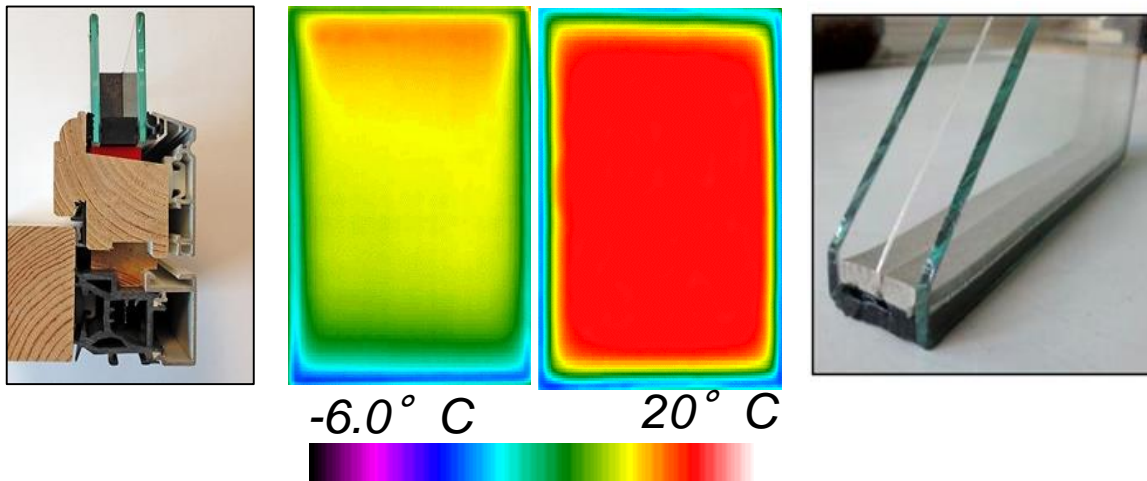


High-R Window Field Validation



Pacific Northwest National Laboratory

In collaboration with Lawrence Berkeley National Laboratory

In partnership with University of Minnesota, Birch Point Consulting, and Efficiency Solutions

Katie Allen Cort, Senior Economist

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Project Summary

Timeline:

Start date: 10/1/2018 – **New Project**

Planned end date: 9/30/2021

Key Milestones for this year

1. Develop advisory panel - 3/31/19
2. Conduct techno-economic analysis - 4/3/19
3. Design field study protocols as informed by techno-economic analysis and advisory panel – 8/11/19

Key Partners:

BirchPoint Consulting	University of Minnesota
Efficiency Solutions	Bonneville Power Administration

Budget:

Total Project \$ to Date:

- DOE: \$500,000

Total Project \$:

- DOE FY19: \$500,000
- DOE FY20: \$490,000
- DOE FY21: \$516,000

Project Outcome:

PNNL will conduct validation studies of high-R (>R-5) thin triple-glazed windows. A field study will be conducted that includes multiple homes, home types, and climate zones. The field study will be used to validate window performance as an individual measure and in terms of whole-house performance, peak load reduction, and system trade-offs.

Based on DOE residential characterization data (RECS 2015), there are about 115 million homes that would benefit from thermally improving window performance in their homes with high-R windows. The technical potential of doing so is estimated to be 2.3 quadrillion Btu in energy savings. This market-pull strategy, in combination with an innovation push on the windows industry, will help move the market toward meeting this potential.

Team

Pacific Northwest National Laboratory



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Efficiency Solutions



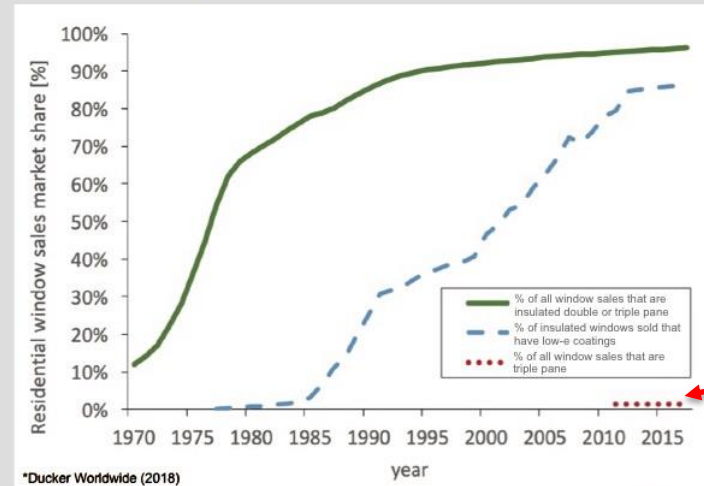
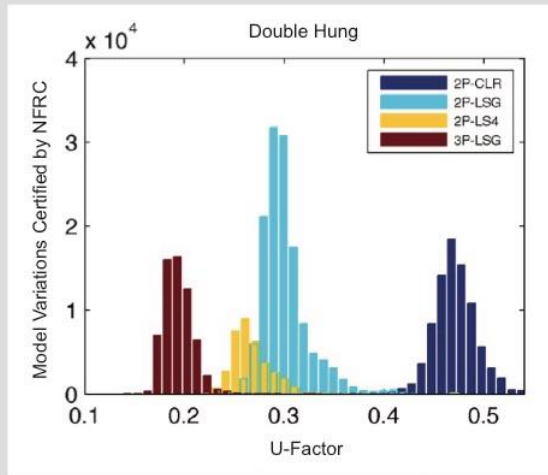
Greg Sullivan

Challenge



- ~\$25 billion annual residential HVAC costs attributable to heat transfer through windows
- Standard High-R triple-panes are
 - Too heavy
 - Too wide
 - Too expensive
- = Long return on investment and limited market uptake

Current State of Windows



Triple Pane

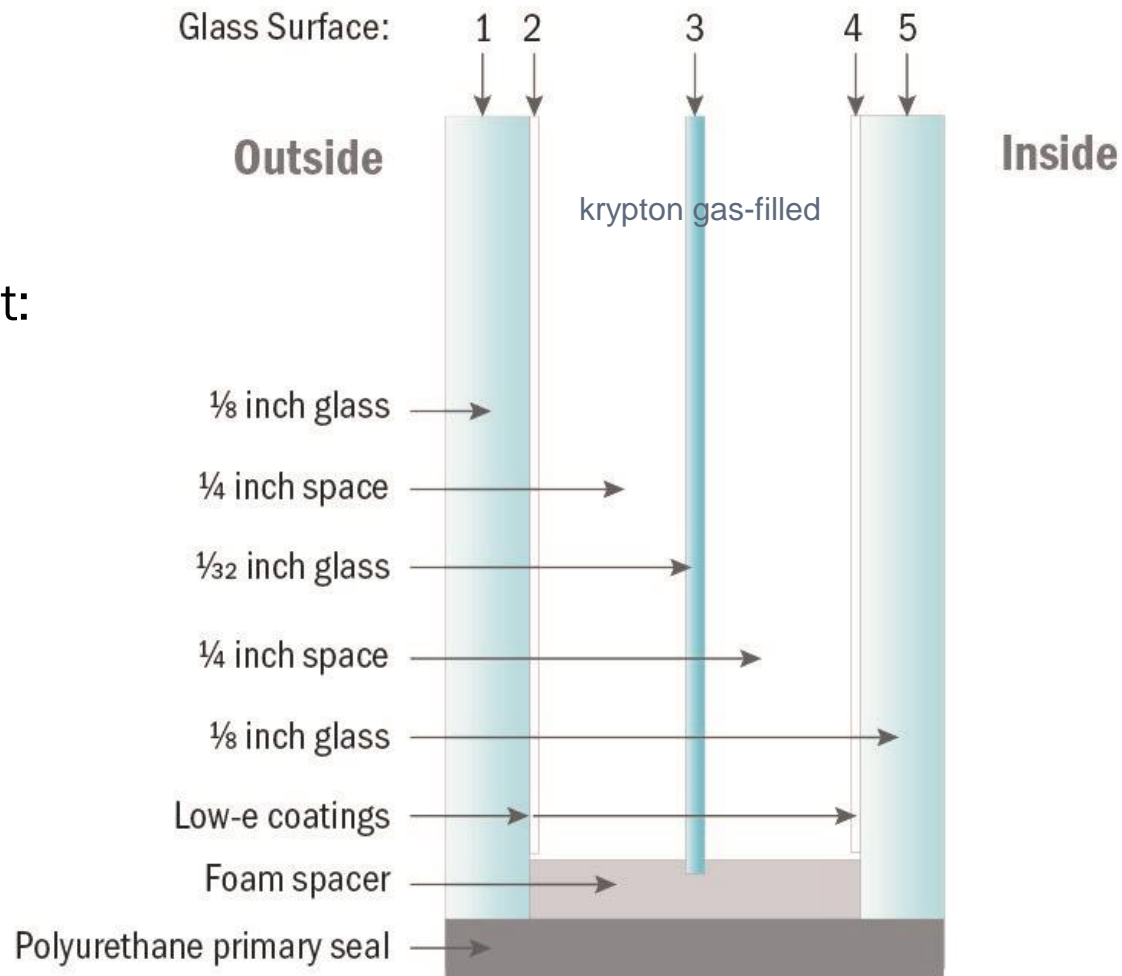
Of all double-hung window model variations certified by the NFRC, 11% are triple-pane models, but triple-pane windows constitute only 1% of total U.S. window sales! A drop-in replacement transformed the market from clear glass to low-e. Can a drop-in thin-triple transform the market from double-pane to triple-pane?

Approach: Supply Push – Demand Pull Strategy

Supply Push, Led by LBNL

- Work with manufacturers to drive development of “drop-in” replacement triple-pane insulated glass unit (IGU) that:
 - Doubles performance of IGU to R-8
 - Minimizes weight
 - Has same width as double-pane IGU
 - Low entry cost
 - Thin float glass
 - Krypton gas fill
 - Single foam spacer

Thin Triple-Pane IGU



Approach: Supply Push – Demand Pull Strategy

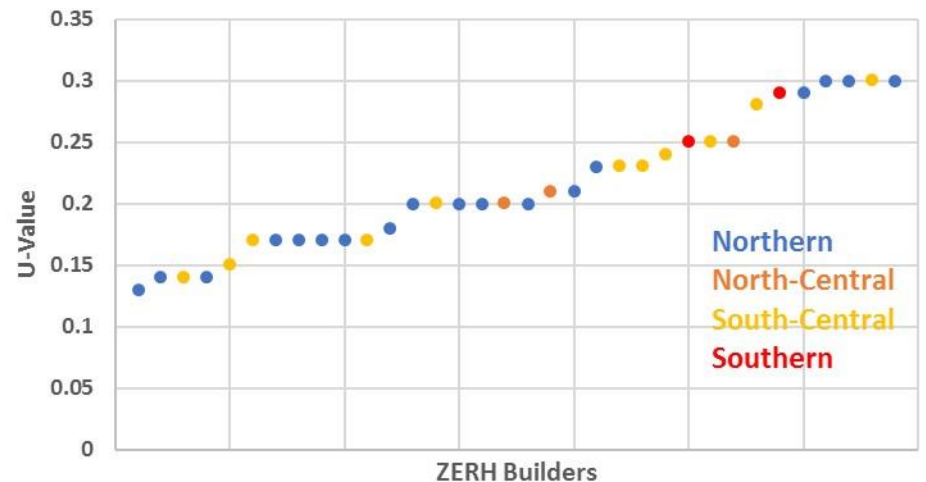
Demand Pull, Led by PNNL

- Conduct technology evaluations and economic and market analysis to inform field validation planning and approach
- Develop experimental plan and field protocol tests to assess costs, validate benefits and trade-offs
- Recruit strategic field study participants and partnerships
- Conduct field studies and quantify these values for consumers, builders, and utilities



Habitat Home, Kalamazoo, MI

U-Values for ZERH Builders, by ENERGY STAR Climate Zone



Approach and Near-Term Goals

Supply Push

- Manufacture and test thin-triple IGU
- Cost trajectory: < \$5/sf retail
- Potentially scalable with acceptable aesthetics

Demand Pull

- Analyze value proposition to builders and homeowner
- Explore utility incentives and rebates arrangements and research energy codes/rating angle
- Engage with key stakeholders to inform field validation

What are we Validating?

- **Costs in terms of:**
 - Material and upfront costs
 - Labor/installation
 - Supply chain (availability)
 - Drop-in feasibility
 - Trade-offs (envelope and HVAC)
- **Performance in terms of:**
 - HVAC savings
 - Grid system benefits/peak
 - HVAC design load
 - System trade-offs (envelope and HVAC)
 - Non-energy benefits (comfort, acoustics)
 - Condensation or other unintended consequences

Approach and Progress

Thin Triple Alpen Window

- Thin floating glass (center pane)
- Krypton gas fill
- U-factor = 0.19 (R-5.3)
- SHGC near 0.27
- 20-year warranty
- 50 sq. ft. size limit
- Lead-time for delivery about 1-2 months
- Relative cost = \$\$\$



Thin Glass WILL Change High Performance Windows



Date: Feb 27, 2019 Categories: [Awards & Recognition](#), [Commercial](#), [Energy Efficiency](#), [In the News](#), [Products](#)

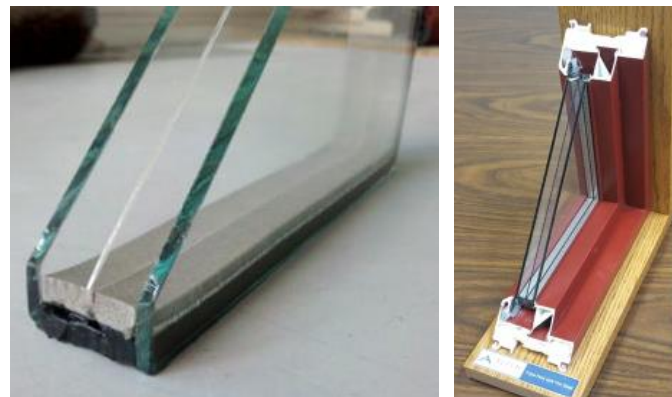


Photos courtesy of Alpen Windows

Approach and Progress

Alpen Windows manufacturing thin-triple as “drop-in” IGU

- Using an arrangement of a lower cost vinyl frame/sash and the thin-triple IGU, final window can be provided for an incremental cost of \$6/s.f.
- Demonstrated in Model Home in Fresno, California, using Anlin frame/sash and Alpen thin-triple
- Exploring arrangements with Alpen/Kensington Windows IGU/frame-sash combination for NYSERDA multi-family deep energy retrofit pilot

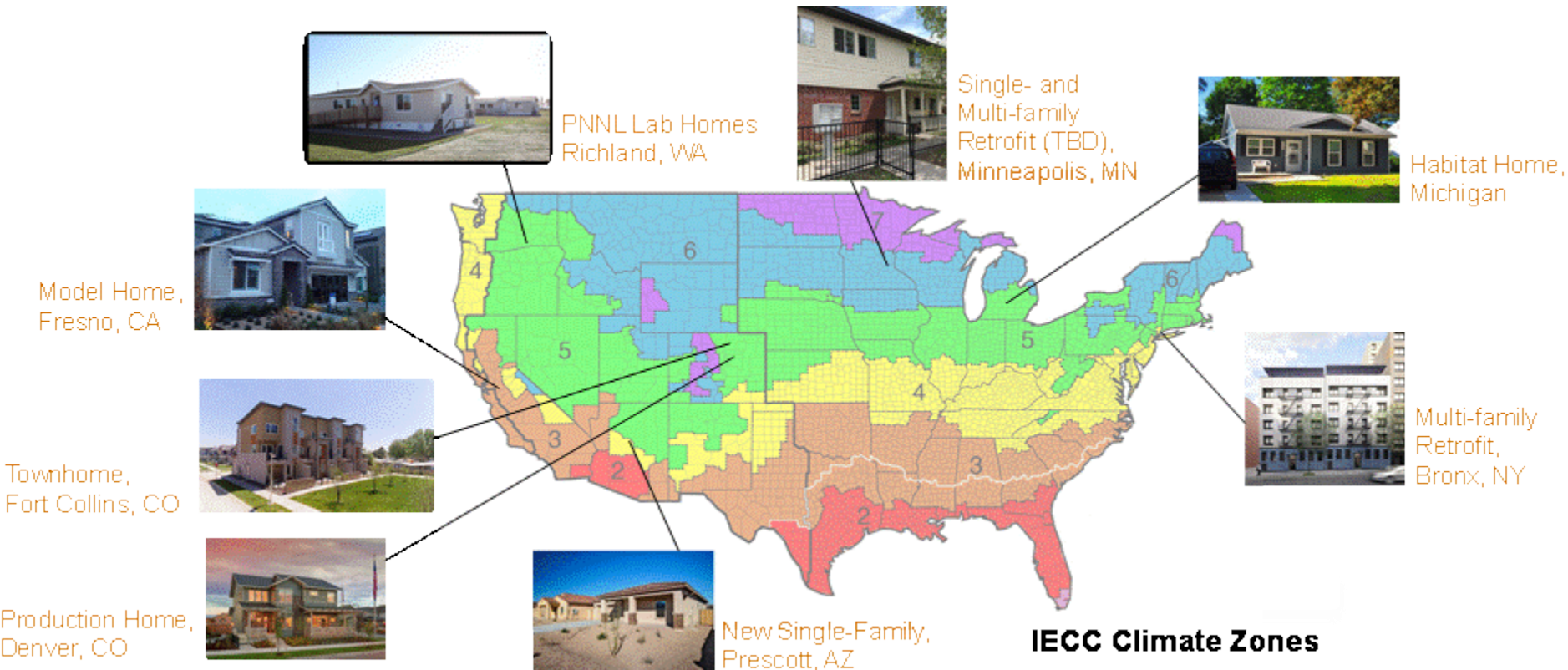


Model Home, Fresno, CA

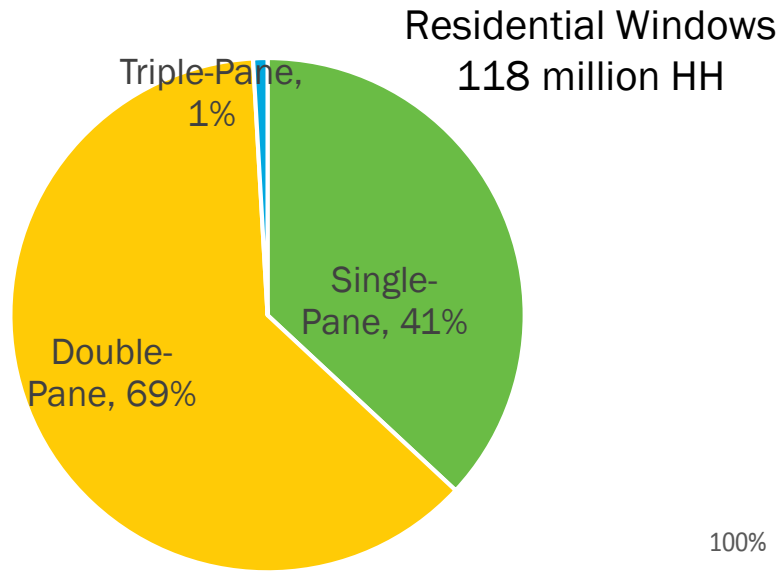
Progress

Recruiting in progress

- Multiple building types and climate zones secured



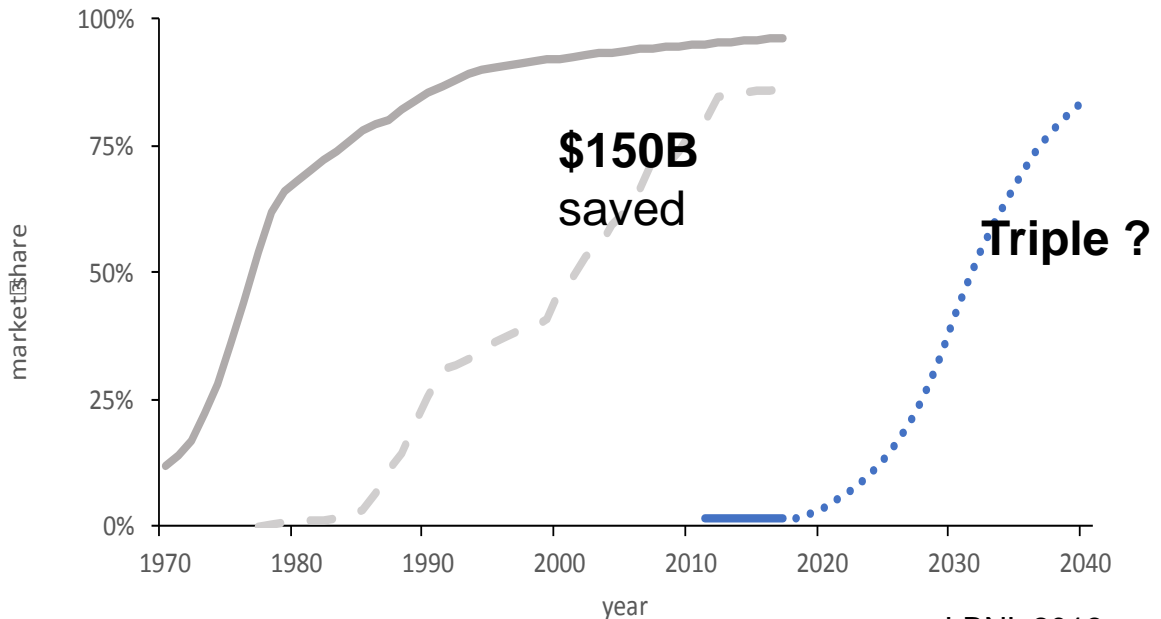
Impact



High-R Windows can impact:

- Residential HVAC energy use (current consumption ~4.8 QBtu)
- Summer cooling peak, load shape, grid impacts
- Winter peak heating and impact for electric heating

Technical Potential Savings of Highly Insulating Windows in Residential Sector = 2.3 Q Annual Energy
(Heating: 1.30 Q Cooling: .94 Q)



LBNL 2018

Stakeholder Engagement

Current Engagement

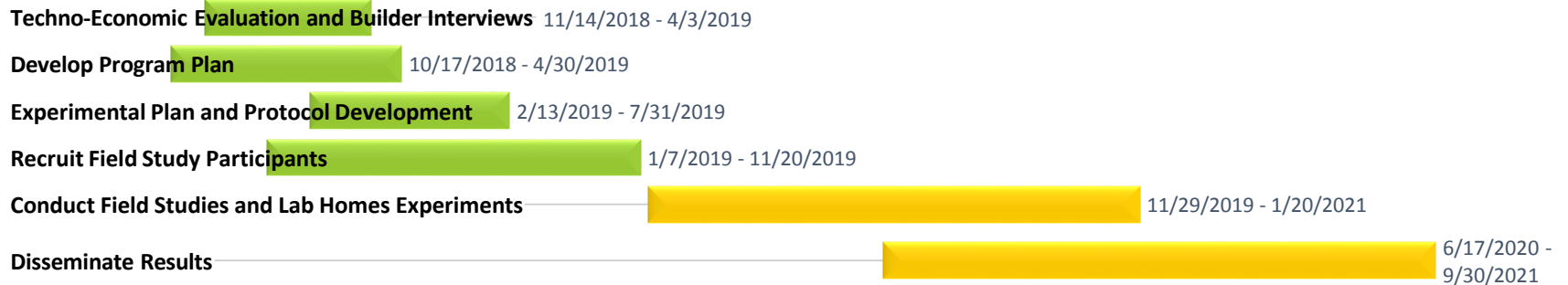
- Manufacturers
 - Alpen, Kensington, Anlin, Marvin, Anderson, Wasco, Cardinal
- High Performance Builders
 - Thrive, Mandalay, PhilGreen
- Utility and Energy Efficiency Program Managers
 - NEEA, BPA, NYSERDA, Benton County PUD, Xcel Energy
- Community Action and Low-Income Assistance
 - Minneapolis Public Housing Authority and Habitat Homes, Michigan Habitat,
- Codes, Ratings, and Energy Star
 - California Energy Commission, Zero Energy Ready Homes, Energy Star

Future Plans

- Solidify partnerships and help develop program pathways to high-R incentives and requirements
- Host strategic workshops and training sessions with manufacturers, builders, program planners and implementation teams

Remaining Project Work

- Solidify commitments from utilities, programs, and field validation partners
- Explore additional recruitment opportunities
- Develop field protocols and experimental plans
- Conduct field testing and experiments
- Document results
- Develop and execute information dissemination plan
- Conduct strategic workshops and training



Thank You

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REFERENCE SLIDES

Project Budget

FY19 Project Budget: 500k

Variances: None

Cost to Date: \$246.6k (including commitments)

Additional Funding: \$40k committed by BPA

Budget History

FY18 (none)		FY 2019 (current)		FY 2020 – FY2021 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
		\$500k	\$40k	\$1006k	TBD

Project Plan and Schedule

- On time and budget

