Introduction to the Policy Analysis Modeling System (PAMS) and Case Study

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NIST
1. Use of PAMS

2. Policy scenario(s)

3. Methodology

4. Inputs needed and potential data sources

5. Case Study
Use of PAMS

Policy Analysis Modeling System PAMS was developed by CLASP and Lawrence Berkeley National Laboratory (LBNL) to help local policymakers assess the benefit of standards and labeling programs, and it is available at clasponline.org

- Excel workbook
- Bottom-up approach

A. The Consumer Perspective examines costs and benefits from the perspective of the individual household

B. The National Perspective projects the total national costs and benefits including both financial benefits, energy savings and environmental benefits.
Use of PAMS

Used to estimate savings potential from implementing policies that improve the energy efficiency of new products in any economy

At the **National Level:**

- **Energy savings** – lower electricity consumption due to the market introduction of more efficient appliances
- **Environmental Impacts** - carbon dioxide emissions mitigation due to reduced electricity consumption

At the **Consumer level:**

- **Energy bill savings** – reduced energy bills for users due to lower electricity consumption
Policy scenario(s)

Policies implemented in 2020, impacts estimated through 2030:

- **Base case** → no policies requiring improvements made to the appliances

- **Policy case 1** → **Design 1** a specific efficiency improvement
- **Policy case 2** → **Design 2** a specific efficiency improvement
- **Policy case 3** → **Design 3** a specific efficiency improvement

Results: a comparison between the policy and the base case
PAMS methodology for stock and sales forecasting:

- Ownership levels are based on a diffusion model based on:
  - household income
  - electrification,
  - urbanization, and
  - a climate variable for air conditioners

- Sales forecast considers:
  - First purchase (increase in number of households and ownership levels)
  - Replacement of retired appliances
Inputs needed and potential data sources

**Product data**
- Lifetime
- Baseline Price $
- Baseline Unit Energy Consumption

**Country data**
- Electricity price ($/kWh)
- CO2 emissions factor
- Transmission & distribution losses
- Consumer discount rate

**Efficiency data**
- Efficiency design options and cost of efficiency

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- National market assessments
- Local manufacturers / importers
- Industry associations

- Normally provided by Ministry of Energy, Environment or other relevant agency

Technical reports that support regulatory processes:
- EU preparatory studies
- US DOE rulemakings
- Other countries’ regulatory analysis
Case Study

Technical Assistance provided to CONUEE in the Elaboration and Revision of MEPS

Revision of the Mexican standards of refrigerators/freezers and room air conditioners and their possible alignment with new US DOE rulemaking

- Impact assessments were developed using PAMS and included:
  - A market analysis
  - A cost-benefit analysis
  - Summary of national impacts: energy savings and GHG emissions mitigation
MEPS revision for Room Air Conditioners (RACs)

Alignment between Mexican NORMS (MEPS) and the US DOE is preferred when possible

MEPS in Mexico:

• 1\textsuperscript{st} standard NOM-073-SCFI-1994
• Revision NOM-021-ENER/SCFI/ECOL-2000
• Revision NOM-021-ENER/SCFI-2008

Last revision from US DOE:

• \textit{Direct Final Rule} published in 2011 to be implemented in 2014

The analysis presented the regulatory impact assessment of revising MEPS levels in Mexico to those proposed in the US DOE rulemaking
Market Analysis

RACs market share per technology type

- RACs are mostly used in hot and dry areas in the north, and hot and humid areas in the south
- RACs use has increased in recent years due to warmer weather
- For consumers, energy costs related to the use of RACs represent up to 20% of household income
- For utilities, RACs use pressures system growth due to increased demand during peak loads
- RACs ownership ~ 20%
### Table 1: RACs market share per cooling capacity

<table>
<thead>
<tr>
<th>Cooling capacity</th>
<th>Number of units 2008</th>
<th>Market share [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal kW</td>
<td>BTU/h</td>
<td></td>
</tr>
<tr>
<td>&lt; 1.758</td>
<td>3400 – 5999</td>
<td>73,500</td>
</tr>
<tr>
<td>1.759 - 2.343</td>
<td>6000 – 7999</td>
<td>56,500</td>
</tr>
<tr>
<td>2.344 - 4.101</td>
<td>8000 – 13999</td>
<td>194,500</td>
</tr>
<tr>
<td>4.102 - 5.859</td>
<td>14000 – 19999</td>
<td>120,500</td>
</tr>
<tr>
<td>5.860 - 10.548</td>
<td>20000 – 36000</td>
<td>55,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>500,000</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

### Table 2: Efficiency levels

<table>
<thead>
<tr>
<th>CC (W)</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>1759</td>
<td>2.90</td>
<td>2.93</td>
<td>2.84</td>
<td>2.87</td>
<td>2.86</td>
<td>2.87</td>
</tr>
<tr>
<td>Classes 2-3-4</td>
<td>3518</td>
<td>2.95</td>
<td>2.99</td>
<td>2.93</td>
<td>2.97</td>
<td>3.05</td>
<td>3.1</td>
</tr>
<tr>
<td>Class 5</td>
<td>5861</td>
<td>2.64</td>
<td>2.67</td>
<td>2.64</td>
<td>2.68</td>
<td>2.71</td>
<td>2.67</td>
</tr>
</tbody>
</table>

Hours of operation: 8-12 h/day
Cost-benefit analysis

Develops an impact assessment to the consumer by providing answers to the following questions:

• Will the revised MEPS result in a net financial benefit or net financial cost to the consumer?

• Which of the proposed energy efficiency levels results in maximum net financial benefit?

• What are the net financial impacts to a consumer of harmonizing MEPS with the US DOE?

Costs and benefits from the consumer perspective use a Life-Cycle Cost (LCC) calculation.
PAMS calculates the LCC for two cases:

- Baseline: the case where no improvements are made to the appliance
- Policy case: a specific efficiency improvement is made to an appliance

The LCC calculation demonstrates how:

- increases in efficiency may increase the purchase price of an appliance for a consumer, and
- the energy savings can result in reduced energy expenses
RESULTS:
LCC for RACs Class 1

<table>
<thead>
<tr>
<th></th>
<th>EER</th>
<th>Incremental cost</th>
<th>UEC</th>
<th>LCC</th>
<th>ΔLCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base case</td>
<td>2.89</td>
<td></td>
<td>1332</td>
<td>$14,021</td>
<td></td>
</tr>
<tr>
<td>Option 1</td>
<td>2.96</td>
<td>$126</td>
<td>1301</td>
<td>$13,759</td>
<td>$(262)</td>
</tr>
<tr>
<td>Option 2</td>
<td>3.11</td>
<td>$293</td>
<td>1211</td>
<td>$13,259</td>
<td>$(762)</td>
</tr>
<tr>
<td>Option 3</td>
<td>3.25</td>
<td>$528</td>
<td>1077</td>
<td>$12,836</td>
<td>$(1,185)</td>
</tr>
<tr>
<td>Option 4</td>
<td>3.34</td>
<td>$754</td>
<td>933</td>
<td>$12,651</td>
<td>$(1,370)</td>
</tr>
<tr>
<td>Option 5</td>
<td>3.42</td>
<td>$1,541</td>
<td>789</td>
<td>$12,701</td>
<td>$(1,320)</td>
</tr>
</tbody>
</table>

Option 3 corresponds to the proposed level by US DOE.

Options 1 to 5 always result in net financial benefits for the consumer.
Cost-benefit analysis

PAMS also calculates the payback period: *the period of time required for the return on an investment to "repay" the sum of the original investment*.

<table>
<thead>
<tr>
<th>Class</th>
<th>EER</th>
<th>PP (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base case</td>
<td>2.89</td>
<td></td>
</tr>
<tr>
<td>Option 1</td>
<td>2.96</td>
<td>0.6</td>
</tr>
<tr>
<td>Option 2</td>
<td>3.11</td>
<td>0.9</td>
</tr>
<tr>
<td>Option 3</td>
<td>3.25</td>
<td>1.1</td>
</tr>
<tr>
<td>Option 4</td>
<td>3.34</td>
<td>1.4</td>
</tr>
<tr>
<td>Option 5</td>
<td>3.42</td>
<td>2.6</td>
</tr>
</tbody>
</table>

In this case, the payback period is always less than half of the equipment lifetime (average lifetime = 10.5 y).

Very good!!
National impacts

• Energy savings – lower electricity consumption due to the market introduction of more efficient air conditioners

• Net Present Value - Net financial savings due to the lower electric bill (and the higher cost of equipment), discounted at the current year

• Environmental Impacts - carbon dioxide emissions mitigation due to reduced electricity consumption

• Avoided Generation Capacity – Reduction of peak demand and the need to implement new power plants
National impacts

- Efficiency trends – Class 3 policy case
RESULTS:
Cost and savings for Class 1

![Cost and Saving of Modeled Appliance](chart.png)
RESULTS:
Energy and economic impacts at a national level

<table>
<thead>
<tr>
<th></th>
<th>EER</th>
<th>Site NES 2030 (cumulative)</th>
<th>Source NES 2030 (cumulative)</th>
<th>Equipment cost (national)</th>
<th>Energy Savings</th>
<th>NPV</th>
<th>Cumulative CO2 emissions in 2030</th>
<th>Avoided generation capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>W/W</td>
<td>GWh</td>
<td>Mtoe</td>
<td>millions MX$</td>
<td>millions MX$</td>
<td>millions MX$</td>
<td>Mt</td>
<td>MW</td>
</tr>
<tr>
<td>Base case</td>
<td>2.89</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Option 1</td>
<td>2.96</td>
<td>261</td>
<td>0.054</td>
<td>$ 12</td>
<td>$ 719</td>
<td>$ 707</td>
<td>0.2</td>
<td>15</td>
</tr>
<tr>
<td>Option 2</td>
<td>3.11</td>
<td>785</td>
<td>0.162</td>
<td>$ 50</td>
<td>$2,159</td>
<td>$2,109</td>
<td>0.6</td>
<td>46</td>
</tr>
<tr>
<td>Option 3</td>
<td>3.25</td>
<td>1,262</td>
<td>0.261</td>
<td>$105</td>
<td>$3,470</td>
<td>$3,366</td>
<td>1.0</td>
<td>74</td>
</tr>
<tr>
<td>Option 4</td>
<td>3.34</td>
<td>1,515</td>
<td>0.313</td>
<td>$157</td>
<td>$4,166</td>
<td>$4,009</td>
<td>1.2</td>
<td>88</td>
</tr>
<tr>
<td>Option 5</td>
<td>3.42</td>
<td>1,752</td>
<td>0.362</td>
<td>$339</td>
<td>$4,818</td>
<td>$4,479</td>
<td>1.4</td>
<td>102</td>
</tr>
</tbody>
</table>
RESULTS:
Three scenarios were analyzed for each product class:

- **S1** – Alignment of Mexican MEPS with US DOE
- **S2** – A scenario of maximum profitability of MEPS levels for each product class
- **S3** – A scenario with maximum energy savings without penalizing the consumer

<table>
<thead>
<tr>
<th>Product Class</th>
<th>S1 (EER W/W)</th>
<th>LCC savings (US DOE level)</th>
<th>S2 (EER W/W)</th>
<th>LCC savings (maximum financial benefits)</th>
<th>S3 (EER W/W)</th>
<th>LCC savings (maximum energy savings)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.25</td>
<td>$1,185</td>
<td>3.42</td>
<td>$1,320</td>
<td>3.42</td>
<td>$1,320</td>
</tr>
<tr>
<td>3</td>
<td>3.19</td>
<td>$967</td>
<td>3.51</td>
<td>$1,739</td>
<td>3.51</td>
<td>$1,739</td>
</tr>
<tr>
<td>5</td>
<td>2.75</td>
<td>$1,109</td>
<td>2.87</td>
<td>$2,663</td>
<td>2.98</td>
<td>$1,674</td>
</tr>
</tbody>
</table>
RESULTS:

• The analysis shows that aligning Mexican MEPS with US DOE will be profitable for the consumer for all product classes.

• It also shows that there are MEPS levels more profitable than those aligned to US DOE.

• For classes 1 and 3, the max. tech. level gives maximum benefit to consumers; for class 5, a level 4% below the max. tech does.
Thank you!