# A Comparison of National Energy Efficiency Policy Evaluation Methods: Models versus Indexes

Goal of international climate change agreements is to foster

**"Measurable, reportable and verifiable nationally appropriate mitigation commitments or actions..."**

Bali Action Plan (2007)

**There are 3 known ways to measure the energy savings from energy efficiency measures, programs, or policies**

1. Add up **IPMVP** impact evaluations (sum individual program/equipment impacts = BOTTOM UP).

2. Energy efficiency indexes (TOP DOWN ***reporting*** of aggregate consumption ratios without simultaneous multivariate analysis = top-down, e.g. ODEX).

3. Econometric models (***analyze*** aggregate consumption or ratios = TOP DOWN, what EMEEES refers to as "unit energy consumption of a subsector" or "total consumption" energy savings (ES) indicators).

# 1. Add up IPMVP impact evaluation findings

- **IPMVP** techniques are microdata-dependent – **EXPENSIVE**. Most studies are OPTION A: short-term partial monitoring combined with ex-ante or deemed assumptions. Often okay for annual evaluations of industrial and ESCO projects or program management, not for large-scale policy analysis

  **NOTE**: Two of the 4 top-down "**energy savings indicators**" (ES) of EMEEES project rely on ex-ante assumptions or OPTION A ("market diffusion" (or "market share") and "specific energy consumption of an equipment." I consider at least 7 of the 14 top-down EMEEES case studies to be BOTTOM-UP).

Methods and concepts used to arrive at **NET SAVINGS** are controversial (with good reason).

- **IPMVP-estimated impacts not truly separable or additive**

- **IPMVP savings are short term, only – a honeymoon isn't a marriage**

## Measure retention studies

There are +200 programs/yr in CA alone. Long-term savings (aka **SAVINGS PERSISTENCE**) is not measured.

CALMAC lists over 70 retention studies, mostly for 1994-1996 program years. This is a trivial amount.

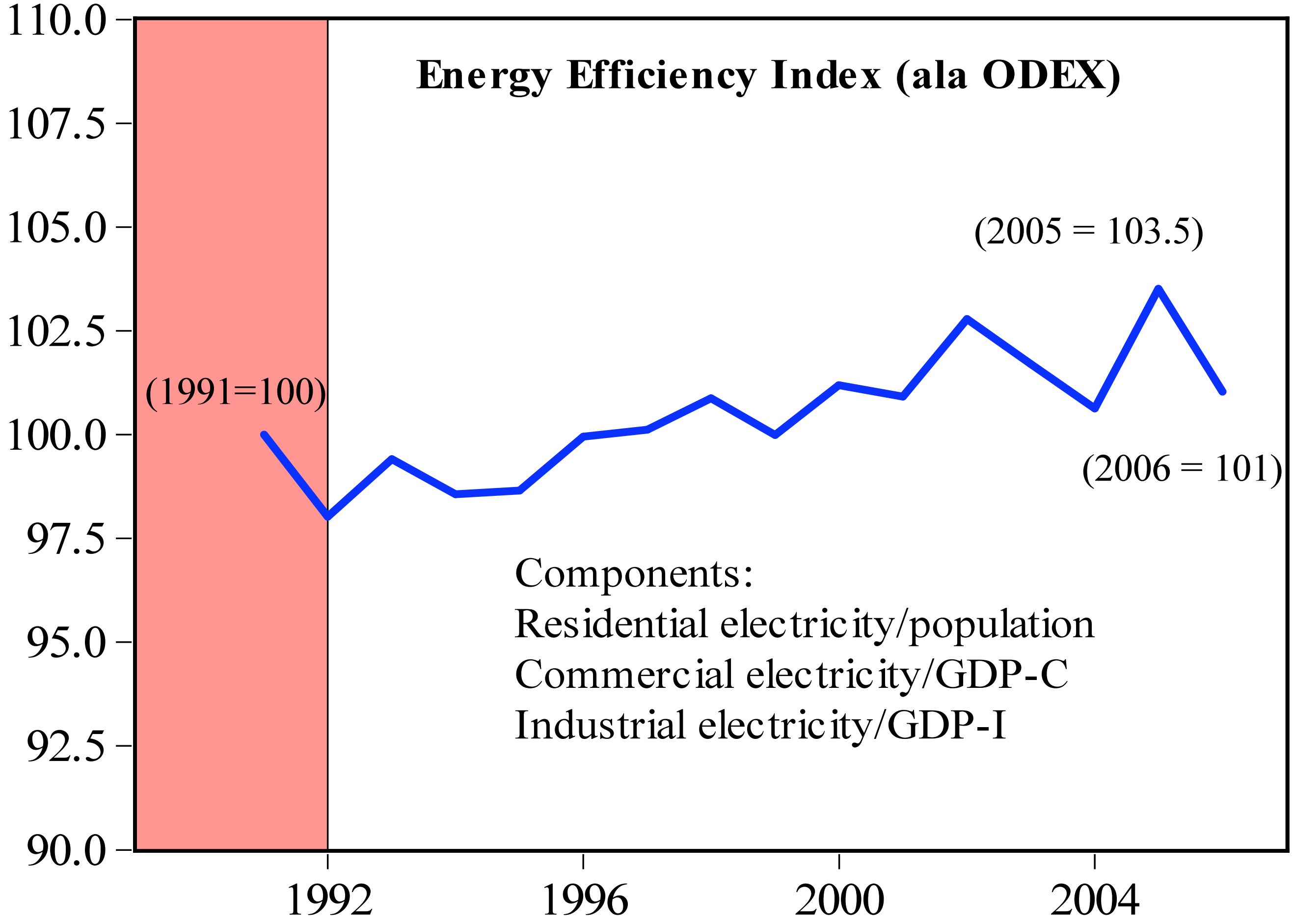
If CA implemented 200 programs annually from 1994 forward, and each program measure has a 6 year effective life...you would need thousands of studies by 2006 alone!

| **LIFETIME OF SAVINGS = 6 YEARS** | | | |
|---|---|---|---|
| YR | 1st yr Evaluation | Retention Study every 2 yrs | Retention Study every 3 yrs |
| 1994 | 200 | 0 | 0 |
| 1995 | 200 | 0 | 0 |
| 1996 | 200 | 200 | 0 |
| 1997 | 200 | 200 | 200 |
| 1998 | 200 | 400 | 200 |
| 1999 | 200 | 400 | 200 |
| 2000 | 200 | 600 | 400 |
| 2001 | 200 | 600 | 400 |
| 2002 | 200 | 600 | 400 |
| 2003 | 200 | 600 | 400 |
| 2004 | 200 | 600 | 400 |
| 2005 | 200 | 600 | 400 |
| 2006 | 200 | 600 | 400 |
| **TOTAL # Evaluations** | **2,600** | **5,400** | **3,400** |

# 2. Energy Efficiency Indexes

- Intuitively appealing
- Simple, elegant, inexpensive
- Unreliable & uninterpretable

**Using econometric analysis, U.S. EE policy savings is 9.9%, the equivalent of EE Index = 90.1.**
**Using the ODEX formula, the EE Index value = 101.0**



**Indexes are just as much determined by the changes in the numerators as by the changes in the denominators.**

**US residential kWh per Dog (1996 – 2007) = -8%**

**US residential kWh per Capita (1996 – 2007) = +11%**

## Not only is the selection of denominators problematic...

but the EE index is not capable of separating:

1. economic effects like price and income,
2. or technological breakthroughs and productivity advances

<u>from</u>

3. public policy effects

This is explicitly recognized by ODYSSEE researchers ("ODYSSEE indicators can in principle provide a measurement of total energy savings, whatever their origin"). This acknowledges that there is <u>a missing "counterfactual</u>" for measuring policy impacts.

## Top-down component of the EMEEES project attempted to correct for this flaw with econometric analysis – this was a good first try…

The EMEEES approach "was very pragmatic and relied on what is feasible…" Unfortunately, the research agenda suffered from two major shortcomings:

1. The econometric models specifications and depth of statistical analysis were truncated due to standardization goal

2. Counterfactuals were not well-defined

# 3. Econometric models (analysis of ratios or volume sold/consumed)

| | | |
|---|---|---|
| *E* | = | *commercial sector electricity consumption* |
| P | = | GDP for the commercial sector |
| *F* | = | *industrial sector electricity consumption* |
| Q | = | GDP for the industrial sector |
| *G* | = | *residential sector electricity consumption* |
| R | = | U.S. population |

**Electricity = f(kWh price, NG price, Income, Capital Stock, HDD, CDD,…)**

**or**

**Electricity Intensity = f(kWh price, NG price, Income, Capital Stock, HDD, CDD,…)**

***estimated independently for each sector and fuel***

# E'-E F'-F G'-G

Econometric models control for key factors and produce counterfactuals (E', F', G'). These are estimates of E, F, and G in the absence of energy efficiency policies

| Variable | Commercial ESCBMBTU | Industrial ESIBMBTU | Residential ESRBMBTU |
|---|---|---|---|
| Actual Consum. -1991 | 2,902,594,618 | 3,215,279,349 | 3,246,241,328 |
| Actual Consum.- 2006 | 4,416,874,944 | 3,401,105,484 | 4,602,559,396 |
| Counterfactual - 2006 | 4,760,590,200 | 4,722,509,587 | 4,162,459,464 |
| Policy-Related Savings | 343,715,256 | 1,321,404,103 | -440,099,932 |
| **U.S.- 48 States: % Impact in 2006** | | **9.9%** | |

$$\% \text{ Policy Impact} = \left( \frac{(E_1 + F_1 + G_1) - (E'_1 + F'_1 + G'_1)}{E_1 + F_1 + G_1} \right)$$

**Note the difference between policy analysis that comes from counterfactuals versus from ODEX**

**Counterfactual E', F' and G' are estimated using econometric analysis of E/P, F/Q, and G/R**

**Energy efficiency index based on actual values; it does not have estimated counterfactuals.**
**There's no analysis of the ratios.**

$$\left( \frac{(E_1 + F_1 + G_1) - (E'_1 + F'_1 + G'_1)}{E_1 + F_1 + G_1} \right) \neq \left( \begin{array}{l} \left[ \left( \frac{E_1}{P_1} \middle/ \frac{E_0}{P_0} \right) \times \left( \frac{E_1}{E_1 + F_1 + G_1} \right) \right] \\ + \left[ \left( \frac{F_1}{Q_1} \middle/ \frac{F_0}{Q_0} \right) \times \left( \frac{F_1}{E_1 + F_1 + G_1} \right) \right] \\ + \left[ \left( \frac{G_1}{R_1} \middle/ \frac{G_0}{R_0} \right) \times \left( \frac{G_1}{E_1 + F_1 + G_1} \right) \right] \end{array} \right) - 1$$

# CONCLUSIONS

IPMVP is a program management tool, not a policy evaluation tool.

Energy efficiency indexes may be useful in a limited number of applications, but intrinsically they do not permit policy attribution.  Analysis is necessary for policy evaluation.

**Top-down analyses of EMEEES project are a step in the right direction, but much more work needs to be done to make the econometric analyses successful**



# RECOMMENDATIONS

**# of DOGS**
**(+36% from 1996-2007) =**

**DOGS/PERSON**
**(+21% from 1996-2007) =**

**f(first cost, operating cost, income, # of children, location, housing characteristics, job, autonomous trend, public policy, …)**

**Top-down econometric methods are the least expensive and most reliable ways to measure and report national energy efficiency policy impacts**