“Development and implementation of a Cool Roof standard in Mexico”

CRRC annual membership meeting
Las Vegas, NV June 18th 2015

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Produquímicos Industriales / ANAFAPyT
OVERVIEW

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   • Buildings in Mexico
   • Residential energy use

2. Background
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   • Time line

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   • Key results

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   • Parameters
   • Certification

5. Next steps and conclusions
   • Next steps
   • Conclusions
1. JUSTIFICATION
WEATHER IN MEXICO

Source: Assessing energy savings from "Cool Roofs" on residential and non-residential buildings in Mexico (CENIDET, 2013)
BUILDINGS IN MEXICO

• Residential

  • Walls - Bricks, concrete blocks, concrete cast
  • Roofs - Flat Roofs, concrete slab, prefabricated elements
  • Waterproof coatings to prevent water infiltration
BUILDINGS IN MEXICO

• Non Residential / Commercial / Industrial
  • Walls - Bricks, concrete blocks, metal panels
  • Roofs - Low slope, concrete slab, steel structure / metal sheet
  • Waterproof coatings to prevent water infiltration
RESIDENTIAL ENERGY USE

- Space conditioning: 44%
- Lighting, kitchen and appliances: 33%
- Water heater: 14%
- Fridge: 9%

Source: Comisión Nacional para el Uso Eficiente de la Energía (conue.gob.mx, 2011)
2. BACKGROUND
EARLY ATTEMPTS

• 1990

• White elastomeric waterproof coatings start selling in Mexico
  • Mainly in north part of the country
  • Inexact claims

(Claim: Waterproof coating and thermal insulator)

• No knowledge about the physical phenomena
• Still end user could “feel” the difference
• Explosive growth in the warm areas
• Thermal insulation manufacturers tried to refute the claims and discredit the products
EARLY ATTEMPTS

- **1991**
  - FIPATERM program in Mexicali
    - Government trust fund to install thermal insulation in residential buildings

- **1997**
  - FIPATERM changes to ASI and includes:
    - Substitution of AC to HE AC, and air leaking sealing
  - NOM-018-ENER-1997 - Thermal insulations for buildings
    - Certification for K and R factor of building materials
    - ASI program products should be certified

- **2001**
  - NOM-008-ENER-2001 - Thermal envelopes, commercial buildings
EARLY ATTEMPTS

- Calculate heat gains in a reference building using temperatures obtained by sol-air method.
- Reference building includes thermal insulation
- Heat gains in projected building ≤ heat gains reference building
- Sol-air temperatures consider 0.1 SR for both roof and walls
- Influence of thermal insulation manufacturers
- It was never used or enforced

- **2002**
  - **FIPATERM program started to operate nationally**
    - Market growth for thermal insulation

- **2003**
  - **Main thermal insulation manufacturers created AEAEE (Association for energy savings in buildings)**
EARLY ATTEMPTS

- 2007
  - Improved Cool Roof products in México
    - Big market growth

- 2009
  - AEAEE creates NMX-C-460-ONNCCE-2009 - R value for residential building envelopes in Mexico
    - Insulation materials should be certified by NOM-018
  - INFONAVIT launches Green Mortgage Program
    - Felipe Calderon got awarded with Star of Energy Efficiency
    - The use of eco-techs from the catalog award points
    - Depending on income, houses must meet some points
    - Thermal insulation on roofs awards the most points for warm climate buildings.
EARLY ATTEMPS

• Developers start installing thermal insulation (High cost)

• Some Cool Roofs got certified by NOM-018 (130 layers to achieve the needed thickness!)

• Developers buy Cool Roofs, apply two layers and claim to meet the requirement

• AEAEE loses market and start war against Cool Roofs

• 2011

• NOM-020-ENER-2011 - Thermal envelopes, residential buildings
  • Calculate heat gains in a reference building using temperatures obtained by sol-air method.
  • Reference building includes thermal insulation
  • Heat gains in projected building ≤ heat gains reference building
  • Sol-air temperatures consider 0.25 SR for both roof and walls
  • Influence of AEAEE
CLEAN ENERGY MINISTERIAL

- Global forum
- Share best practices
- Promote public policy to promote clean energy global economy.
- Emission reduction, energy safety, energy access and promote economic growth
GLOBAL SUPERIOR ENERGY PERFORMANCE PARTNERSHIP (GSEP)

- Industry and buildings energy efficiency

“Cool Roofs and Pavements” group:

- Share best practices
- Support local plans for Cool Roofs
- Quantify the impact of Cool Roofs
- Promote policy making, institutions and infrastructure to support Cool Roofs growth
TIME LINE

- Sept 2011, Washington, USA: 1st GSEP Cool Roofs group session
- Feb 28th 2012, Mexico City: Workshop “Cool surfaces in building envelopes” organized by DOE, GCCA and CONUEE hosted by AEAEE (Potential conflict of interest)
- Mar 5th 2012, Mexico City: Action plan approved for Cool Roof program in Mexico
  - Key points:
    ✓ Cool Roof program is beneficial for Mexico
    ✓ Start process that would lead to include Cool Roofs in Mexico’s existing construction codes
  - Actions (Estimated 3 year):
    ✓ Develop NMX voluntary standard for Cool Roofs
    ✓ Encourage INFONAVIT and CONAVI to include this NMX in their programs
    ✓ National potential impact study
    ✓ Meeting this, CONUEE would propose this NMX to become mandatory
    ✓ Pilot programs (after considered unnecessary)
    ✓ Knowledge exchange
TIME LINE

• Oct 3rd 2012, Nueva Delhi: 2nd GSEP Cool Roofs group session
  • COTENNAREC/ANAFAPyT was selected to host the working group for
    the NMX.
  • CENIDET was selected to perform the potential impact study

• Oct 26th 2012: COTENNAREC enrolls the NMX in the National
  Normativity Calendar and creates the redacting working group

• Nov 7th 2012: First working session of NMX redacting group
  • The group met once or twice a month, more than 40 companies and
    institutions were represented

• Jan 30th 2013: CONUEE approved method and model buildings for
  impact study

• Feb 24th 2013: LBNL: Cool Roofs workshop. CONUEE, COTENNAREC
  and CENIDET personnel attended

• Mar 12th 2014: Impact study results presented and approved by
  CONUEE
TIME LINE

• May 7th 2015: NMX was signed and set for publication and public consult period.

“PROY-NMX-U-000-SCFI-2015 Industria de la construcción - Edificaciones - Revestimientos para techo con alto índice de reflectancia solar - Especificaciones y métodos de ensayo”

• June 3rd 2015: NMX was presented to authorities and a support document was signed.
3. IMPACT STUDY
• 5 cities / 5 climate zones
• Weather variables from Meteonorm data base
• Base buildings according to NOM-008-ENER (Non residential) and NOM-020-ENER (Residential)
• Including recommended thermal insulation
• Dynamic simulation / Energy Plus and Design builder
• SR was varied from 0.1 to 0.9 in 0.1 intervals
• Annual building cooling loads.
• Annual city cooling loads.
• CO$_2$ emission savings.
• Payback period
• Current Cool roof penetration using Google earth and Manifold GIS 8.0
RESULTS

Annual savings, per city non residential
### RESULTS

Total money savings in 5 years per building, non residential

<table>
<thead>
<tr>
<th></th>
<th>Merida</th>
<th>Monterrey</th>
<th>Hermosillo</th>
<th>Mexico</th>
<th>Tulancingo</th>
</tr>
</thead>
<tbody>
<tr>
<td>R=0.3</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>R=0.6</td>
<td>$48,559.75</td>
<td>$23,359.75</td>
<td>$24,319.75</td>
<td>$15,599.75</td>
<td>$24,639.75</td>
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<tr>
<td>R=0.7</td>
<td>$49,672.22</td>
<td>$20,472.22</td>
<td>$22,632.22</td>
<td>$15,992.22</td>
<td>$23,352.22</td>
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<tr>
<td>R=0.8</td>
<td>$46,372.43</td>
<td>$23,252.43</td>
<td>$27,252.43</td>
<td>$13,812.43</td>
<td>$23,412.43</td>
</tr>
</tbody>
</table>
RESULTS

Annual cooling energy savings, TWh

City

Merida
Monterrey
Hermosillo
Cd. de México
Tulancingo

0.24
0.41
0.32
0.19
0.04

0.32
0.48
0.66
0.38
0.05

0.84
0.60
0.67
0.52
0.06

0.70
0.80

Annual savings, per city residential
Total money savings in 5 years per building, residential
RESULTS

- Condensed results for the cities that showed highest savings both for non residential and residential buildings.

<table>
<thead>
<tr>
<th></th>
<th>Non Residential Mexico City</th>
<th>Residential Monterrey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof reflectance</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Concept</td>
<td>Quantity</td>
<td>Quantity</td>
</tr>
<tr>
<td>Savings on energy consumption</td>
<td>5.16</td>
<td>0.84</td>
</tr>
<tr>
<td>Monetary savings due to energy production</td>
<td>5,572,800</td>
<td>90,720,000</td>
</tr>
<tr>
<td>Reduction of CO$_2$ emissions</td>
<td>3,650</td>
<td>590,000</td>
</tr>
<tr>
<td>Equivalence in automotive vehicles</td>
<td>730</td>
<td>118,000</td>
</tr>
</tbody>
</table>
4. NMX STANDARD
Objective: To determine specifications that should be met by roofing products to be denominated “Cool Roofs” and the test methods to measure them

Scope: All roofing products, domestic or imported for selling in Mexico

Characteristics:

- SRI
- Extended contrast ratio (Field applied coatings)
- Declared life span
- Whiteness Index gradient after soiling

Classification:

<table>
<thead>
<tr>
<th>SLOPE</th>
<th>CLASS</th>
<th>FIELD APPLIED COATINGS</th>
<th>PREFABRICATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low slope</td>
<td>L1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low slope</td>
<td>L2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steep slope ≥ 18.4°</td>
<td>S1</td>
<td></td>
<td>S2</td>
</tr>
</tbody>
</table>
### SPECS

- **Solar Reflectance Index (SRI)**

<table>
<thead>
<tr>
<th>SLOPE</th>
<th>CLASS</th>
<th>SRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low slope</td>
<td>L1</td>
<td>≥105</td>
</tr>
<tr>
<td></td>
<td>L2</td>
<td>≥85</td>
</tr>
<tr>
<td>Steep slope</td>
<td>S1</td>
<td>≥50</td>
</tr>
<tr>
<td></td>
<td>S2</td>
<td>≥35</td>
</tr>
</tbody>
</table>

- L1 and S1 recommended for warm areas
- L2 and S2 recommended for temperate areas

- **Extended contrast ratio (Field applied coatings) 0.98**
- Certified products should perform over every possible substrate
• **Whiteness Index gradient (ΔWi) ≤ 20 %**
  ✓ Cool roofs soil
  ✓ Not all soil the same
  ✓ No weathering farms in México soon
  ✓ We compare dirt pick up resistance measuring whiteness index

• **Declared Life span: ≥ 5 años.**
  ✓ Time enough for payback.
  ✓ Declared by manufacturer
  ✓ It has to be sustained with documents
TEST METHODS

- Solar reflectance (SR).
  ✓ Devices and Services portable reflectometer.
  ✓ ASTM C1549

- Thermal Emittance ($\varepsilon$).
  ✓ Devices and Services portable emissometer
  ✓ ASTM C1371
TEST METHODS

• Solar Reflectance Index (SRI)
  ✓ Calculated with SR and TE values
  ✓ ASTM E1980

• Extended contrast ratio
SR over black substrate / SR over white substrate
TEST METHODS

- **Whiteness Index gradient (ΔWI)**
  - Spectrophotometer with integrating sphere
  - 24 h UV to ensure full curing and reaction of photo sensible pigments
  - Initial whiteness index is measured ($W_{Ii}$)
  - Standard iron oxide dispersion
  - Dry 3 h and rinse with water
  - Dry 24 h
  - Measure final whiteness index ($W_{If}$)

\[
\Delta W_I = 100 \times \frac{W_{Ii} - W_{If}}{W_{Ii}}
\]
CERTIFICATION

• Certifying institution
  ✓ 2 specimens from 2 production lots
  ✓ Accredited lab - Prepare samples and test
  ✓ Lab issues report to certifying institution
  ✓ If all of the specs are met, certifying institution issues a certificate
5. NEXT STEPS AND CONCLUSIONS
NEXT STEPS

• NMX publication
  ✓ NMX will be published on DOF - July 2015
  ✓ Public consult 60 day period - Finish September 2015
  ✓ Answer comments - Finish October 2015
  ✓ Final publication - December 2015
• In the mean time
  ✓ Help testing labs to prepare for accreditation
  ✓ Divulgate NMX to INFONAVIT, Developers and construction chambers
• Once published
  ✓ Labs accreditation
  ✓ Products certification
✓ Ask INFONAVIT to include it in Green Mortgage catalog
✓ Ask developers to specify accredited Cool Roofs
✓ CONUEE will include NMX in NOM-008 and 020 ENER

• Medium term
  ✓ To collaborate with LBNL to develop accelerated soiling test for Mexico
  ✓ Keep pushing for Mexican energy efficiency norms to be applied and followed
• Mexico is a great candidate for Cool Roofs
• Push through public policy is critical
• CEM through GSEP is promoting Cool Roof programs globally
• Excellent coordination between public and private institutions in Mexico resulted in a record time results
• GSEP has mentioned Mexico’s process as example for other countries
• Availability of certified Cool Roof products will improve the credibility of the program, it will promote market growth, and help to improve comfort and energy efficiency
• It is very important to keep the effort until Cool Roofs are widely used in Mexico
Questions?

¡Thank you!

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