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thirsty THURSDAY

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Designing with Multi-Cavity Insulating Glass Units

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August 22, 2019

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October 17, 2019
Webinar

Annual Conference
January 13-15, 2020
La Jolla, CA

BEC Conference
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Nashville, TN

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OUTLINE

1. Basics of multi-cavity IGUs

    a) Design
    b) Performance
    c) Challenges

2. Drivers of multi-cavity IGU selection

3. North American vs International

4. Trends

Multi-Cavity Insulating Glass Units

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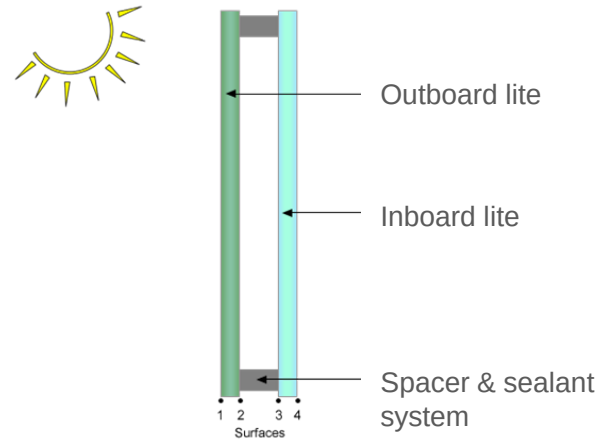
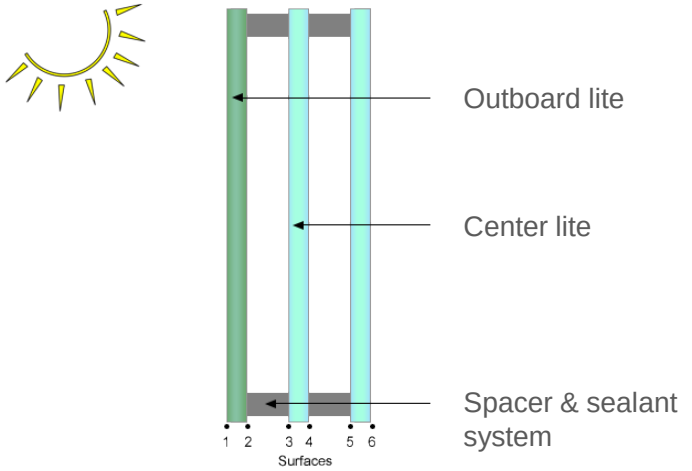
INTRODUCTION

- Multiple cavity insulating glass units (Multi-cavity IGUs) refer to an IG with more than one air space in the unit
  - Effective method to improve energy efficiency of the glazing
- Improved U-factors are needed to meet the demands of stricter energy codes
- Multi-cavity IGUs are already widely used in Europe and their adoption is increasing in North America and Canada
- This presentation will describe the use and features associated with Multi-cavity IGUs.

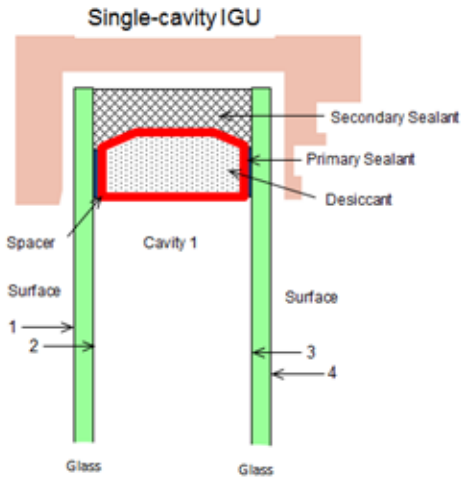


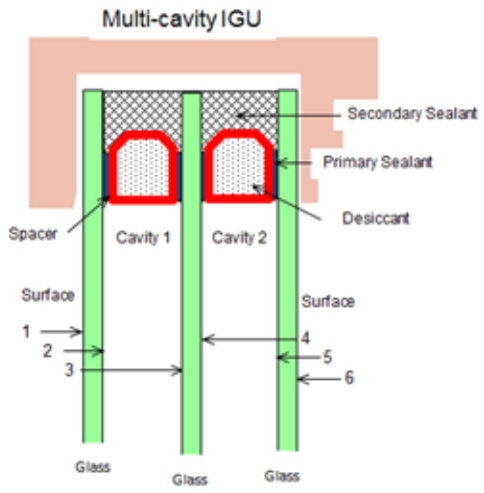


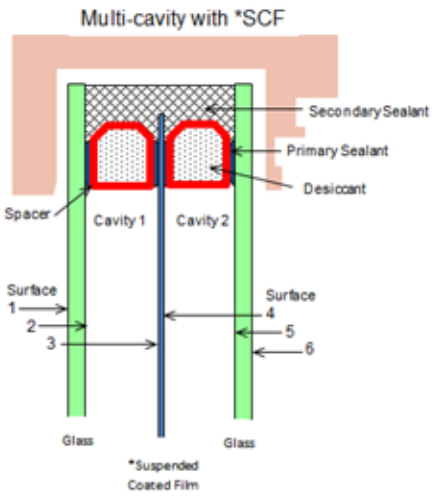
MULTI-CAVITY IG DESIGN

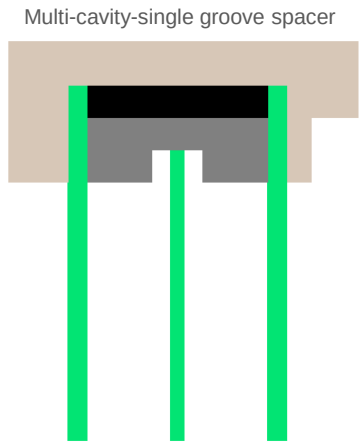
DESIGN

- Multi-cavity IGUs can have a number of spacer designs
  - Center glass lite(s) using spacer(s) for each cavity
  - Center glass lite(s) using a single grooved spacer(s) for both cavities
  - Center suspended film(s) using spacer(s) for each cavity







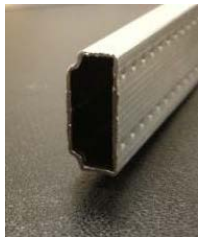


DESIGN

Spacer types include:

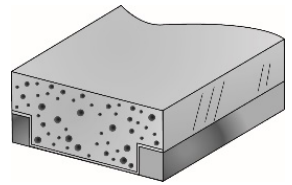
- Rigid: metal, plastic or combination that are extruded, roll formed or assembled to create rigid spacer. Are typically filled with desiccant.

- Flexible: thermoset or thermoplastic rubber material with desiccant integral to spacer.









DESIGN

Low-e Coatings

- The main benefits of low-e coatings are:
  - U-factor improvement
  - Solar control

- The location of one or more low-e coating(s) within the IGU affects thermal and solar performance:
  - A low-e coating located close to the exterior surface of an IGU generally results in lower SHGC values.
  - Positioning low-e coating(s) closer to the interior generally result in higher SHGC values.
  - Multiple coatings, often in combination with tinted glass, provide aesthetically pleasing and enhanced thermal performance results.

- Generally, only one low-e coating is used per air space.

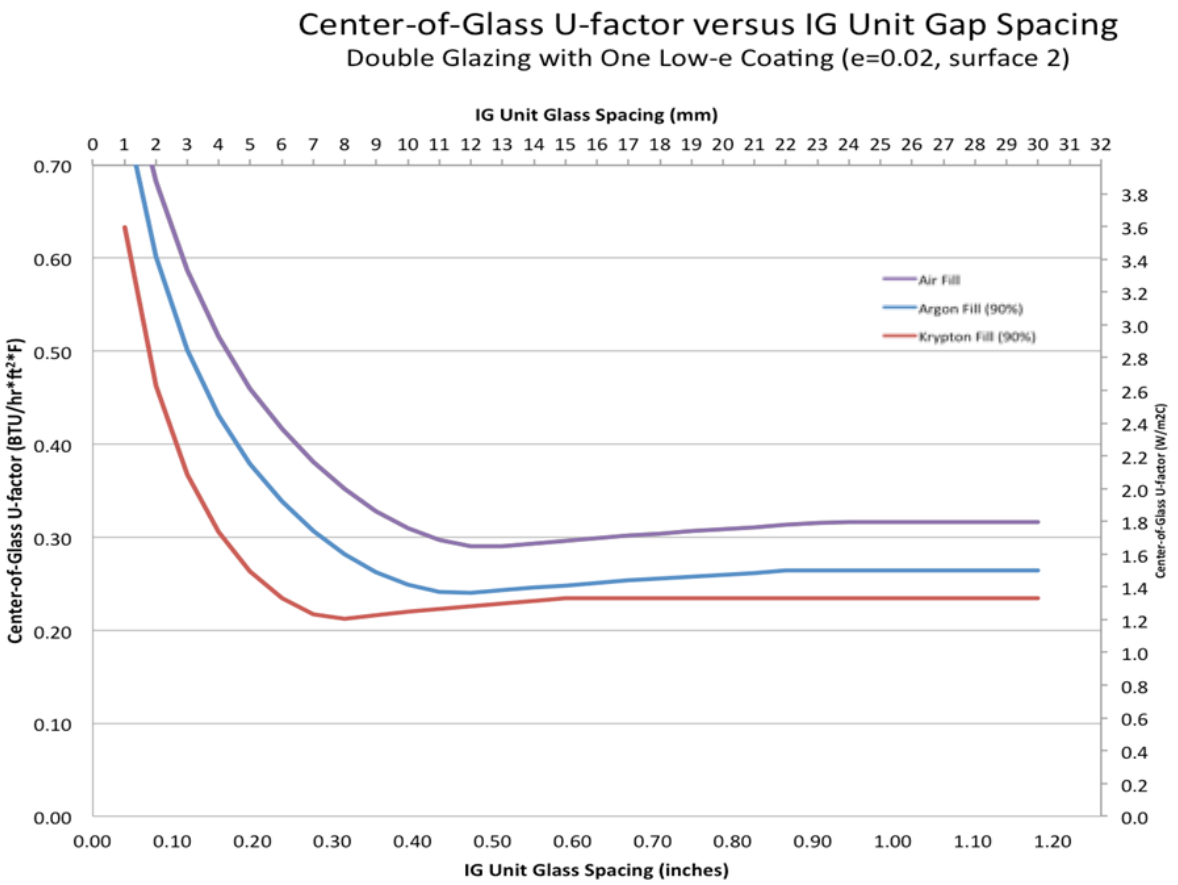
PERFORMANCE

Multiple performance attributes to be considered:

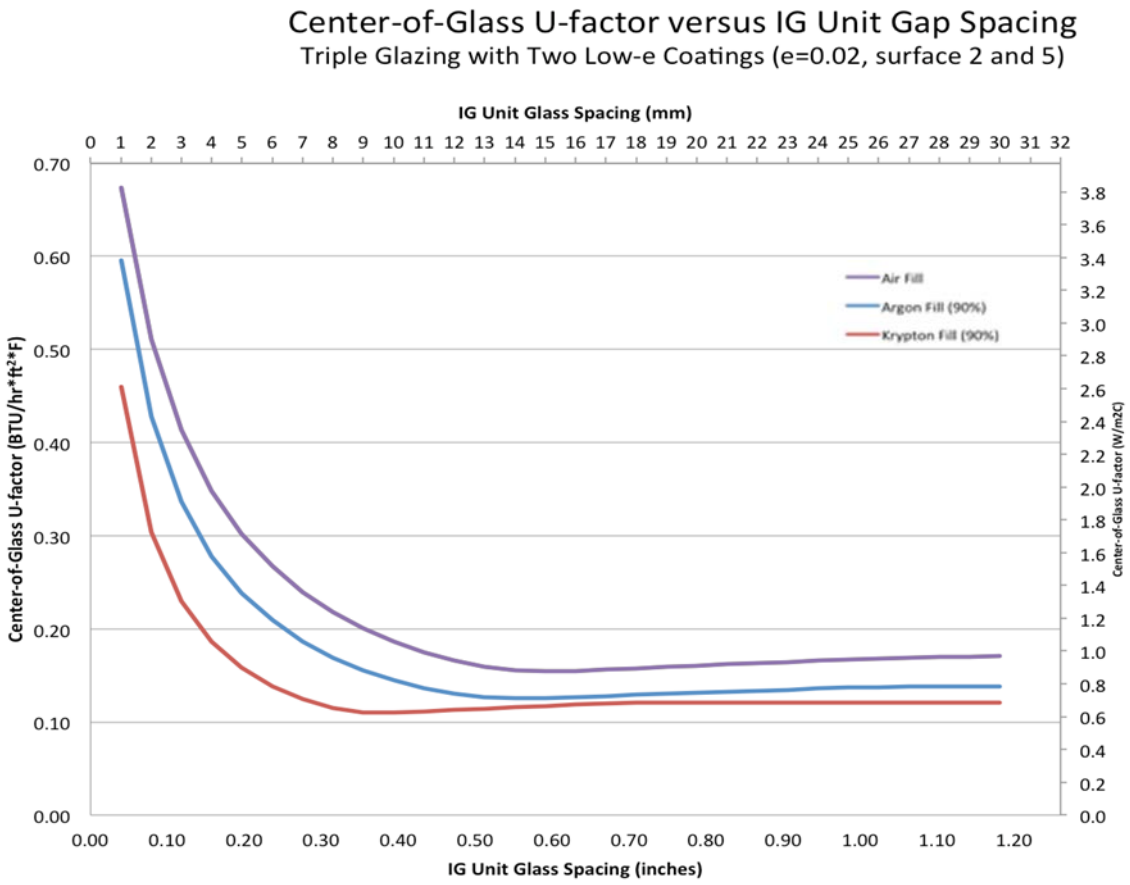
- Durability (internal condensation/fogging; gas retention)
  - Double transmission paths
  - Higher internal pressurization due to temp
  - Fabrication complexity
- Thermal Factor (U-Factor, SHGC, condensation resistance)
  - Dual low-e
  - Krypton for narrower profile
  - Unbalanced for Kr/Ar
  - Typical double vs. triple IG performance – various configurations
  - Visible transmission (VT) reduction
  - Surface 1 condensation
- Acoustical
  - Mass effect
  - Airspace effect

PERFORMANCE: THERMAL

- U-factor - Typical Double IGU performance



- U-factor – High Performance-Triple IGU performance



(Courtesy of WESTLab)

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MULTI-CAVITY CHALLENGES

CHALLENGES

- **Thermal Stress**
- **Load Resistance/Rating**
- **Weight**
- Coating Detection
- Gap Optimization
- Optical Effects
- Condensation
- **Fabrication**

CHALLENGES

Multi-cavity IGs give many additional design considerations compared to double glazing:

•Thermal Stress

- Absorbed solar heat in the middle lite(s) of a multi-cavity IG cannot easily escape
- Multiple Low-e coatings and/or insulating gas on both sides can result in thermal stress breakage of annealed inner lites
- Using a Low-E coating or tinted glass on the center lite(s) typically requires heat treating
- Contact the primary glass manufacturer for assistance

CHALLENGES

- Load Resistance / Rating
  - Greater glass stress, deflection and edge seal pressure due to magnification of temperature changes and air pressure differentials
  - Load Resistance Rating – ASTM E1300
    - procedure GTF x LSF = 2.4/4.9/9.7 (AN/HS/FT)

- Weight: Multi-cavity IGs use additional glass and other materials which increase weight
  - Added glass and materials can result in more than a 50% weight increase, over a double glazed IG
  - It is important to design the sash or frame properly to compensate for this additional weight; consider use of a thinner center lite of glass

CHALLENGES

- Fabrication considerations
  - Fabrication equipment may limit available product configuration
    - Gas fill in all cavities
    - Coating multiple surfaces
    - Maximum dimensions L x W and thickness
    - Use of laminated product
- Installation
  - Glazing system needs to support unit thickness and weight
  - On-site handling may be different than conventional single cavity
    - Consult Fabricator/Glazing contractor

ENERGY EFFICIENCY TRENDS

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DRIVERS OF ENERGY EFFICIENCY

Building Codes

- ASHRAE and IECC; IgCC

Standards

- ASTM International and NFRC

Certification

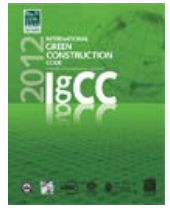
- LEED and Passive House Institute; Living Building Challenge; Green Globes

Government

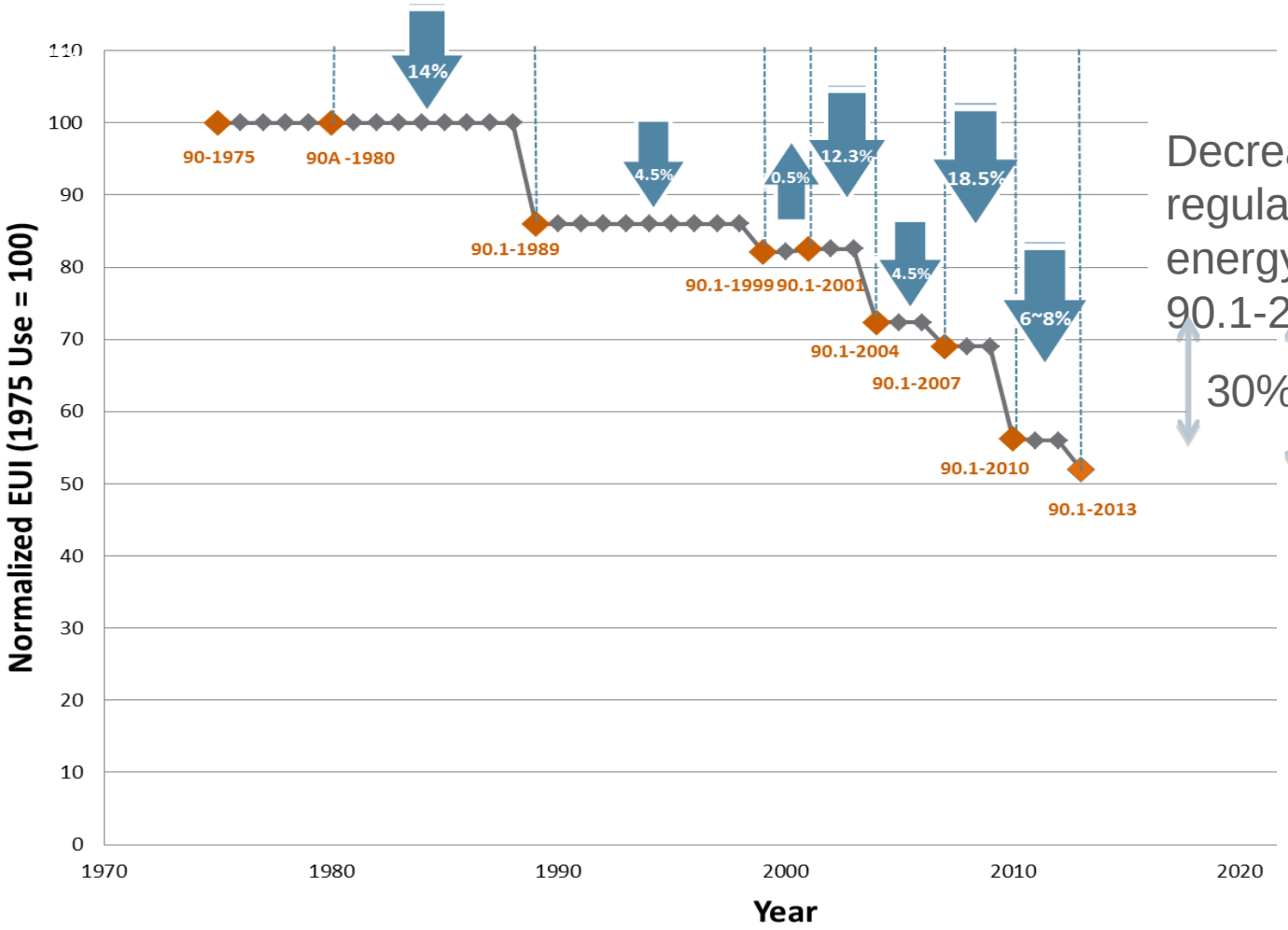
- US DOE; EPA Energy Star

Economics

- Rising energy costs increase the importance of energy efficiency



INCREASED STRINGENCY OF ASHRAE 90.1



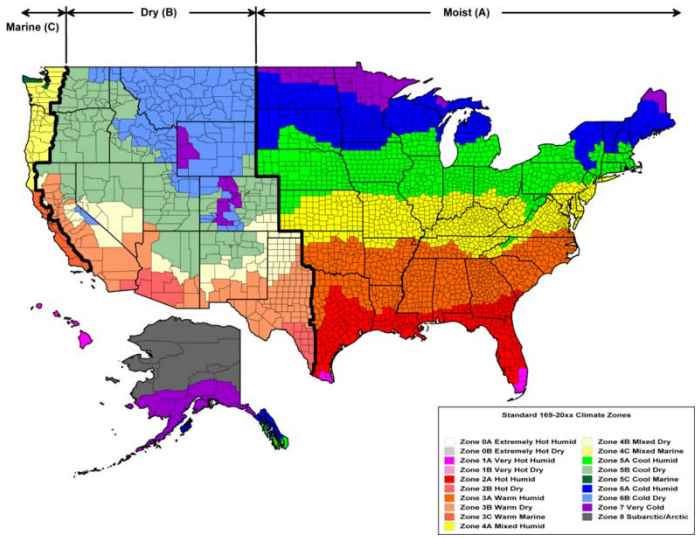
Decrease in regulated loads energy use since 90.1-2004:

30% 38%

Vertical Fenestration – Energy Efficiency

ROUGHLY what is needed to meet U-factor for 90.1-2016?

- **Zone 1:** Low-e, double glazing
- **Zones 2-3:** Low-e double glazing, thermally broken frame
- **Zones 4-5:** Low-e, thermally broken frame and ***pick 1***:
  - argon
  - high performance thermal break
  - two low-e coatings (#2 / #4)
- **Zone 6:** Low-e, thermally broken frame and ***pick 2***:
  - argon
  - warm edge spacer
  - high performance thermal break
  - two low-e coatings (#2 / #4)
- **Zone 7:** Low-e, thermally broken frame and ***pick 3***:
  - argon
  - warm edge spacer
  - high performance thermal break
  - two low-e coatings (#2 / #4)
- **Zone 8:** all of the above in double glazing, or more likely, go to triple



Courtesy of Birch Point Consulting (NGA BEC presentation)

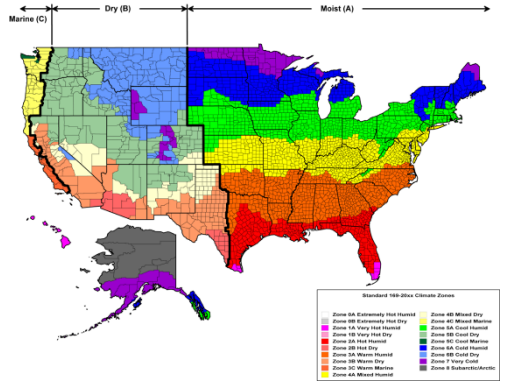
Vertical Fenestration – Energy Efficiency

ROUGHLY what is needed to meet U-factor for 90.1-2019?

- **Zone 1:** Low-e, double glazing ***+ lower 0.23 SHGC***
- **Zones 2-3:** Low-e double glazing, thermally broken frame
- **Zones 4-5:** Low-e, thermally broken frame and ~~***pick 1***~~: ***+ pick 2***
  - argon
  - high performance thermal break
  - two low-e coatings (#2 / #4)
  - ***warm edge spacer***
- **Zone 6:** Low-e, thermally broken frame and ~~***pick 2***~~: ***+ pick 3***
  - argon
  - warm edge spacer
  - high performance thermal break
  - two low-e coatings (#2 / #4)
- **Zone 7:** Low-e, thermally broken frame and ~~***pick 3***~~:
  - argon
  - warm edge spacer
  - high performance thermal break
  - two low-e coatings (#2 / #4)
- **Zone 8:** ~~all of the above in double glazing~~, ~~or more likely~~, go to **triple**

Thrm. improved + argon or WE (Z2)

Standard TB + air (Z2, Z3)



all of these in double glazing, or go to triple

Courtesy of Birch Point Consulting (NGA BEC presentation)

Updated Commercial Fenestration Requirements

- 90.1-2019 and 2021 IECC will continue to push improved framing, warm edge spacers, argon gas fill, and 4th surface low e coating while still being cost effective and practical.
  … and with no reductions in window area.

  - 5-17% reduction in U-factor;
  - only modest reductions in SHGC – but new criteria for fixed vs. operable SHGC.

- In many cases, very roughly a “zone shift” between 90.1-2016 and 90.1-2019: what was required in Zone 7 will move to Zone 6, Zone 6 to Zone 5, etc.

- 90.1 and IECC will use same product categories, without regard to material type.

Courtesy of Birch Point Consulting

NA vs OTHER MARKET

European Market

- ~66% of EU market is triple pane
- Germanic region ~75% is triples

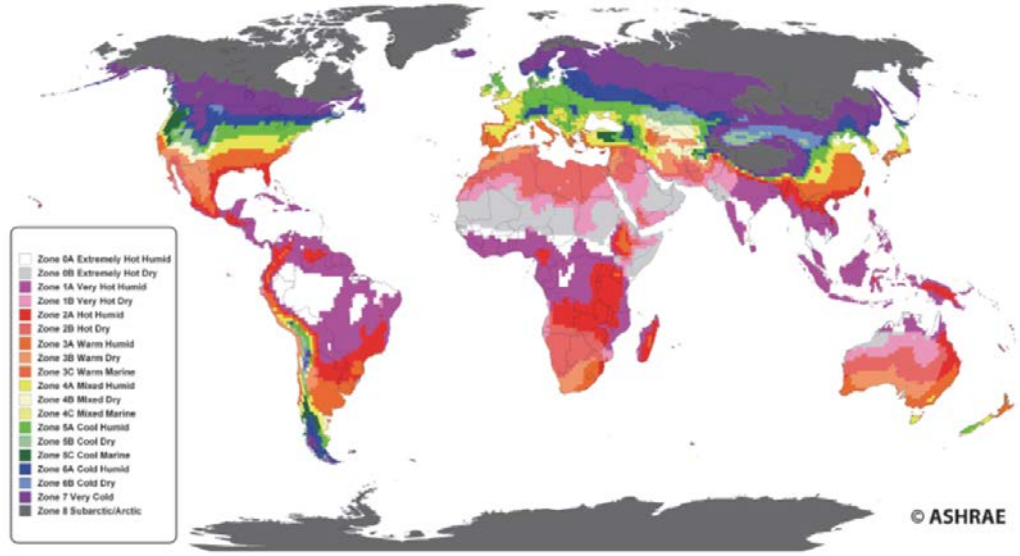


FIGURE C-2 World climate zones map.

- Warm edge make up the majority of triples
  - ~40% of EU glazing market is warm edge

NA vs OTHER MARKET

UK Market

- UK is 10-15% Triples
  - mainly in residential
- Primary driver for triples is acoustics

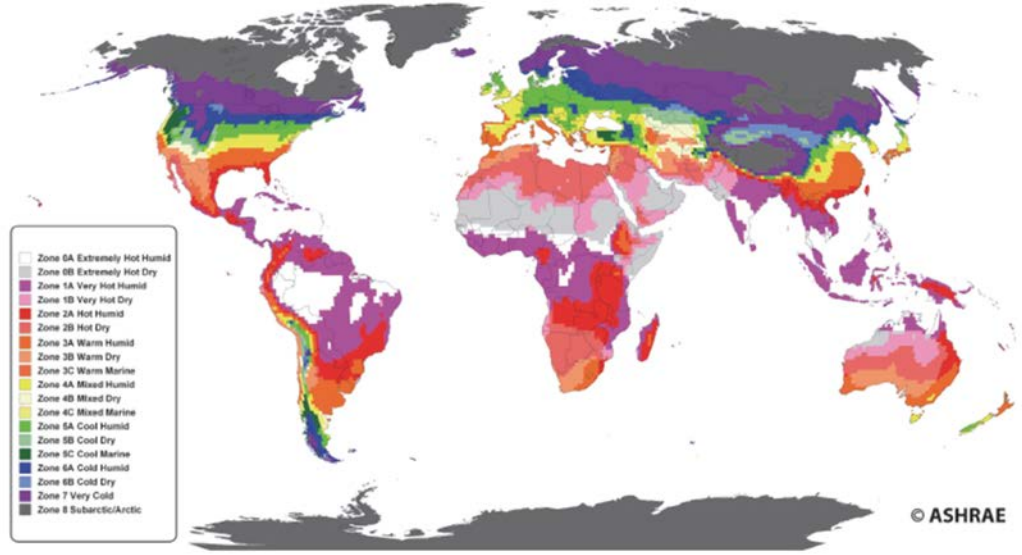


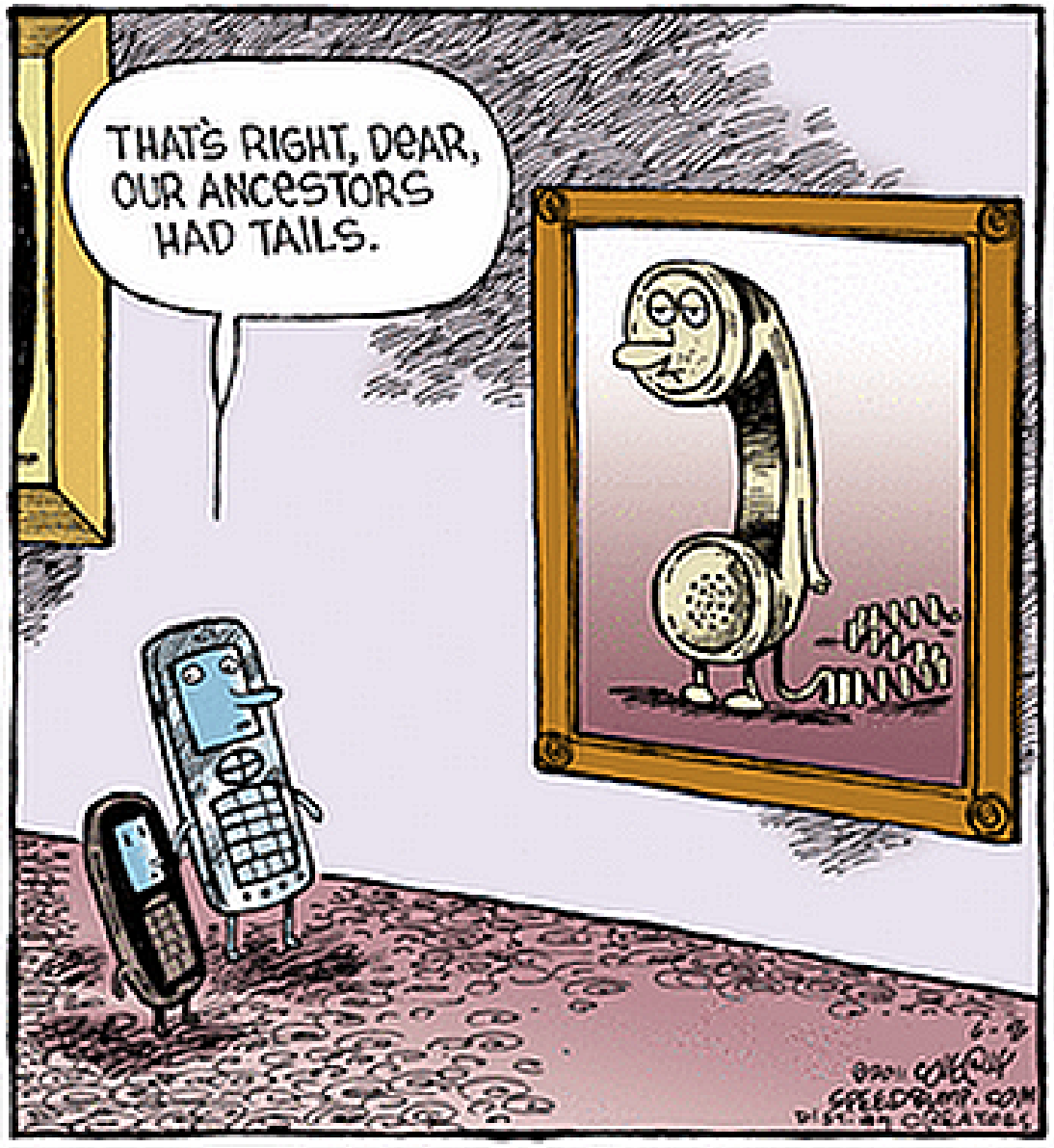
FIGURE C-2 World climate zones map.

- Majority of manufacturers are using warm edge, argon, low E and high performance framing to meet code vs triples

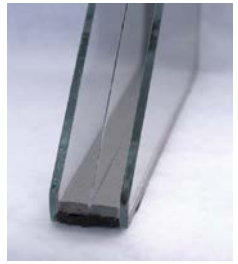
NA vs OTHER MARKET

Manufacturing perspective

- EU- Labor, energy cost drive investment in vertical automation for small, medium and large fabricators
- Small, medium US fabricators have been less likely to invest in automation (lack of perceived ROI)



production



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Thirsty Thursday

August 22, 2019

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