



## Residential Energy Efficiency Stakeholder's Meeting March 16-18, 2011 - Atlanta, Georgia

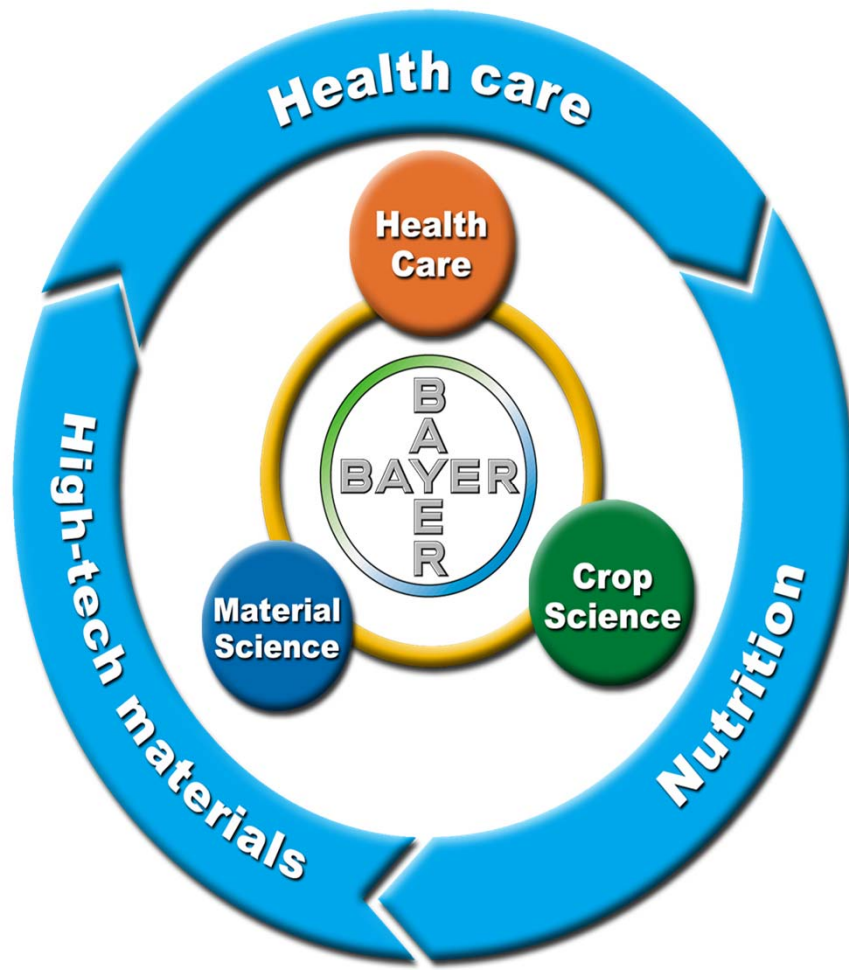


### **Designing Low Air Leakage Homes Insulated with Spray Polyurethane Foam**

Spray polyurethane foam combines dual attributes of insulation and air barrier, making it a material of choice when a low blower door result is desired. Bayer MaterialScience is developing design solutions for congruent use of SPF with other building materials and components to create a high performance building envelope.

**Jim Lambach** – Manager, BMS Spray Insulation Technology & Technical Marketing

# Bayer Companies



## Science For A Better Life



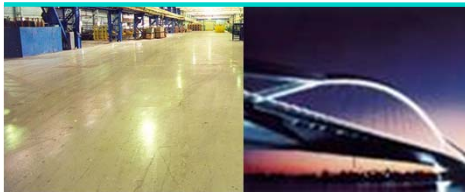
# Bayer MaterialScience

## High-tech Polymers, Innovative Solutions

### Basic Chemicals



### Coatings, Adhesives, Sealants



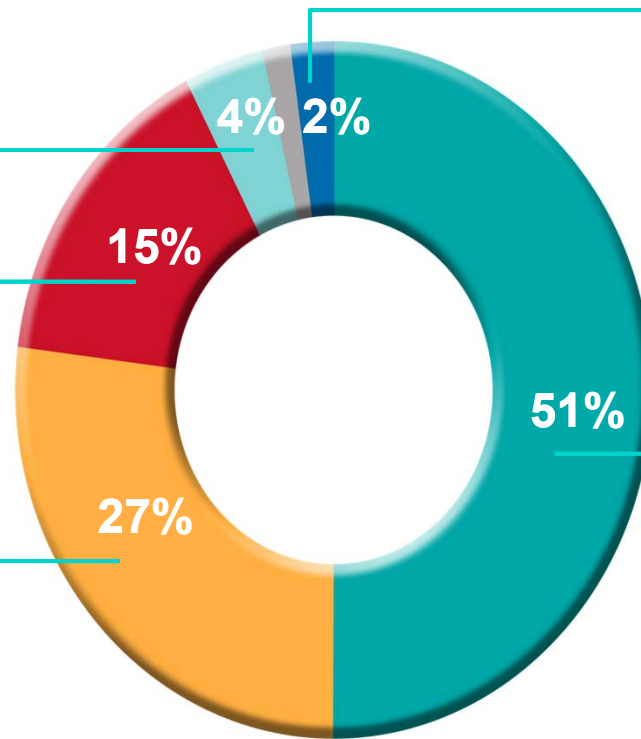
### Polycarbonates



### Thermoplastic Polyurethanes



### Polyurethanes



# Bayer MaterialScience

## Participation in the Construction Segment

### **Daylighting**

*windows, skylights*

single, multi-wall sheet  
diffuser sheet  
pultruded lineals  
encapsulated framing

### **Sustainable Energy**

*photovoltaic, geothermal*

encapsulant film  
pultruded lineals  
water pillow tanks

### **Insulation**

*roof, walls, floors*

SPF insulation  
SPF roofing  
polyiso board  
Refrigerators  
Water heaters

### **Artificial Illumination**

*LED lighting systems*

optics & lenses  
covers & housings  
diffuser film

### **Smart Grid**

*charging stations, smart meters*

housings, covers  
displays  
plugs

### **Indoor Environment Quality**

*efficient, low emission formulations*

coatings, adhesives, sealants  
OSB binders, SPF insulation



# Focused on Implementing Sustainable Manufacturing Practices

<b>KEY ECOLOGICAL DATA</b>	<b>2008</b>	<b>2009</b>
<b><u>USE OF RESOURCES</u></b>		
• Energy use (in petajoules)	82.8	77.3
• Water use (in MM m <sup>3</sup> /day)	1.20	1.11
<b><u>EMISSIONS</u></b>		
• Direct greenhouse gas emissions (CO <sub>2</sub> equiv. in MM tons)*	5.09	4.57
• Indirect greenhouse gas emissions (CO <sub>2</sub> equiv. in MM tons)*	3.57	3.53
• VOC emissions (in kt p.a.)	3.16	2.59
• Total phosphorus in wastewater (in kt p.a.)	0.78	0.74
• TOC in wastewater (in kt p.a.)	1.59	1.35
• Total nitrogen in wastewater (in kt p.a.)	0.67	0.64
<b><u>WASTE</u></b>		
• Hazardous waste generated (in kt p.a.)	365	375
• Hazardous waste landfilled (in kt p.a.)	81	89

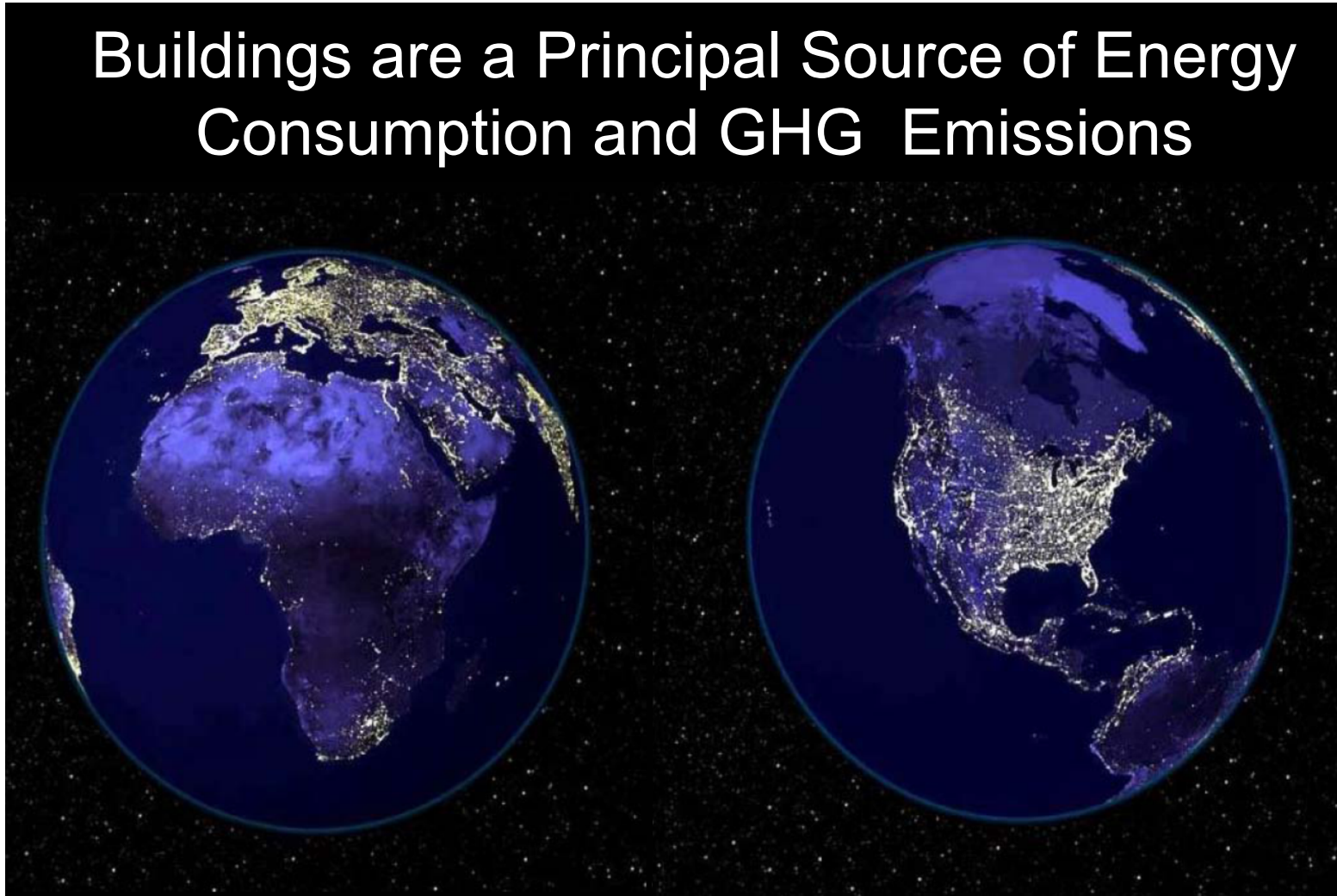
*\*Portfolio adjusted as per Greenhouse Gas Protocol*



# Committed to Developing Sustainable Building Technologies



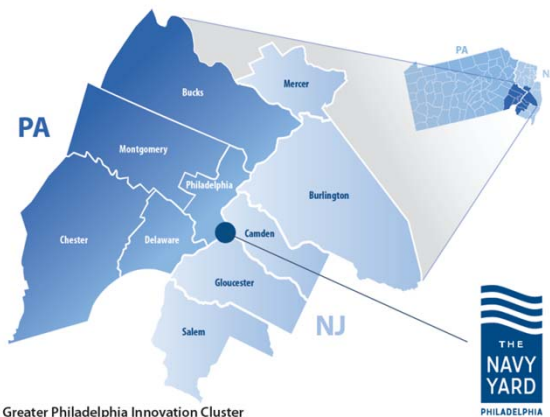
Buildings are a Principal Source of Energy Consumption and GHG Emissions



# DOE Hub Member

## **GPIC** | Greater Philadelphia Innovation Cluster for Energy Efficient Buildings

- Transform building industry from fragmented approaches to an integrated systems approach.
- Improve energy efficiency & operability & reduce carbon emissions of new & existing buildings.
- Stimulate private investment & quality job creation in the Greater Philadelphia region & beyond.

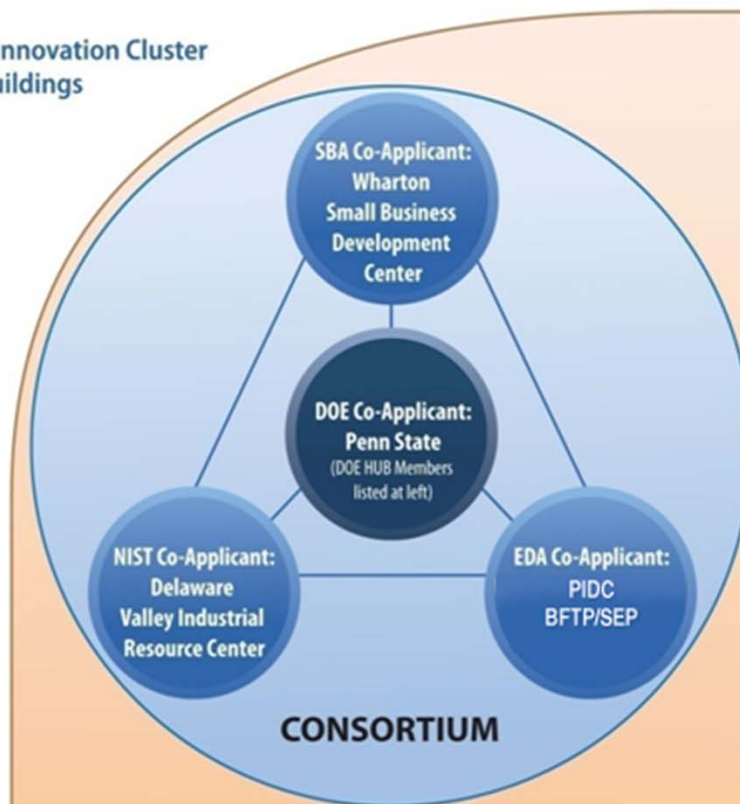


### Strategic Focus

Full-spectrum retrofit of existing average size commercial & multi-family residential buildings.

### DOE HUB Members

Penn State (lead)  
 Bayer Material Science  
 Ben Franklin Technology Partners of SE PA  
 Carnegie Mellon University  
 Collegiate Consortium  
 Delaware Valley Industrial Resource Center  
 Drexel University  
 IBM Corporation  
 Lawrence Livermore National Laboratory  
 Morgan State University  
 New Jersey Institute of Technology  
 Philadelphia Industrial Development Corporation  
 PPG Industries  
 Princeton University  
 Purdue University  
 Rutgers University  
 Turner Construction  
 United Technologies Corporation  
 University of Pennsylvania  
 University of Pittsburgh  
 Virginia Tech  
 Wharton Small Business Development Center



### GPIC Stakeholder Groups

- Local STEM Community
- Apprenticeship Programs
- Secondary Schools
- Career and Technical Institutes
- One-Stop Career Centers
- Workforce Investment Boards
- Community Organizations
- Local and State Agencies
- Economic Development Agencies
- Philanthropic Foundations
- Venture Capitalists
- Banks and Financial Institutions
- Publicly and Privately Held Businesses
- Industry Associations
- Labor Organizations

### GPIC Partners

#### Industry Partners

- Air Products and Chemicals
- ALSTOM Power
- Ametek
- Armstrong World Industries
- Boeing Company
- C.B. Richard Ellis
- CertainTeed Corporation
- Construction Specialties
- Deloitte Services LP
- Dow Chemical Company
- DuPont Building Innovations
- Flad Architects
- HOK
- Horton Lees Brogden Lighting Design
- Johns Manville
- Lafarge
- Lam Partners
- Larson Design Group
- Linc Lighting and Electrical
- Lockheed Martin
- PECO
- Pfizer Global Engineering
- PJM Interconnection
- Pittsburgh Corning
- Rose Companies
- Saint-Gobain
- Sauer, Inc
- Schneider Electric
- Siemens
- Thornton-Tomasetti Group
- URS Corporation
- Viridity Energy
- Weber Murphy Fox, Inc.

#### Industry Associations

- AIA Philadelphia
- Alliance to Save Energy
- Center for Environmental Innovation in Roofing
- CEO Council of Growth
- Chamber of Commerce Southern New Jersey
- Cleantech Alliance Mid Atlantic
- Delaware Valley Green Building Council
- Greater Philadelphia Chamber of Commerce
- National Electrical Manufacturers Association
- New Jersey Technology Council
- Sustainable Business Network of Greater Philadelphia
- World Business Council for Sustainable Development
- World Trade Center of Greater Philadelphia

#### Education and Workforce Partners

- Bucks County Workforce Investment Board
- Camden County Workforce Investment Board
- Chester County Workforce Investment Board
- Delaware County Workforce Investment Board
- Franklin Institute
- Garrison Institute
- Greater Philadelphia Regional Compact for STEM Education
- Liberty Science Center
- Montgomery County Workforce Investment Board
- Philadelphia County Workforce Investment Board

#### Banking and Finance Partners

- Emerald Stage2 Ventures
- Minority Angel Investor Network
- Mid-Atlantic Angel Group

#### Community and Economic Development Partners

- Economy League of Greater Philadelphia
- Citizens for Pennsylvania's Future
- Select Greater Philadelphia
- University City Science Center

#### Government Partners

- Commonwealth of Pennsylvania
- Delaware Valley Regional Planning Commission
- City of Philadelphia
- Naval Surface Warfare Center Carderock Division
- New Jersey Economic Development Authority

#### Labor organizations

- National Roofing Contractors Association
- Penn-Del-Jersey Chapter of NECA

#### Philanthropic Foundations

- William Penn Foundations

#### International Partners

- Lund University, Sweden
- Tsinghua University, China



# EcoCommercial™ Building Network



**We're building a collaborative network that brings together innovative products and services to make sustainable, environmentally-friendly, and profitable building solutions possible.**

## Customized Concepts

- Innovative product & service solutions
- Energy-based concept implementation
- Material & technology solutions

## Analytical Consulting

- Analytical tools
- Energy & ecology metrics
- Certification assistance

## Financial Consulting

- Target value design
- Cost assessment & efficiency
- Financing & funding processes

# Introduction of the High Performance Residential Program



- Whole house energy solution built on the unique insulation and air sealing performance of spray polyurethane foam.
- Comprehensive, cost effective approach to producing energy efficient, healthy, and comfortable homes.
- Standards and Guidelines used during design phase overlay the builder's performance targets within a high performance framework.



# Builder Listening Events

## Industry Input Prior to Launch



- **Conducted one-on-one meetings with cross-section of builders.**
  - Purpose: Gather input on cost and value of program. Learn more about challenges to implementation and support needed.
  - Senior management involvement in ~70% of interviews.
  - Nearly 80% of are building some type of energy efficient product.
- **General builder interviews also conducted through the Alliance.**
  - Purpose: Determine business challenges. Identify topics of interest and help needed.



# Builder Listening Events – Bayer

## Key Feedback



- **Value in SPF solution exists, but buyers need to be educated on “cost of ownership”.**
- **Providing help in the design process is important.**
- **Need better process and communications with trade contractors.**
  - Need standardized installation times for SPF.
  - Need to better understand direct costs for installation.
  - Education needed on building science fundamentals with SPF.
  - Concerns over availability of skilled labor and scheduling.

**Business Processes and Approach are as Important as Technology to Achieve Higher Standard**



# Builder Listening Events – Alliance



## Key Feedback

- **Builders still need help understanding how to look at whole house design as performance targets continue to change (ENERGY STAR, codes).**
- **The process of engaging internal and external teams, implementing new standards, and managing change is an even bigger challenge.**
- **Bottom line: It has to be cost-effective. Homebuyers need to understand the value.**

**Business Processes and Approach are as Important as Technology to Achieve Higher Standard**



The Standards & Guidelines are adapted from Building America's Builders Challenge and ENERGY STAR.

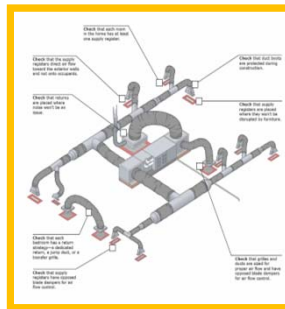
Several unique additions are focused on building science considerations for homes with very low air leakage.

### Building Enclosure



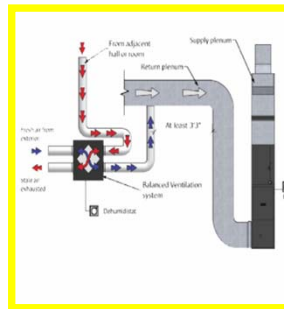
The building enclosure of all homes in the program will utilize Spray Polyurethane Foam Insulation

### Heating & Cooling



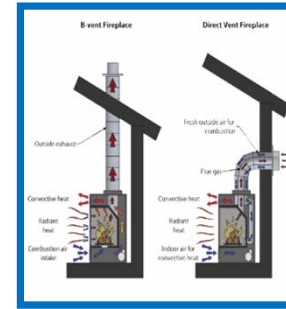
All homes are **REQUIRED** to have their heating and cooling system right-sized

### IAQ & Ventilation



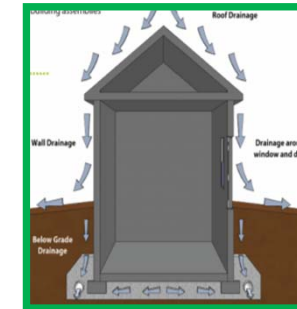
All homes are **REQUIRED** to have ventilation that meets ASHRAE 62.2

### Appliance, Lighting, Etc



All homes are **REQUIRED** to have ENERGY STAR equipment and be combustion fuel safe.

### Water Management



All homes are **RECOMMENDED** to be risk free of all water intrusion issues.

- Energy Modeling with RESNET<sup>®</sup> Approved Software
- EnergySmart Home Scale<sup>SM</sup> Used for Reporting
- No Specific HERS Target ... Builder Defines
- Builder Optional Energy Usage Guarantee



# Utilization of Spray Polyurethane Foam is Required by the Program



Multi-Functional Material in the Energy Efficiency Toolkit



Expands to fill and seal any shape

Adheres to most substrates

Class I installation in architecturally complex thermal envelope

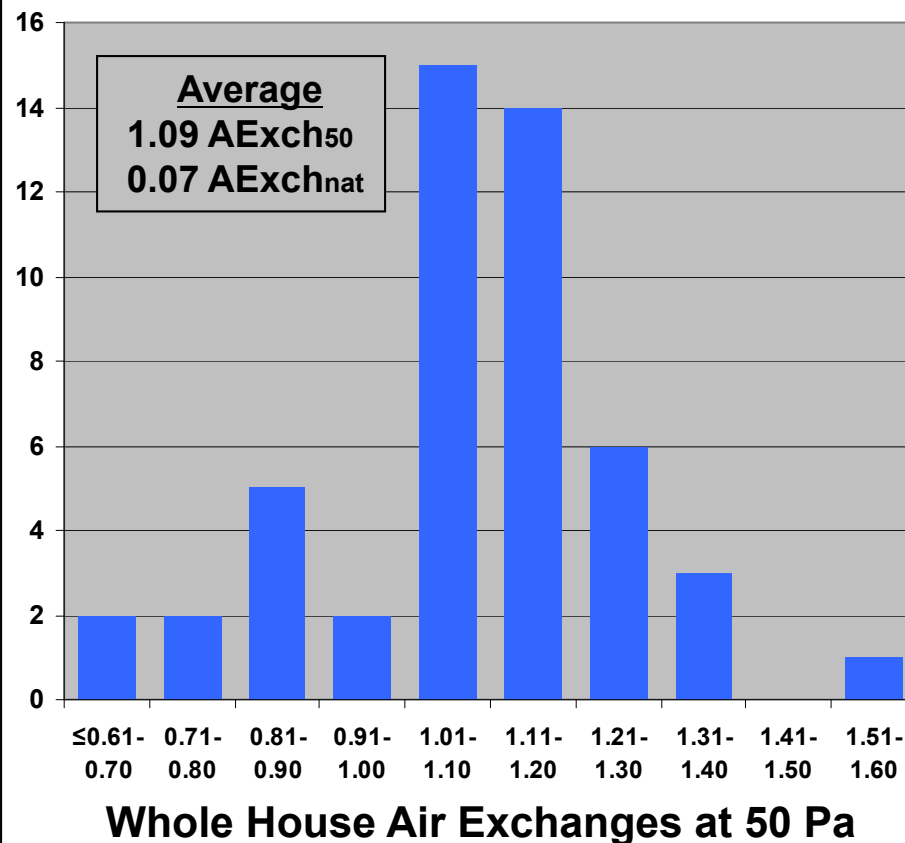
oc and cc-SPF are air-impermeable

cc-SPF high R-value per inch and functions as a vapor retarder

Applications:

- walls - between studs or c.i.
- under roof deck or attic floor
- Basement and crawlspace ceiling or walls
- base and sill plates, etc.

## 50 Production Homes Sealed with SPF and Caulking

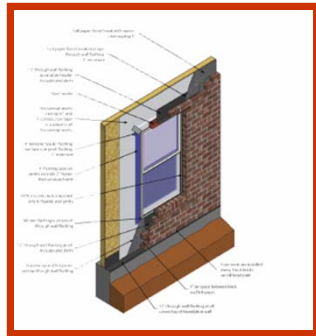




# Standards and Guidelines

## Building Enclosure

### Thermal and Moisture Management



## WALLS

- Two Options:
  1. SPF-only application
  2. Hybrid with blown-in fiberglass or cellulose
- Specified insulation minimums by climate zone for SPF-only
- Climate zone specific calculation tool confirms that dew point is located within the SPF for hybrid solutions
- Unvented crawlspaces recommended
- Sill and band joists, floors over garages, and cantilever floors must be SPF-only

### Thermal Enclosure and Moisture Management

#### REQUIREMENT / SPECIFICATION

1. Complete the High Performance Residential Program Insulation and Air Barrier Checklist for the home. A link to this checklist is listed on the High Performance Residential Program™ [http://www.bayer.com/...](http://www.bayer.com/)
2. Builder must keep signed copy of the Insulation and Air Barrier Checklist in builder's project records. Either builder or third-party verifier may complete the checklist.
3. Third-party verifier must confirm that a signed Insulation and Air Barrier Checklist has been completed.

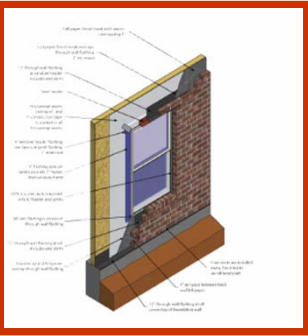
### Option 1

**Table 1. Minimum Amount of Spray Foam Required**

**Based on Compliance with IECC 2009 Energy Cost Performance Path**

Other insulation packages must be designed by the Bayer representative to ensure IECC 2009 Code Compliance

System/ Climate Zone	CZ 1	CZ 2	CZ 3	CZ 4 Except Marine	CZ 5 and Marine 4	CZ 6	CZ 7	CZ 8	
Exterior Wall Cavity	OC – Min 3 inches	OC – Min 3 inches	OC – Min 3 inches	OC – Min 3 inches	OC – Min 3 inches	OC – Min 3 inches	OC – Min 5 inches	OC – Min 5 inches	
	CC – Min 2 inches	CC – Min 2 inches	CC – Min 2 inches	CC – Min 2 inches	CC – Min 2 inches	CC – Min 2 inches	CC – Min 3 inches	CC – Min 3 inches	
Band Joist Cavity	OC – Min 3 inches	OC – Min 3 inches	OC – Min 3 inches	OC – Min 3 inches	OC – Min 3 inches	OC – Min 3 inches	OC – Min 5 inches	OC – Min 5 inches	
	CC – Min 2 inches	CC – Min 2 inches	CC – Min 2 inches	CC – Min 2 inches	CC – Min 2 inches	CC – Min 2 inches	CC – Min 3 inches	CC – Min 3 inches	
Class II Vapor Retarder	Not required	Not required	Not required	Not required	Not required	Not required	REQUIRED for Open Cell Foam	REQUIRED for Open Cell Foam	REQUIRED for Open Cell Foam



# Standards and Guidelines

# Building Enclosure



## Windows

### WINDOWS

Window performance very similar to ENERGY STAR, except for the introduction of the condensation resistance (CR) rating.

The CR rating reduces the risk of selecting a poor performing window in a cold winter environment when condensation can occur.

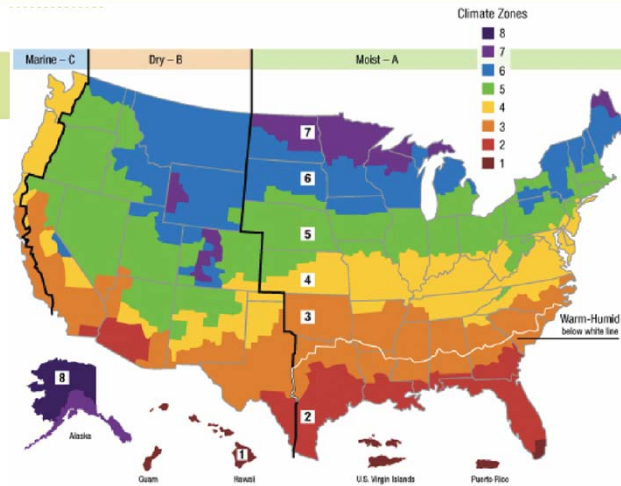
### Windows

#### REQUIREMENT / SPECIFICATION

1. Specify windows and glass doors according to Table 4.1 below. Verify that no aluminum windows without thermal breaks have been specified for this project. Verify installation of specified window units.

**Table 4.1 High Performance Residential Program Performance Ratings by Zone**

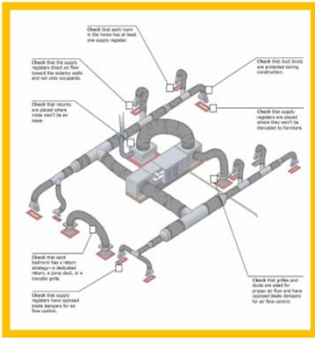
	CZ 1	CZ 2	CZ 3	CZ 4 A, B	CZ 4C; CZ 5	CZ 6	CZ 7	CZ 8
U-Value	.60	.60	.35	.32	.30	.30	.30	.30
Skylight U-Value	.75	.75	.65	.60	.60	.60	.60	.60
SHGC	.27						.40	.40
Condensation Resistance (CR)	40 or greater						50 or greater	50 or greater



# Standards and Guidelines

## Heating & Cooling

### Air Handler and Ductwork Location and Duct Leakage



## DUCTWORK

All ductwork inside the thermal boundary

Tight ductwork ensures that all conditioned air is being retained in the house and the demand in each room is being satisfied with a correct amount of air.

#### Air Handler and Ductwork Location and Duct Leakage

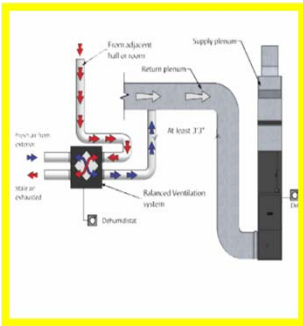
##### REQUIREMENT / SPECIFICATION

1. Air handler equipment and all duct work shall be located within the conditioned envelope of the house. Total measured duct leakage must be  $\leq 6\%$  of conditioned space floor area when measured at 25 Pascal's using duct pressurization methods.
2. Duct boots sealed to floor, wall, or ceiling using caulk, foam, mastic tape, or mastic paste.



# Standards and Guidelines IAQ & Ventilation

## Whole Building Mechanical Ventilation



### VENTILATION

Balanced ventilation approach insures the amount of fresh air introduced into the home is equivalent to the amount of stale air being removed.

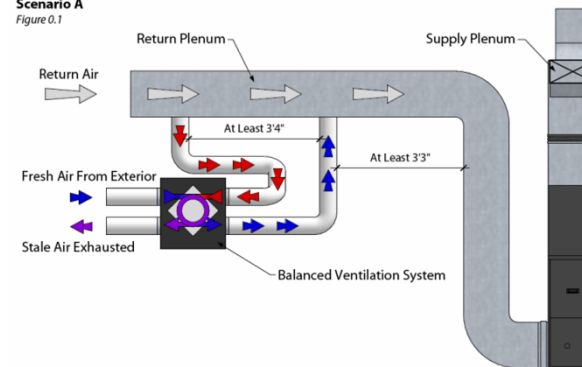
The balanced ventilation system can also be installed independently from the main HVAC air handler.

### Whole Building Mechanical Ventilation

#### REQUIREMENT / SPECIFICATION

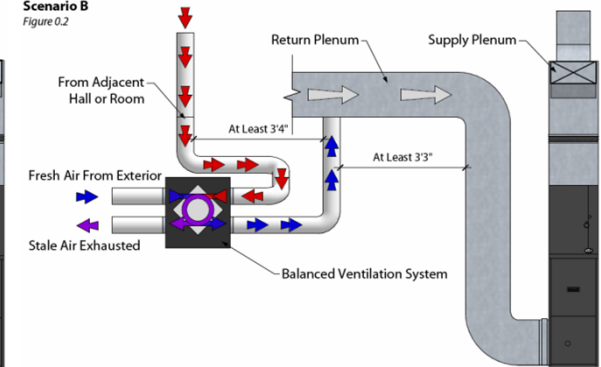
1. Design and install a mechanical system(s) compliant with ASHRAE 62.2 to provide outside air to the indoor environment through a balanced ventilation system or a central dehumidification ventilation system.
2. Equip outside air intakes for ventilation with filters and shutoff dampers.

Tied-in Balanced Ventilation System  
Scenario A  
Figure 0.1



Option A ERV or HRV, streams of air are not mixing in the distribution box.

Tied-in Balanced Ventilation System  
Scenario B  
Figure 0.2

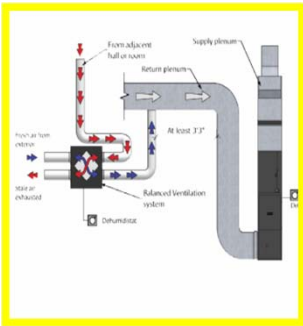


Option B Distribution box, streams of air are mixing in the distribution box.

# Standards and Guidelines

## IAQ & Ventilation

### Dehumidification



## DEHUMIDIFICATION

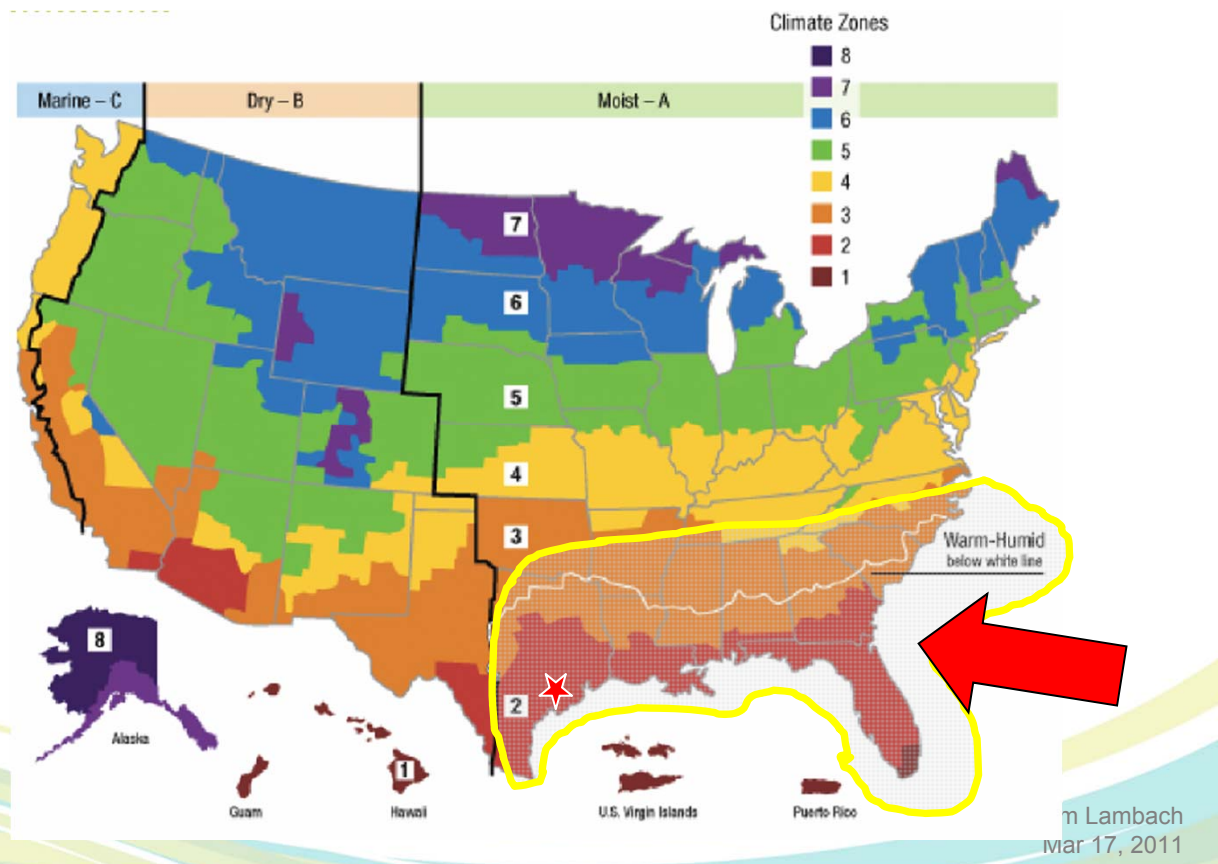
A climate zone specific humidity analysis tool estimates number of days when indoor humidity exceeds 60%.

If humidity cannot be controlled supplemental dehumidification is recommended - - typically needed in warm humid regions of climate zones 1, 2 and 3.

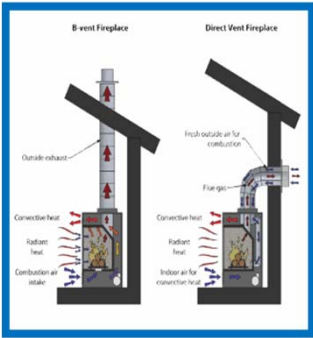
### Dehumidification

#### REQUIREMENT / SPECIFICATION

1. Install equipment with sufficient latent capacity to maintain indoor relative humidity at or below 60% in Climate Zones 1, 2, 3 and 4, as defined by the 2009 IECC Figure 301.1.



# Standards and Guidelines Appliances, Lighting Fireplaces



## DIRECT VENT FURNACES

Direct venting eliminates potential back drafting concerns.

### Fireplaces

#### REQUIREMENT / SPECIFICATION

1. Direct vent fireplaces or Electric fireplaces requires no additional ventilation requirements.
2. Atmospherically vented fireplaces must follow the ventilation requirements.
  - a. Wood burning fireplaces or B-vented fireplaces are allowed only if they have combustion air from outside to the firebox & the firebox is equipped with gasketed doors.
  - b. Wood burning and B-vent fireplaces are only permitted to have a combustion air duct from the outdoors supplied by a rigid sheet metal duct to the firebox.
  - c. All wood burning fireplaces or B-vented fireplaces require a fresh air make up air duct supplied to the home by a 6" duct with a barometric damper. Note: *if kitchen ventilation requires dedicated makeup air to the home than this requirement does not apply.*



Barometric Damper for  
make up air



B-Vent Gas Fireplace



Direct Vent Gas Fireplace

# High Performance Contractor Network

- Health and Safety Training, Occupancy Guidelines, SPF Application Techniques
- Quality Manual/Checklists
- Building Science Education
- Prepared to Support High Volume Builders
- One-Day-Complete for Typical Size Home

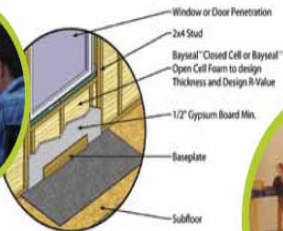


# Roadmap for Production Builders

## Your High-Performance Road Map

### 1 Planning & Development high-performance

- Strategic Planning
- High-Performance Change Management Process
- Builder Performance Target



### 2 Design & Specification customized whole-house solutions

- Standards & Guidelines Achievement
- SPF System Specification
- Home Energy Performance Modeling
- HVAC Design Optimization

### 3 Construction one day, complete!

- Builder Team Training
- Certified Quality Contractor Program
- Home Performance Testing



### 4 Marketing & Sales home buyer value creation

- Marketing Collateral
- Sales Team Training



### 5 Customer Care guaranteed advantage

- Bayer Limited Heating/Cooling Guarantee\*
- Homeowner Guide
- Energy Meter



\* Limited guarantee is subject to participation in the Bayer MaterialScience High Performance Residential Program and compliance with the terms and conditions of the guarantee. Call 800-221-9626 for details.





# Residential Energy Efficiency Stakeholder's Meeting

## March 16-18, 2011 - Atlanta, Georgia



### Designing Low Air Leakage Homes Insulated with Spray Polyurethane Foam

Spray polyurethane foam combines dual attributes of insulation and air barrier, making it a material of choice when a low blower door result is desired. Bayer MaterialScience is developing design solutions for congruent use of SPF with other building materials and components to create a high performance building envelope.

**Jim Lambach** – Head, Spray Insulation Technology and Technical Marketing