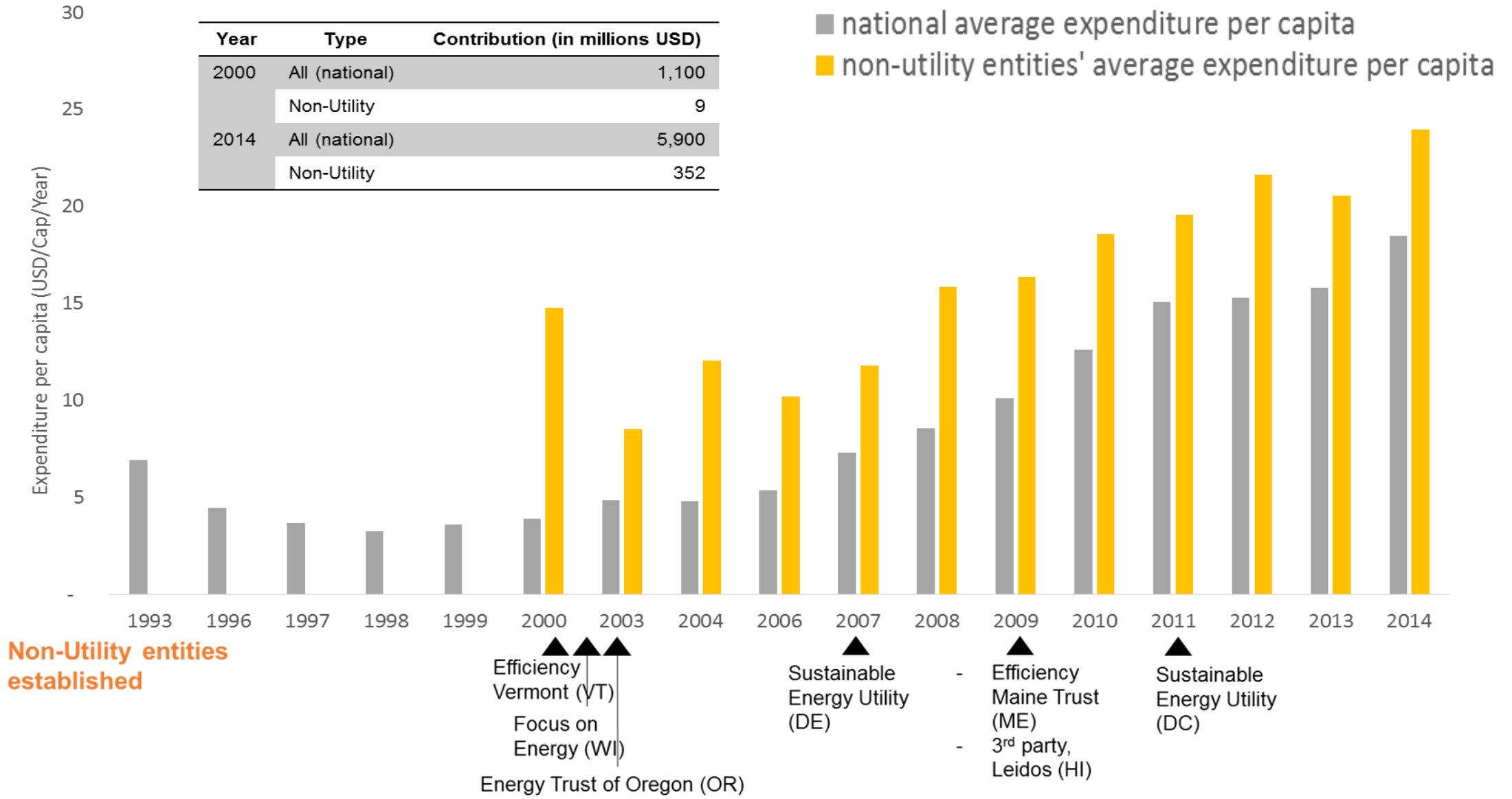
What should be considered for evaluation and comparison with other studies?

Source/ Scope	US			CA	MA	NY	VT
	All*	R*	C&I*	All	All	All	All
<b>UNIGE</b>							
- Programs in 2013							
- 2013 dollar	0.027	0.036	0.021	0.039	0.075	0.024	0.046
- Discount rate 5%							
<b>UNIGE</b>							
- Programs in 2013							
- 2013 dollar	0.028	0.035	0.021	0.038	0.074	0.024	0.045
- Discount rate 6%							
<b>LBNL</b>							
- Programs between 2009-2013							
- 2012 dollar	0.023	0.019	0.025	Approx. 0.027	Approx. 0.058	N/A	Approx. 0.035
- Discount rate 6%							
<b>Difference (%)</b>	18	46	-16	29	22	-	22

\*R: Residential sector, C&I : Commercial and Industrial sector, All : all three sectors in the four states studied (CA, MA, NY, VT)

# Results

## Who administers how much funds?





## Low-income programs - Features

Program	Measures/Services provided	Financial support
<b>Geneva Low-income Program (Eco-sociales)</b>	<ul style="list-style-type: none"> <li>• Energy efficient lighting equipment, shower heads (since 2014)</li> <li>• On-site installation services with energy advice</li> <li>• Household appliances (boilers, power strips, hot water flow restrictors)</li> <li>• Rebates on refrigerators</li> </ul>	Fully subsidized by PA
<b>Massachusetts Low-income Program (Cluett, et al., 2016)</b>	<ul style="list-style-type: none"> <li>• Insulation and air sealing, health and safety measures, and repairs</li> <li>• Refrigerator/freezer replacement/removal, efficient lighting, window air conditioners, and water heater replacement</li> <li>• Heating system repair and/or replacement</li> </ul>	Fully subsidized by PA (CADMUS, 2012)
<b>Efficiency Vermont Low-income Program (Cluett, et al., 2016)</b>	<ul style="list-style-type: none"> <li>• Insulation and air sealing, including targeting high-use households</li> <li>• Adding electrical efficiency measures to Vermont's core WAP services</li> <li>• Partnerships with food bank and food-shelf networks and the WIC food and nutrition program for refrigerator distribution</li> <li>• Distribution and installation of energy efficient products; referrals to deeper energy efficiency initiatives</li> </ul>	Nearly or fully subsidized by PA