Better Buildings Residential Network Peer Exchange Call Series:

Going for Gold: Medal-Worthy Approaches to Energy Efficiency from Around the Globe

February 8, 2018

Call Slides and Discussion Summary

Agenda and Ground Rules

- Agenda Review and Ground Rules
- Opening Polls
- Residential Network Overview, and Upcoming Call Schedule
- Featured Speakers:
  - **Brian Dean,** International Energy Agency
  - **Gomathi Sadhasivan,** DNV GL – Energy
  - **Hui Ben,** University of Cambridge
  - **Diego Ponce de Leon Barido,** UC Berkeley
- Closing Polls and Announcements

Better Buildings Residential Network

Join the Network

Member Benefits:

- Recognition in media and publications
- Speaking opportunities
- Updates on latest trends
- Voluntary member initiatives
- Solution Center guided tours

Commitment:

- Members only need to provide *one number*: their organization's number of residential energy upgrades per year

Upcoming calls:

- February 15: New Tools in the Toolbox: A Fresh Take on Financing
- February 22: Kick the Cold: The Intersection of Healthy Homes and Energy Efficiency
- March 1: Making Energy Efficiency Affordable for Low-Income Communities
- March 8: Top Marketing Strategies to Diversify Your Customer Base

Peer Exchange Call summaries are posted on the Better Buildings website a few weeks after the call

For more information or to join, for no cost, email bbresidentialnetwork@ee.doe.gov, or go to energy.gov/eere/bbrn & click Join

Brian Dean
Lead – Energy Efficiency in Buildings
International Energy Agency

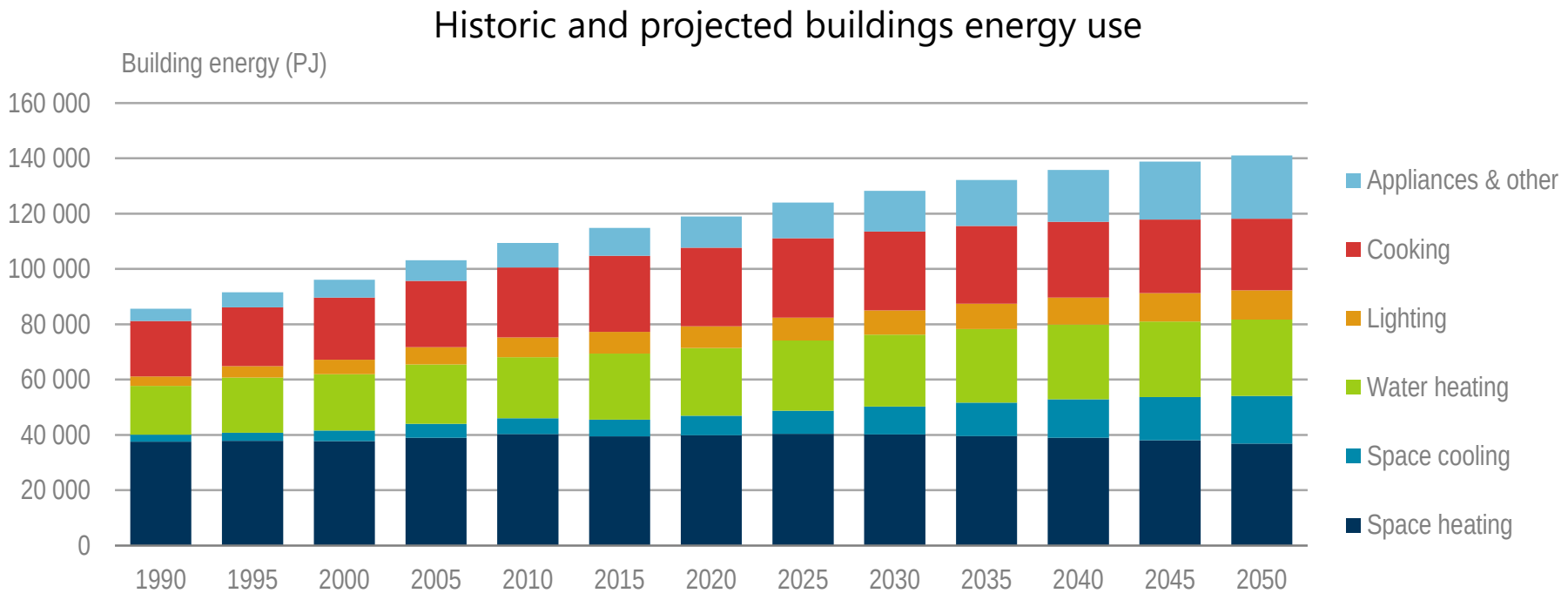
U.S. DEPARTMENT OF ENERGY

Perspectives on Global Energy Efficiency Approaches for Buildings

Brian Dean, International Energy Agency

February 2018

Building energy use: by end-use



www.iea.org/etp

Building energy use in business as usual scenario (RTS) is expected to increase further.

Buildings are not on track to meet 2DS objectives

Tracking Clean Energy Progress 2017

Buildings ↗

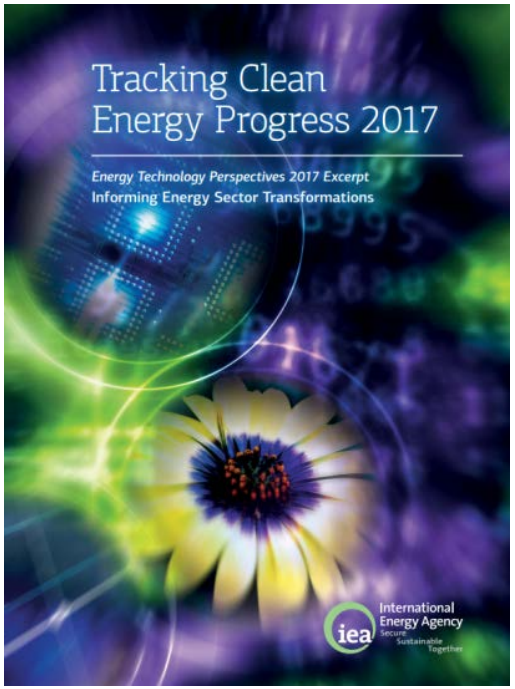
Recommendation for 2017: Countries can take immediate action to put forward commitments for low-carbon and energy-efficient buildings to implement their NDCs as a first step and a clear signal to scale up actions across the global buildings sector.

Building envelopes ~

Recommendation for 2017: Global cooperation should seek to ensure that all countries implement and enforce building energy codes and standards for both new and existing buildings, with improvement in enforcement and verification of codes and standards to overcome barriers to their implementation.

Lighting, appliances and equipment ↗

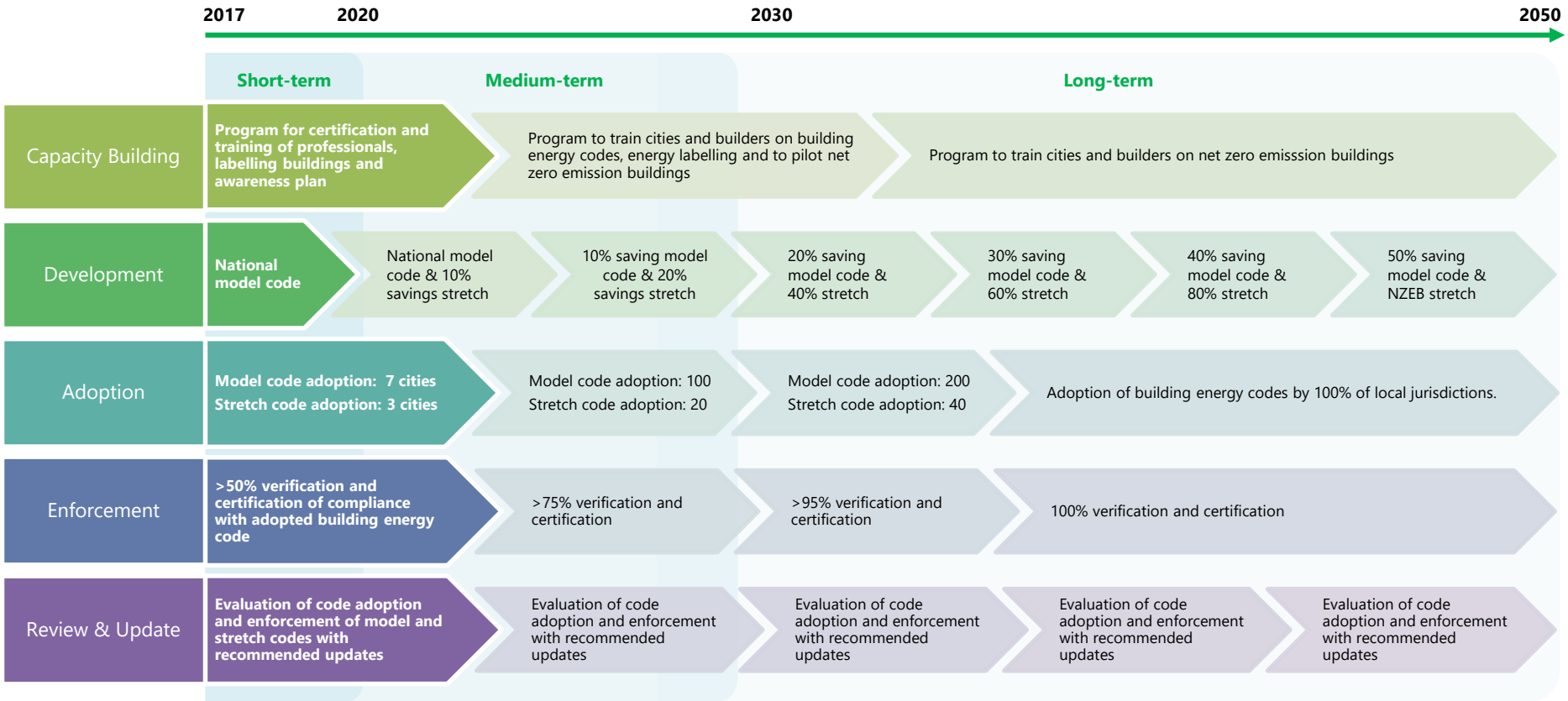
Recommendation for 2017: Countries should seize on momentum under the recent Kigali Agreement to rapidly move global markets for cooling equipment to much higher energy performances.



Source: IEA Energy Technology Perspectives 2017

Despite some positive developments in the last two years, more assertive action is still needed to put the global buildings sector on track.

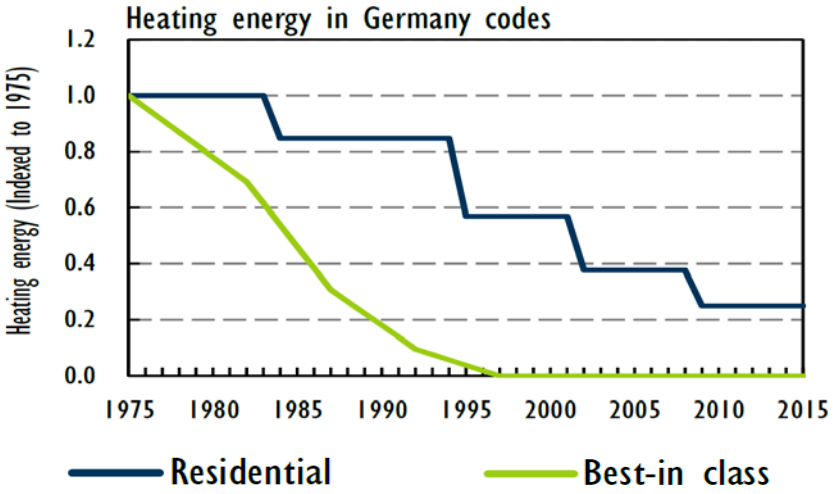
Mexico: Building energy codes roadmap



Source: Mexico and IEA

Germany: Building energy codes and investment

Increasing **regulation** and increasing **technology R&D** to achieve a 75% reduction in heating energy use from 1975-2015.



German government and KFW bank coordinate to increase energy efficiency through the retrofit of residential buildings (with nearly 20 billion per year invested).

- Loan
  - up to EUR 100,000 per housing unit for energy-efficient refurbishment
- Grant
  - 30.0 % for a KfW Efficiency House 55
  - 25.0 % for a KfW Efficiency House 70
  - 20.0 % for a KfW Efficiency House 85
  - 17.5 % for a KfW Efficiency House 100
  - 15.0 % for a KfW Efficiency House 115
- Tied to energy efficiency levels in code

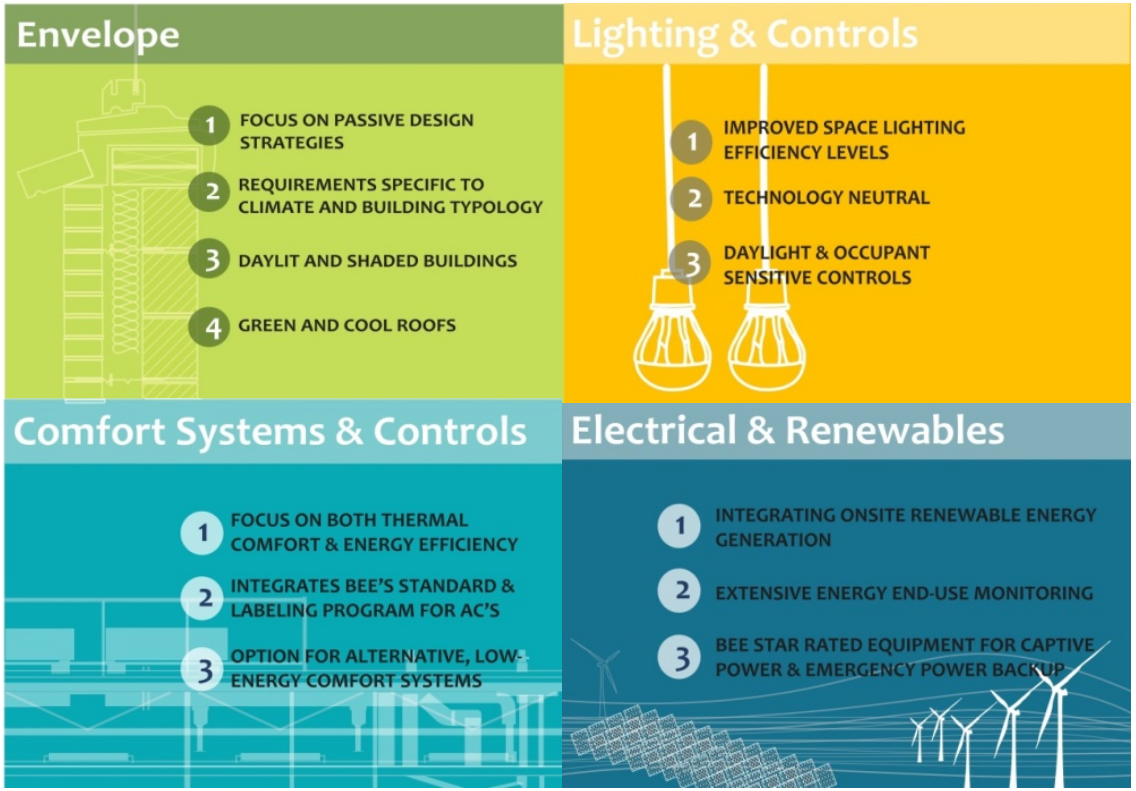
Source: IEA Energy Efficiency Market Report

India: Building energy codes

India's 2017 Energy Conservation Building Code (ECBC 2017) now integrates energy efficiency and renewables.

Now includes incremental energy performance levels:

- ECBC
- ECBC+
- Super ECBC



Source: India BEE

India: PAT and EESL

Perform Achieve and Trade (PAT): historically an industrial program to trade energy savings, is now being expanded to buildings (with hotels as the first batch)

Energy Efficiency Services Limited (EESL): a super ESCO that is innovating how bulk procurement can deliver market transformation, including with lighting and air conditioners.

- currently has delivered more than 287 million LEDs with zero upfront cost (driving the cost of LED bulbs to less than US$1)
- now is working to deliver A/Cs that are 40% more efficient than 5 star (highest label rating in India) air conditioners.

Source: India BEE and EESL

Other recent stories

Switzerland: Building refurbishment program funded through by carbon tax on heating fuels with approximately $200 million per year allocated to building refurbishment programme.

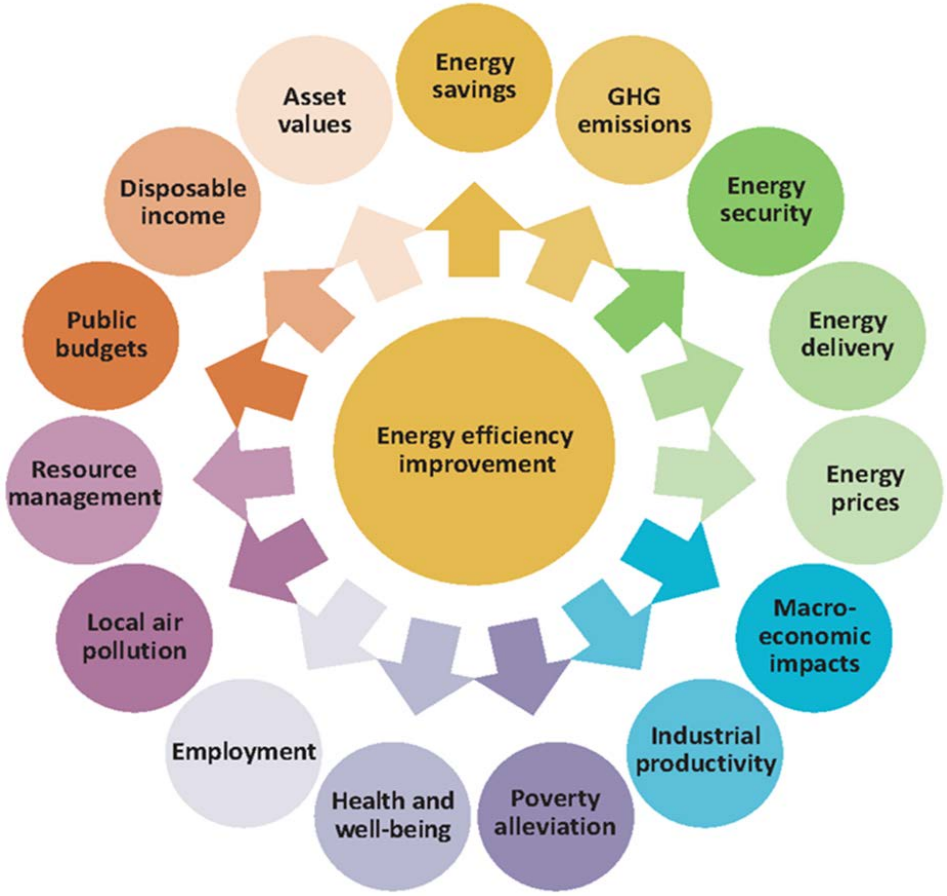
Sweden: In late 2016, the Swedish government introduced a support programme of roughly EUR 100 million for building renovations and energy efficiency measures. The energy consumption of the building must be reduced (and verified) by at least 20% in order to receive the support.

France: Residential building regulation in line with Europe's building directive is requiring all new residential construction in France to be "nearly" zero energy (~15 kWh/m2/year).

Brazil: Currently updating the building label (Procel) with evaluation criteria that account for both energy efficiency and renewable energy.

Sources: Switzerland and Global Alliance for Buildings and Construction

Action needed: deliver multiple benefits through energy efficiency



Energy Efficient Prosperity

Energy efficiency as a means to support economic and social development.

Presentation Highlights: International Energy Agency

- **Innovation in national building codes is driving improvement in energy efficiency**: building codes for net zero energy (Mexico, France) or renewables (India) are on the rise globally.
  - Similar to U.S. and Canada, building codes can be implemented locally, but are not mandatory.
  - Mexico developed a Building Energy Codes Roadmap through 2050 including a number of realistic and aspirational targets to provide direction for desired building performance.
- **A mix of policies and tools are needed to increase overall energy efficiency at national level.**
  - Through a combination of loans, grants, and building codes, Germany managed to retrofit a large number of buildings and reduce heating consumption by 75% from 1975-2015.

Gomathi Sadhasivan
Lead - Customer Decision Sciences
DNV GL - Energy

U.S. DEPARTMENT OF ENERGY

Going for Gold

Medal-Worthy Approaches to Energy Efficiency from Around the Globe

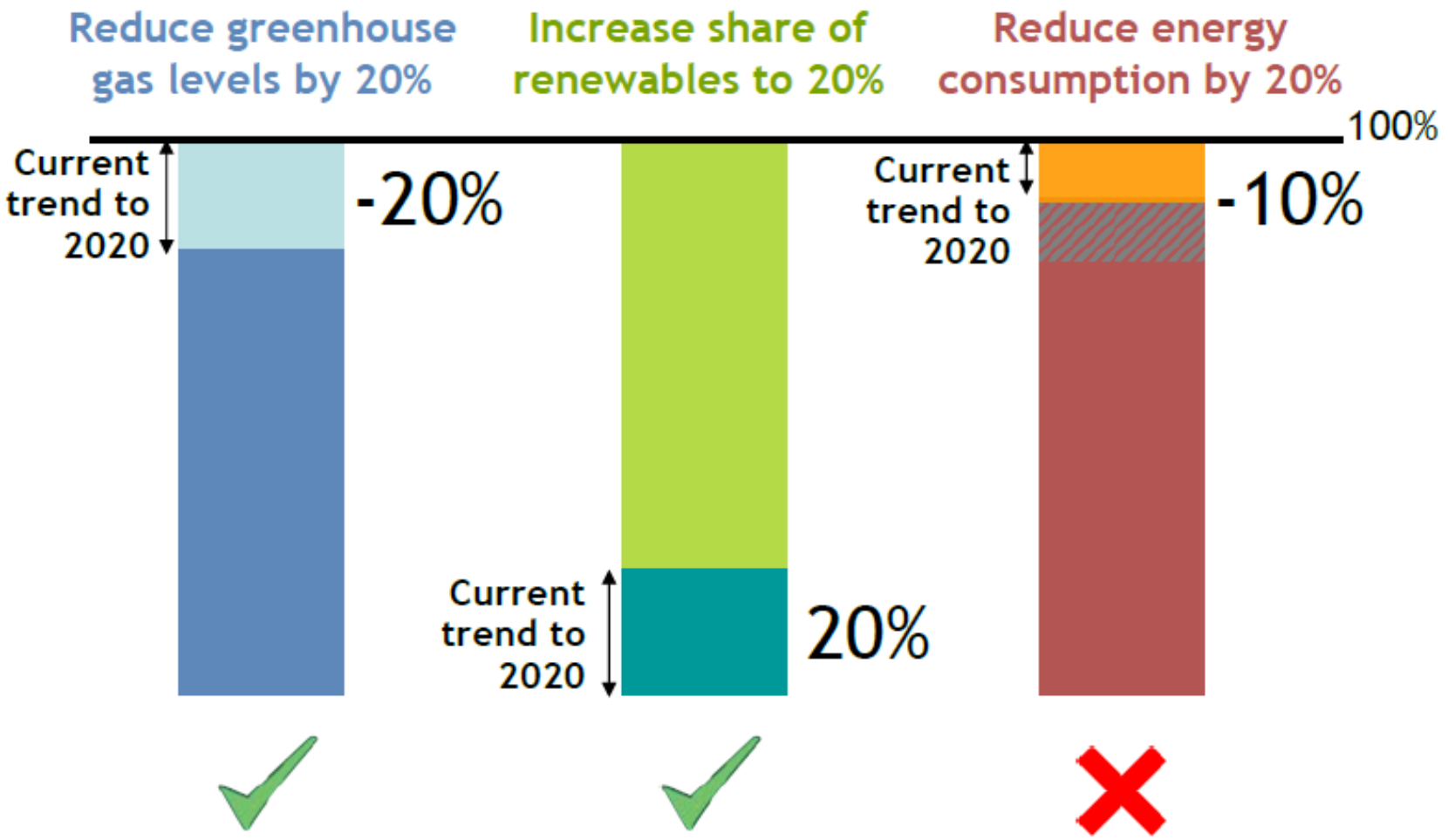
Approaches to Energy Efficiency from Around the Globe

EU Energy Efficiency Directive EED

Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on Energy Efficiency

- Set of binding measures to help the EU reach its 20% EE target by 2020
- Key provisions:
  - Article 3: National energy efficiency targets
  - Article 5: Renovation of central government buildings
  - Article 6: Public procurement
  - **Article 7: Energy efficiency obligations (or alternatives)**
  - **Article 8: Energy audits and energy management systems**
  - **Articles 9-11: Smart metering and billing**
  - **Article 14: Energy efficiency in district heating and cooling**
  - **Article 15: Grids and demand response issues**

EU 20-20-20 Targets by 2020



Market Change & Problem Statement

- The Energy Efficiency Directive (EED) is driving change in the energy efficiency services market. For example:
  - MS are required to reduce electricity sales by 1.5% annually starting in 2015.
  - Large corporations with more than 250 employees are required to conduct energy audits every four years or have an ISO 50001 comparable energy management system. (Article 8)
  - Member States have to renovate 3% of their building stock annually starting in 2015

Member States (MS) had to transpose the EED provisions into national laws by 5 June 2014

Large multi-nationals in Europe need to understand legislation across different MS in order to comply and meet requirements

Going for Gold Approach

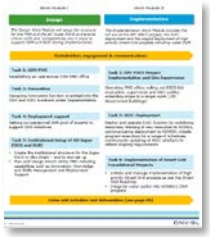
- Identify the legislative requirement to comply with the EED article 8 in 20 different MS
- Provide compliance plans based on the research
- Deliver convenience and cost efficiencies to customers with operations in several MS

Drawing parallels

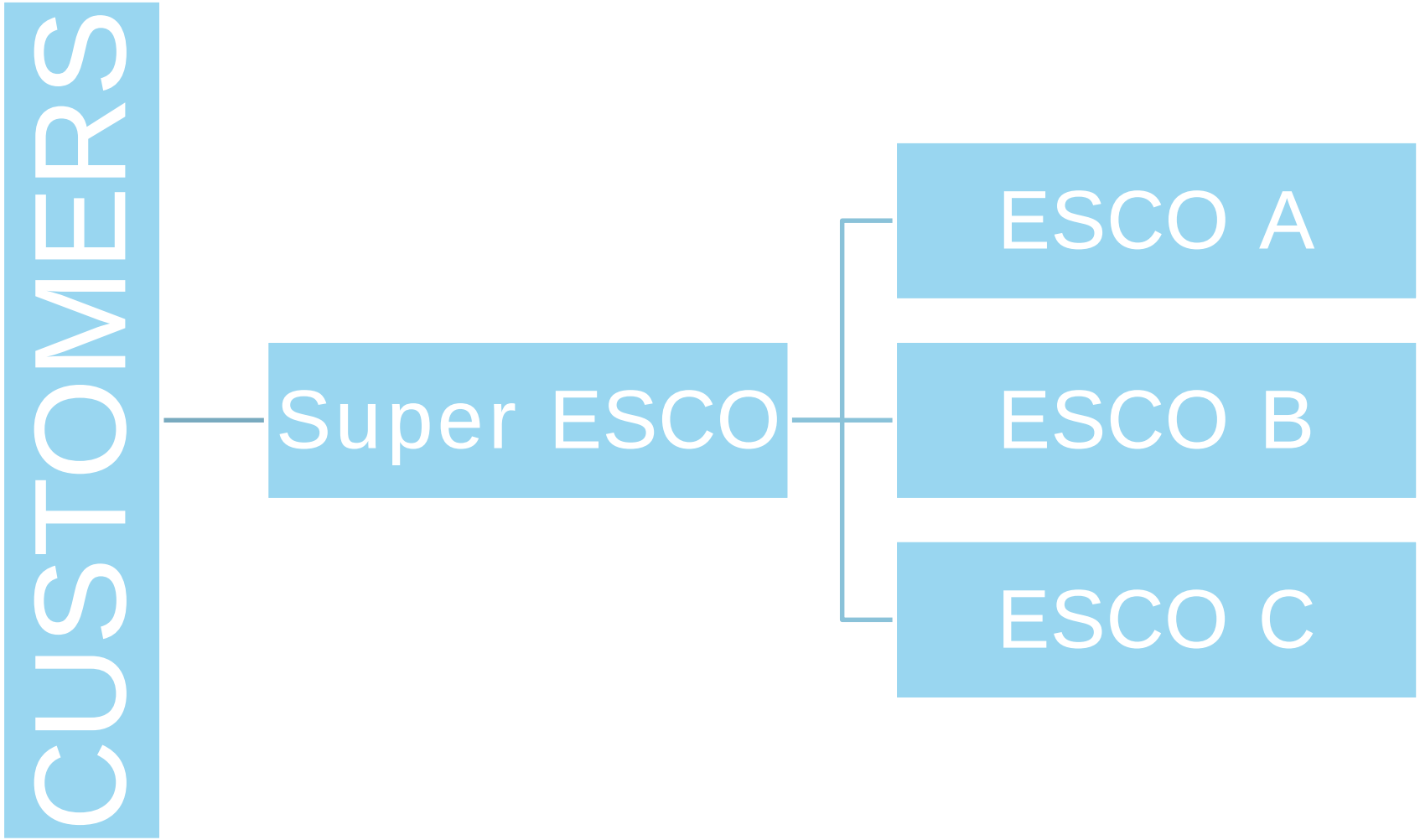
- CA HVAC permit and compliance market assessment
- Non-compliance
  - Transaction friction
  - Lack of education
  - Cost avoidance (indirect & direct)
  - Complexity (Different requirements by climate zone and equipment type)

UAE – Demand Side Management Implementation & Smart Utility Innovation Center

- National Energy Strategy targets 40% EE improvement vs BAU forecast 2050
- DSM Implementation programs undergoing
- ESCO market support framework
- Super ESCO established in Dubai and under development in Abu Dhabi
- Dedicated DSM agency established in Dubai and under development in Abu Dhabi



Super ESCO



Barriers addressed by Super ESCOs

Customer Benefits:

- Reduces friction in the customer experience
- “One-stop shop” for the customer – credible and convenient
- Standardized contracts

Supply Side Benefits:

- Market penetration
- Supports capacity development (training, leasing, financing, equipment)

Thank you!

Gomathi Sadhasivan

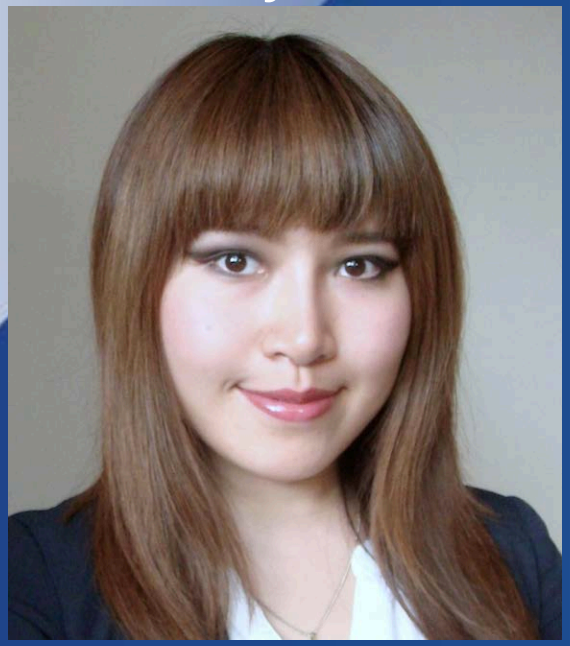
www.dnvgl.com

SAFER, SMARTER, GREENER

Presentation Highlights: DNV GL - Energy

- **The European Union has a 20% energy reduction target by 2020, but it's unlikely it will be met given the current progress.**
  - Part of this is because companies need time to adjust and respond effectively to these requirements.
  - To help companies comply with EU requirements, DNV GL provided compliance plans based on energy efficiency policies.
- **More countries like Dubai or Abu Dhabi, are establishing "super ESCOs" at the national level. "Super ESCOs" can have many benefits such as:**
  - Support capacity building/infrastructure development
  - Function as a one-stop-shop for the whole value chain
  - Reduced burden for everyone

Hui Ben
Trust Scholar and PhD candidate
University of Cambridge



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UNIVERSITY OF CAMBRIDGE

Incorporating Household Archetypes for Domestic Retrofit Strategy

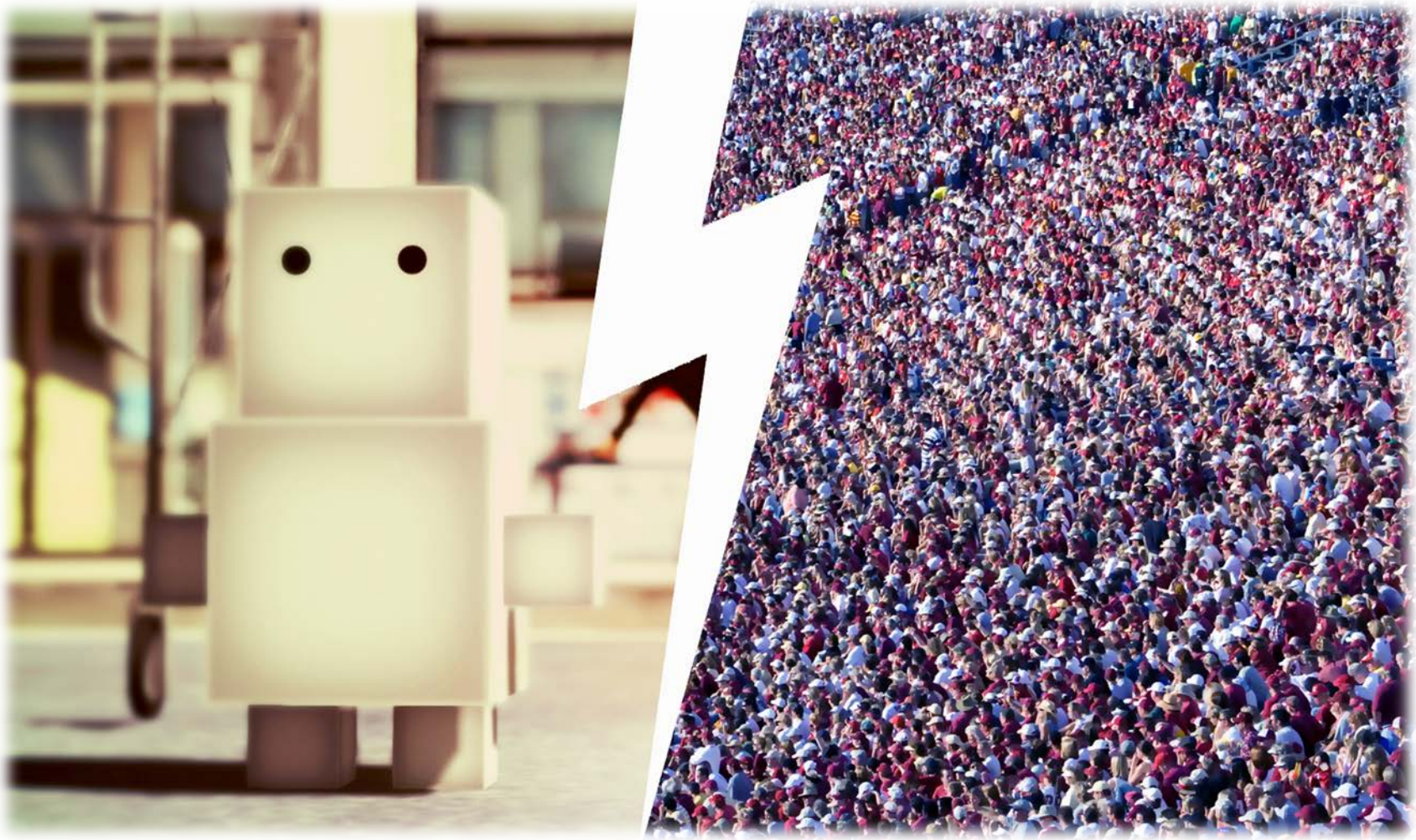
Hui Ben

The Martin Centre for Architectural and Urban Studies, University of Cambridge

UK Retrofit Background

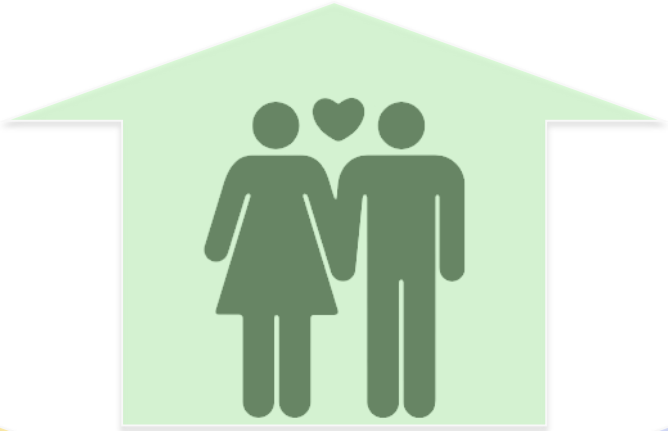
- The UK Government has a target to reduce CO_2 emissions by 80% on 1990 levels by 2050;
- Energy Performance Certificate (EPC) is used to identify ways to save money on home energy bills and improve occupant comfort;
- SAP (Standard Assessment Procedure) and RDSAP (Reduced Data SAP) are the methodology used by the Government to assess and compare the energy and environmental performance of dwellings;
- The aim is to provide accurate and reliable assessments of dwelling energy performances that are needed to underpin energy and environmental policy initiatives.

Occupant behaviour: Standardised vs. Real



Five Household Archetypes/Behavioural Patterns

Active spenders



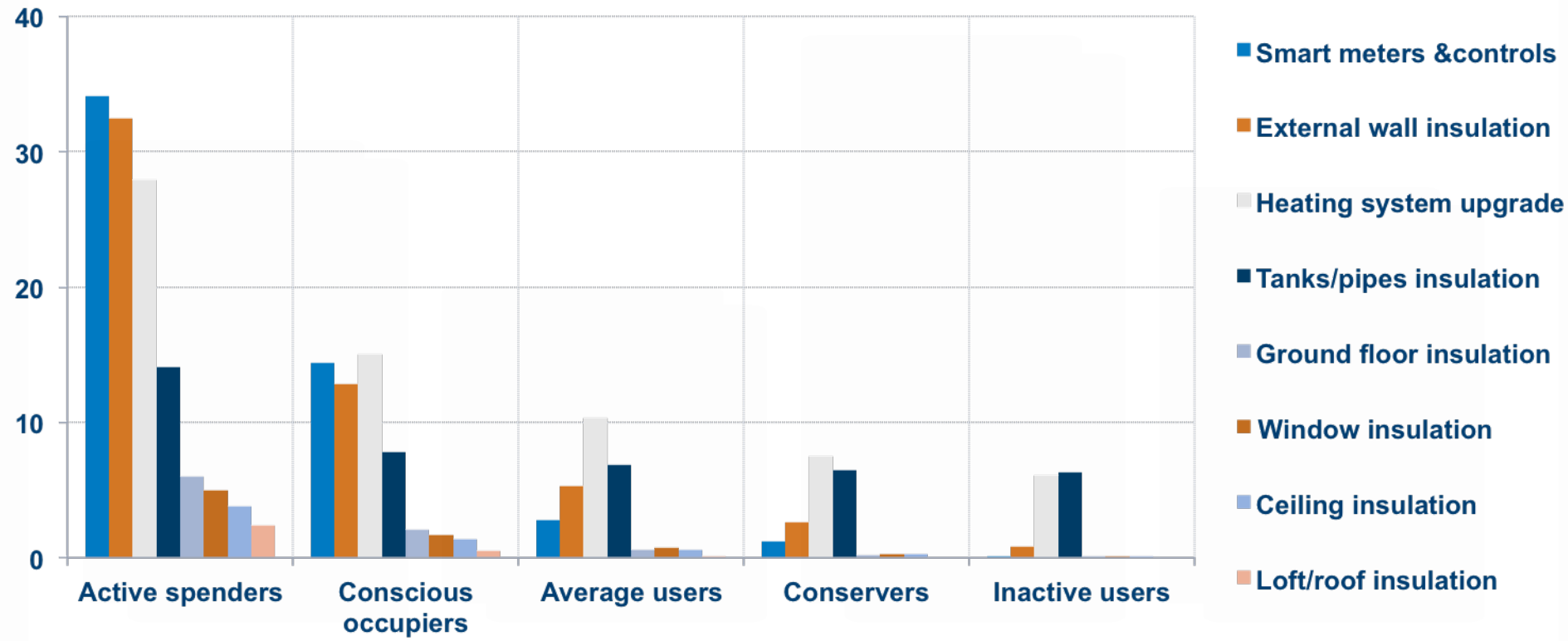
Average users

Conservers

Conscious occupiers

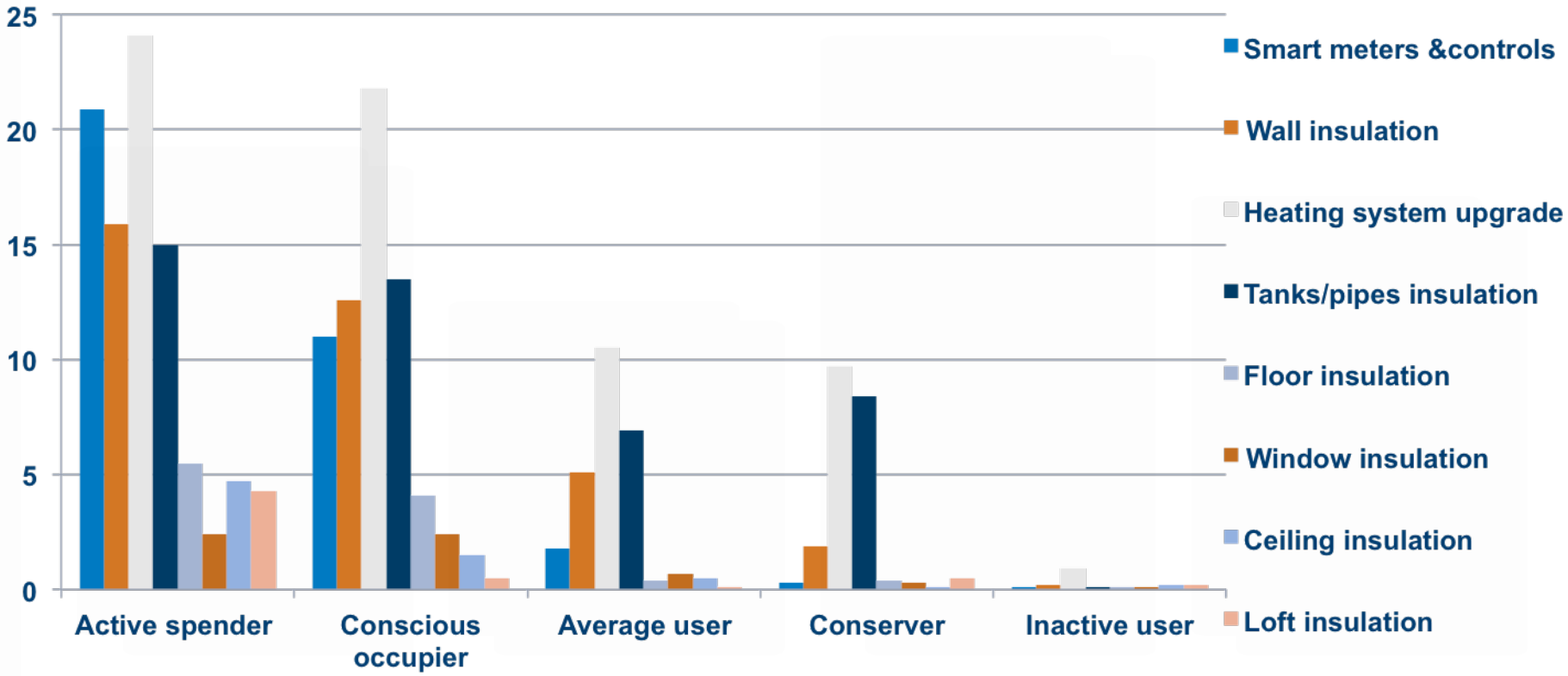
Inactive users

Comparing energy savings in identical dwelling



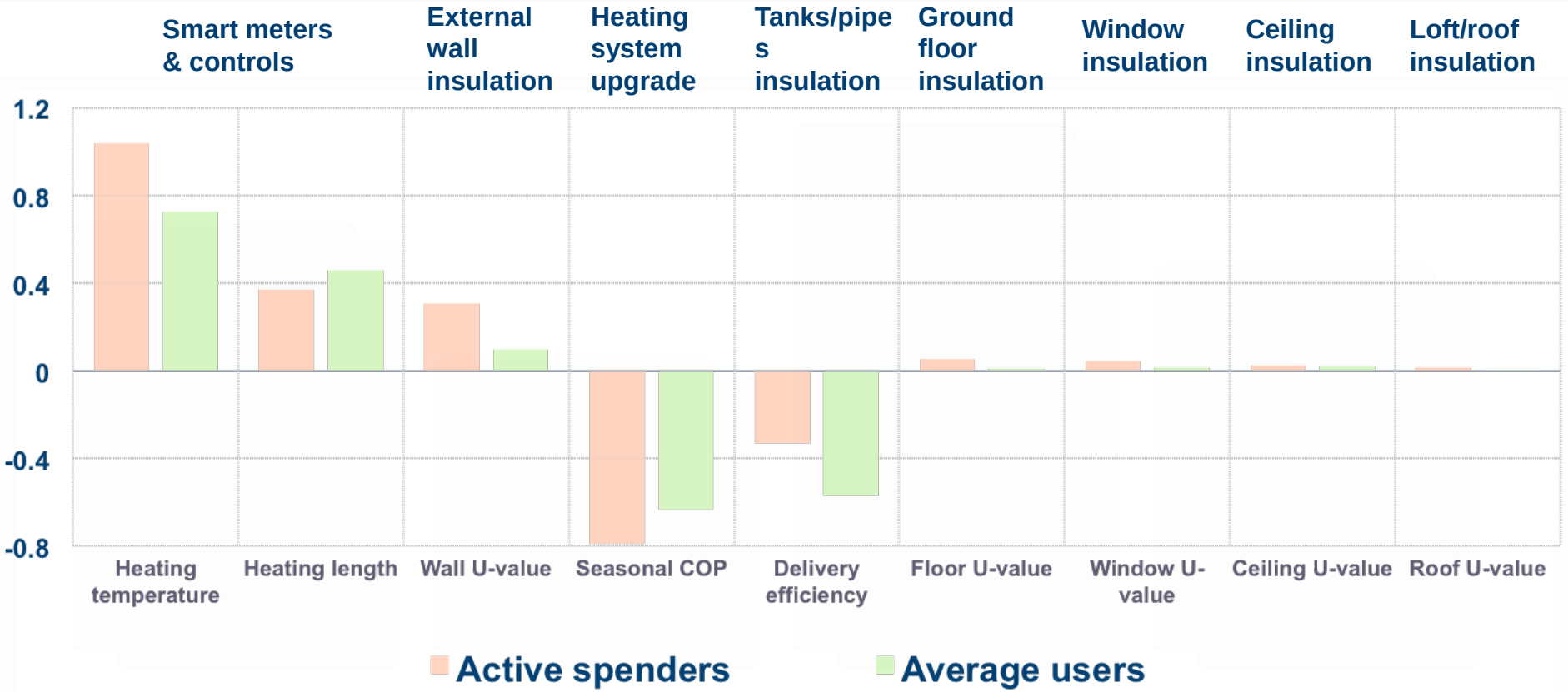
Compare retrofit energy savings (MWh/yr) across five archetypes in mid-terraced dwelling

Comparing energy savings in respective dwellings



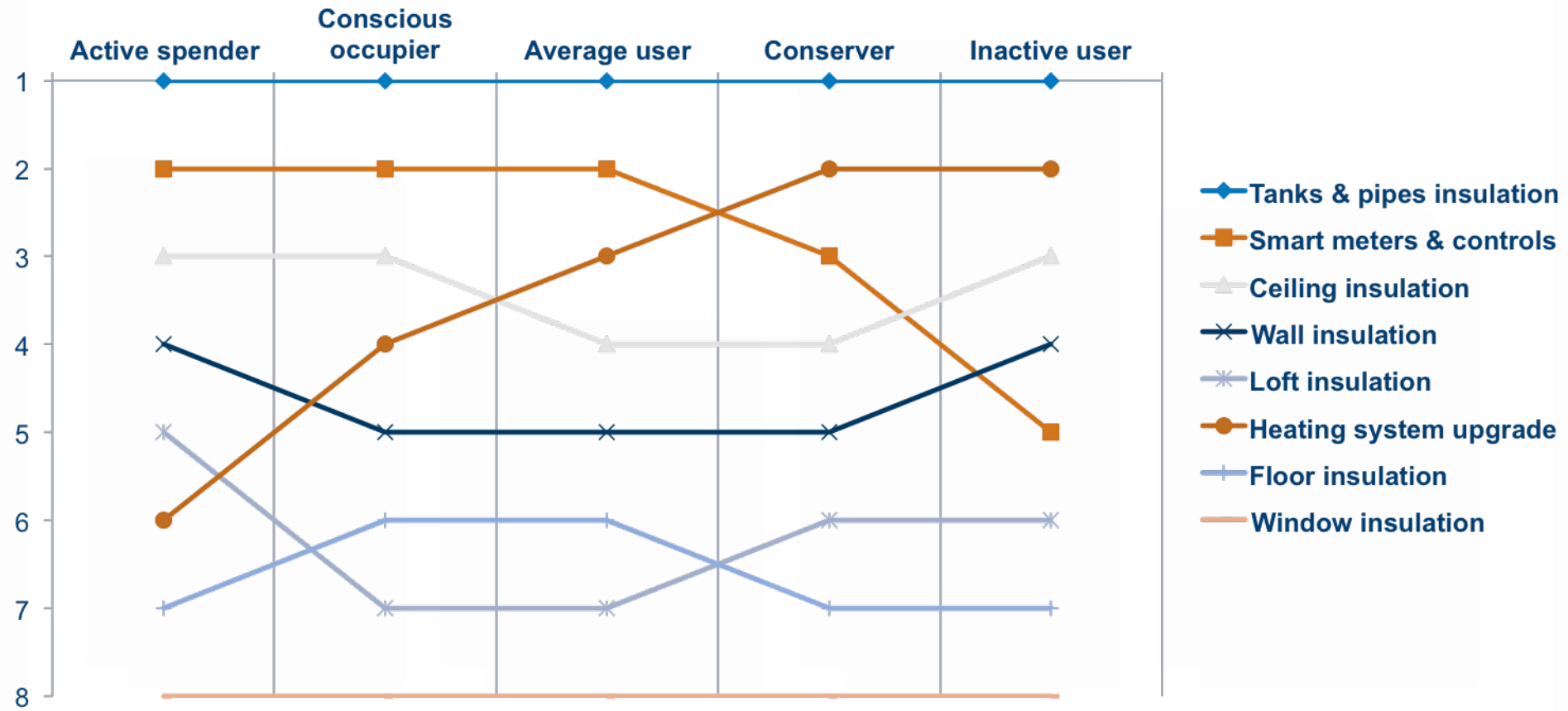
Compare retrofit energy savings (MWh/yr) across five archetypes in respective dwellings

Sensitivity analysis



The impact of each retrofit measure on home energy performance varies according to behavioural patterns

Ranking of Cost Effectiveness of Retrofit Options



Ranking of single retrofit options according to energy saving per pound (kWh/m²/year/£) across five household archetypes

Energy and cost implication of using HA to guide retrofits in comparison with EPC

Retrofit level		EPC saving ($kWh/m^2/yr$)	HA saving ($kWh/m^2/yr$)	Difference per dwelling ($kWh/m^2/yr$)	Difference at dwelling level (£/yr) *	Difference at city level (£/yr) **
I	1st option	70.2	74.2	4.0	14.4	697,970.8
II	1st +2nd options	99.2	160.5	61.3	219.3	10,658,499.4
III	1st to 3rd options	203.7	202.9	- 0.8	- 2.8	-134,278.1
IV	1st to 4th options	209.9	255.2	45.3	162.0	7,875,100.0
V	1st to 5th options	263.6	297.2	33.6	120.3	5,844,319.8
VI	1st to 6th options	269.7	324.9	55.2	197.7	9,608,116.0
VII	1st to 7th options	271.5	331.5	60.0	214.7	10,432,011.7
VIII	1st to 8th options	279.1	341.3	62.2	222.6	10,818,653.0

* Tariff Comparison Rate (TCR): 3.60p per kWh

** Cambridge household number: 48600 (2012 census)

Take-home Message

- **Ranking, energy saving potential and cost effectiveness of retrofit measures can vary significantly depending on household archetypes / behavioural patterns;**
- **Energy efficient retrofit design and policy need to incorporate occupant behaviour through household archetypes.**

Contact info:

Hui Ben
Department of Architecture
University of Cambridge

Presentation Highlights: Cambridge University

- **Energy efficiency behavior has a significant impact on building performance.**
  - The research conducted by the University of Cambridge measured the potential of various energy upgrades based on 5 different household archetypes identified.
- **"Active spenders" have the most potential of saving energy, while "inactive users" have the least potential.**
  - Smart meters and controls are the most effective upgrades for "active spenders", while insulation and heating system upgrades are amongst the best retrofits for "inactive users".
- **Tank and pipe insulation are the most cost-effective upgrade for all behavioral archetypes.**
  - The cost-effectiveness of other energy upgrades varies with the behavioral archetypes.

Diego Ponce de Leon Barido
CEO
Threestone Analytics

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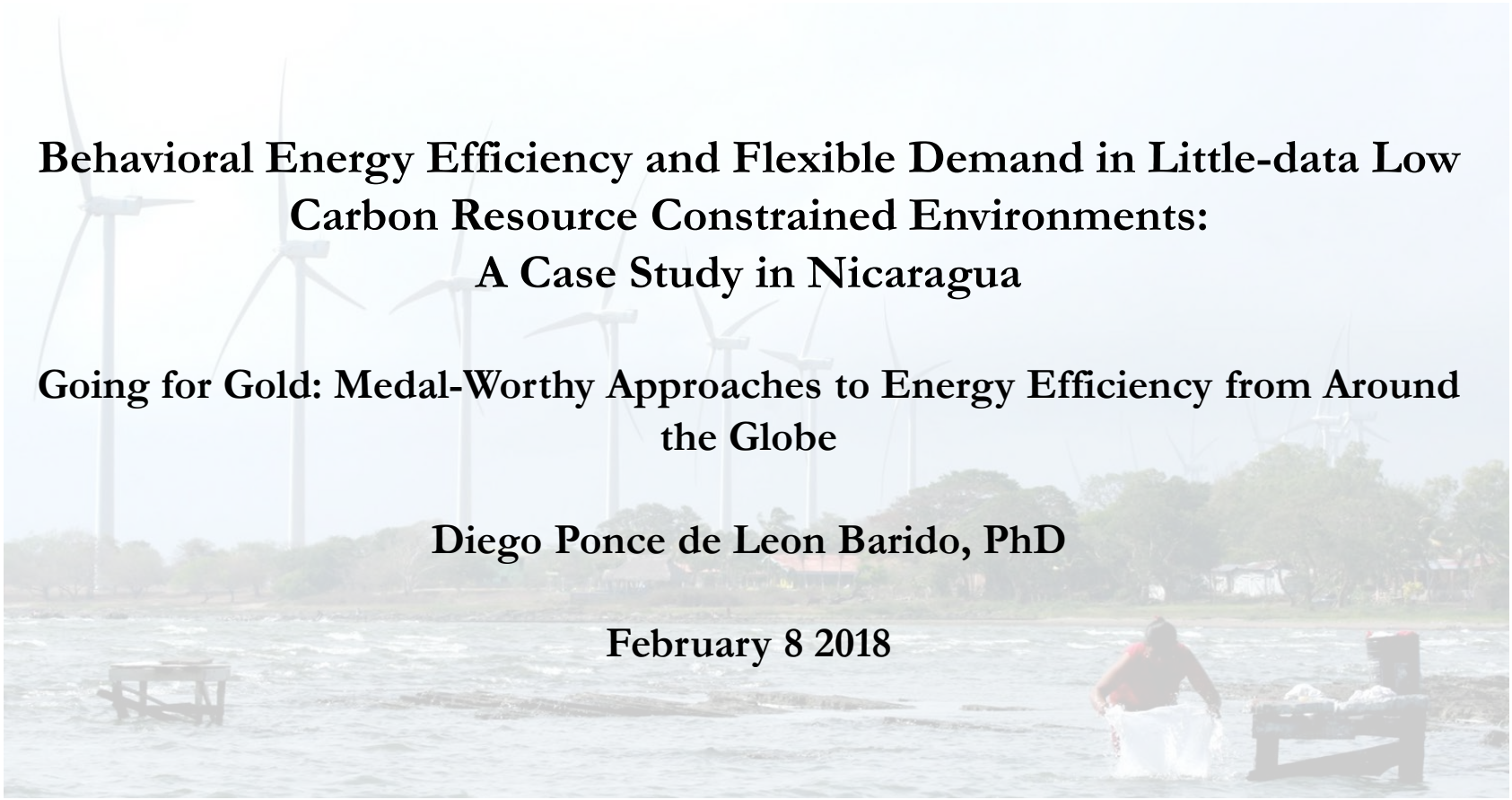
Behavioral Energy Efficiency and Flexible Demand in Little-data Low Carbon Resource Constrained Environments: A Case Study in Nicaragua

Going for Gold: Medal-Worthy Approaches to Energy Efficiency from Around the Globe

Diego Ponce de Leon Barido, PhD

February 8 2018



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threestone

Berkeley
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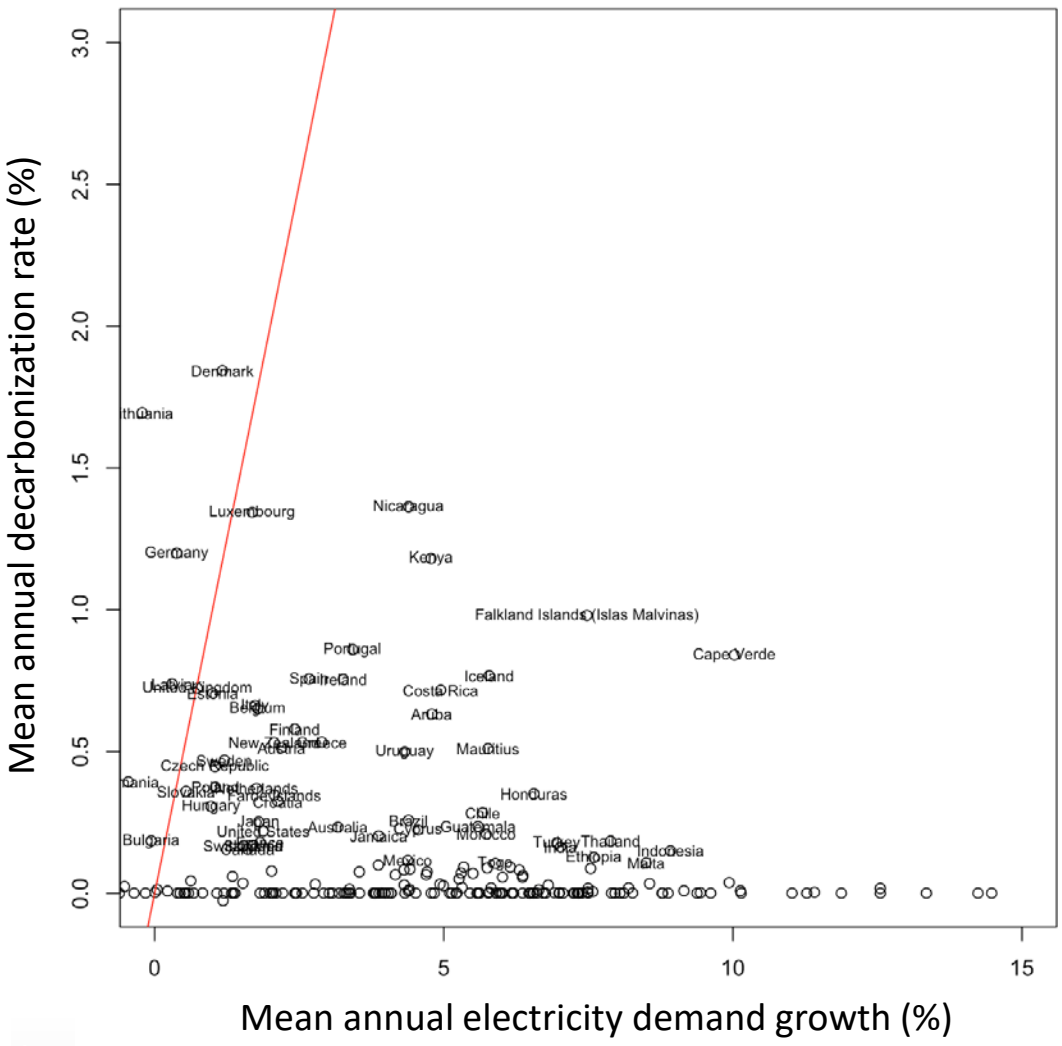
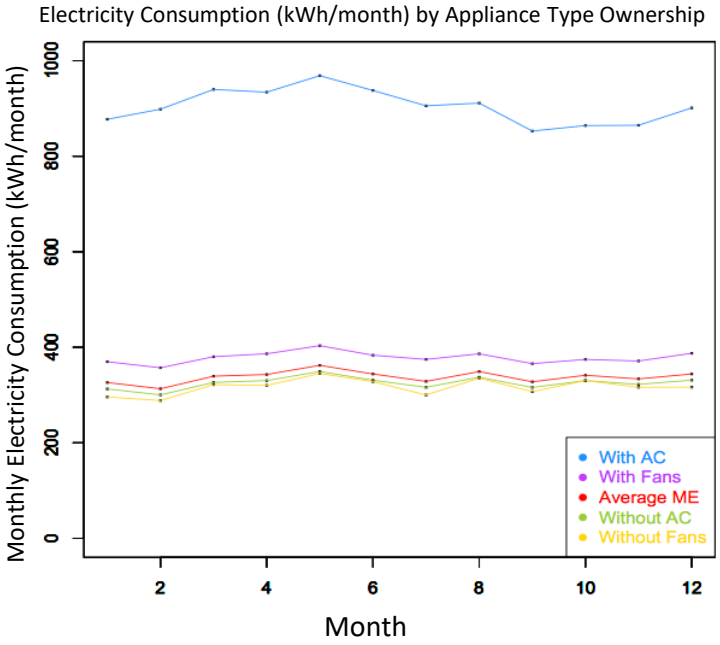
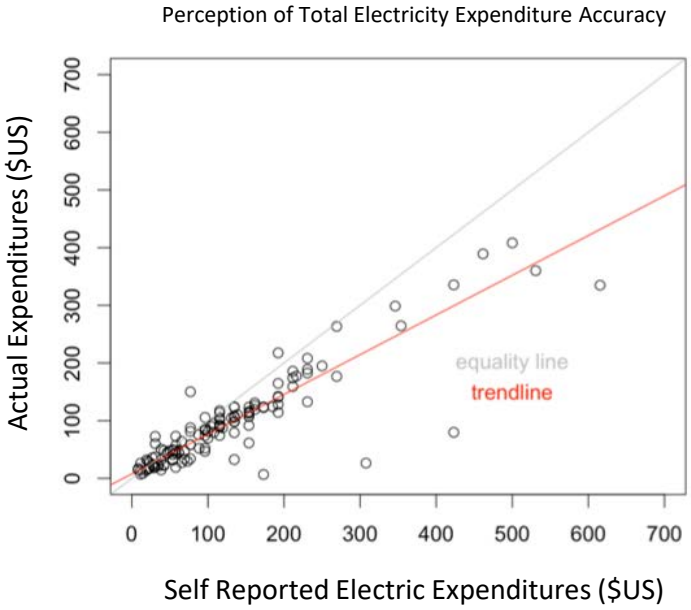

Mean annual decarbonization rate (%)
Mean annual electricity demand growth (%)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0
5
10
15
Denmark
Luxembourg
Nicaragua
Germany
Kenya
Falkland Islands (Islas Malvinas)
Portugal
Cape Verde
Iceland
Ireland
Costa Rica
Aruba
Uruguay
Mauritius
Honduras
Chile
Jamaica
Ethiopia
Malta
Indonesia


Nuevo
HAIR
Chiclets

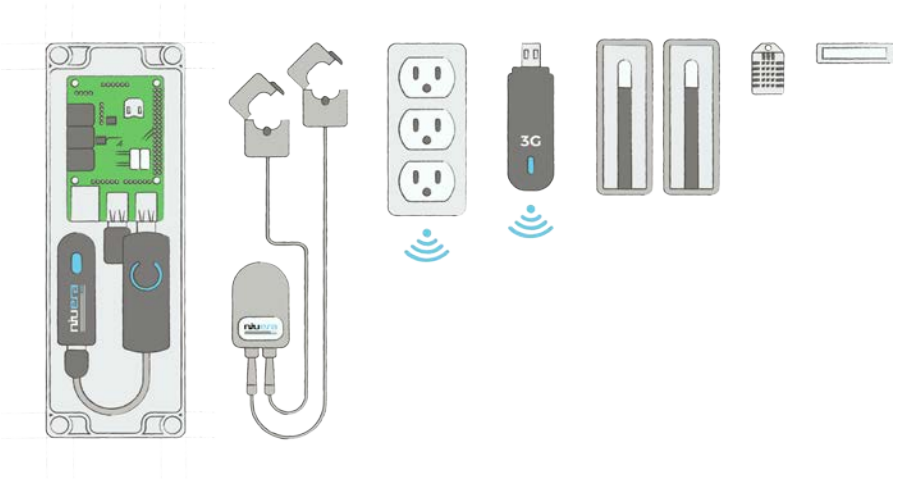
500 Survevs: Homes & Micro-Enterprises





(1) Voluntary load shedding: 71% .
(2) Perception on Reliability: 70% Ok with outages, 72% satisfied with system reliability.
(3) Costs: US$ 0.33/kWh, with 60% struggling to pay.
(4) Cost perception: 30-50% difference (perceived vs actual).
(5) Education: 70% don't understand their electricity bill.

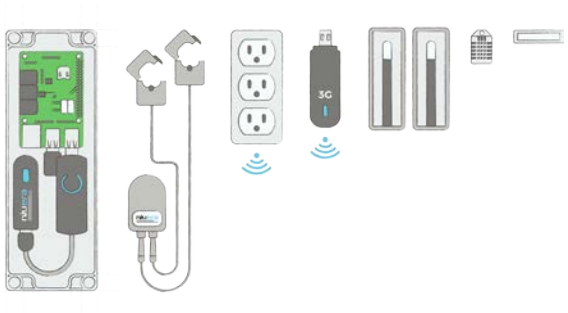
Flexible Demand and Behavioral Energy Efficiency



Ponce de Leon Barido, D., Rosa, J., Suffian, S., Brewer, E., Kammen, M.D. Enabling Micro-Level Grid Flexibility in Resource Constrained Environments. IEEE IoTDI ’17 Proceedings of the Second International Conference on Internet-of-Things Design and Implementation, 2017.

Ponce de Leon Barido, D., *et al.* Enabling Behavioral Energy Efficiency and Flexible Demand in Low-Carbon Resource Constrained Environments (in adv. prep.)

Flexible Demand and Behavioral Energy Efficiency



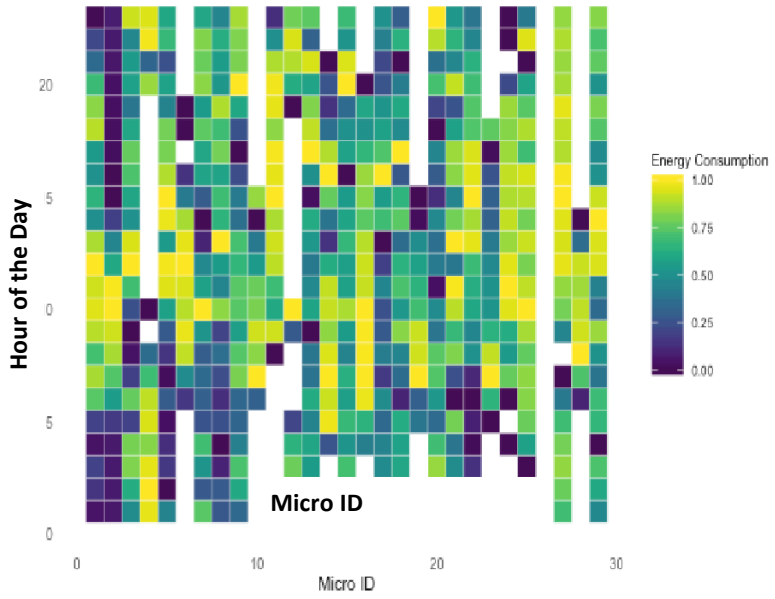
30 Treatment and 30 Control

Intervention: Co-design of behavioral information and sensor network for flexible demand + Monthly flexible demand payments ($6/month).

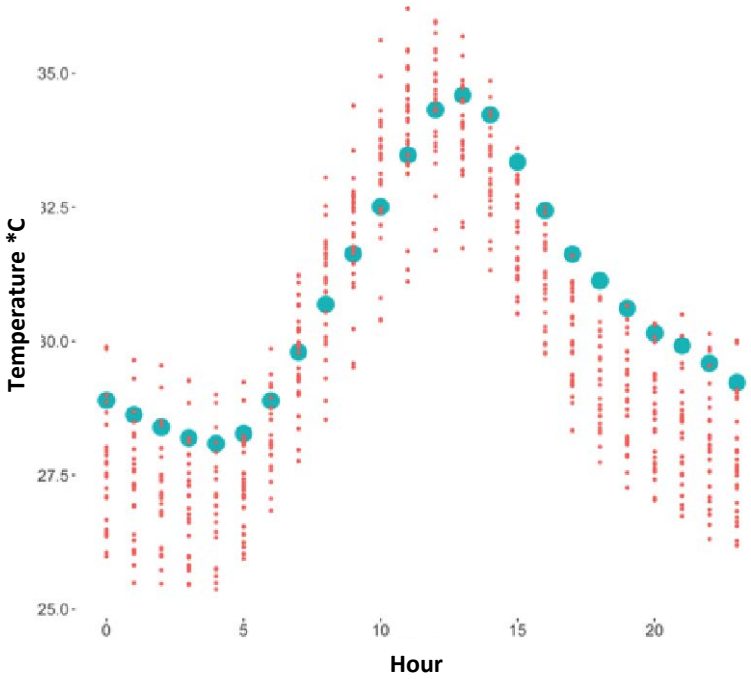
Outcomes: 1) Energy reduction, 2) Reducing stress relate to energy payments, 3) Incentive design for participating in energy efficiency smart grid programs.

Example Sensor Network data

Fridge Energy Consumption by Hour (Normalized –1 by Micro ID).

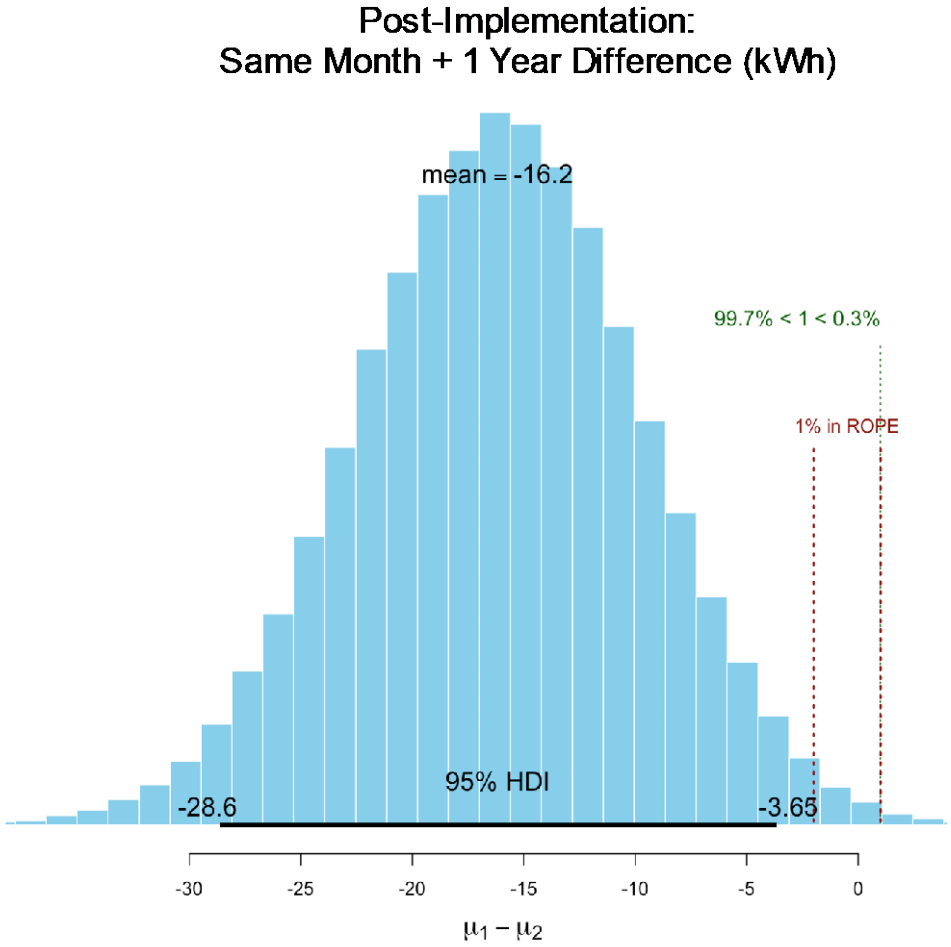


Urban Ovens



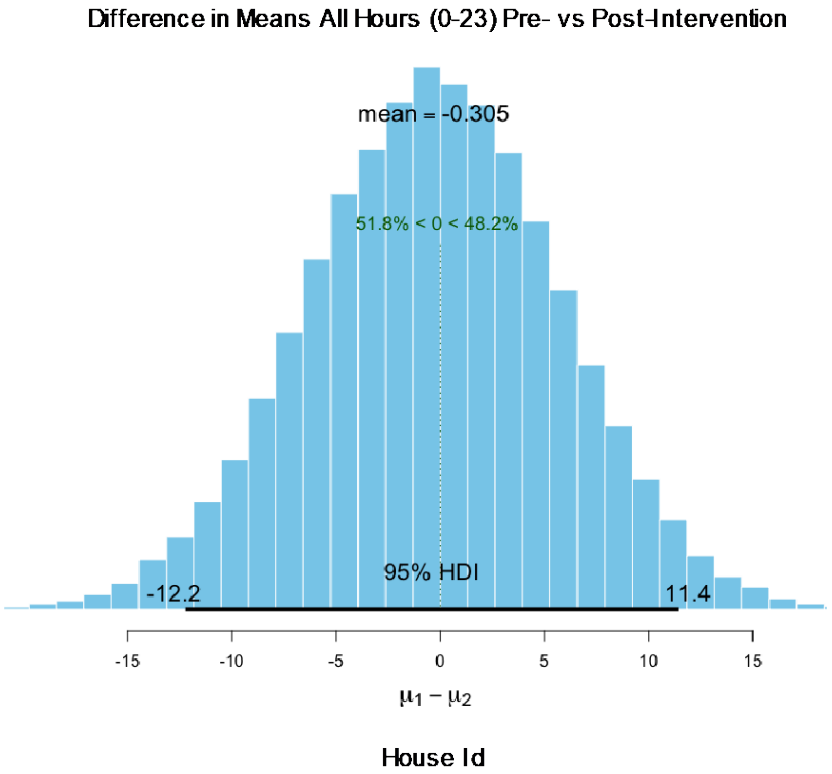
ICTs and Behavioral Energy Efficiency

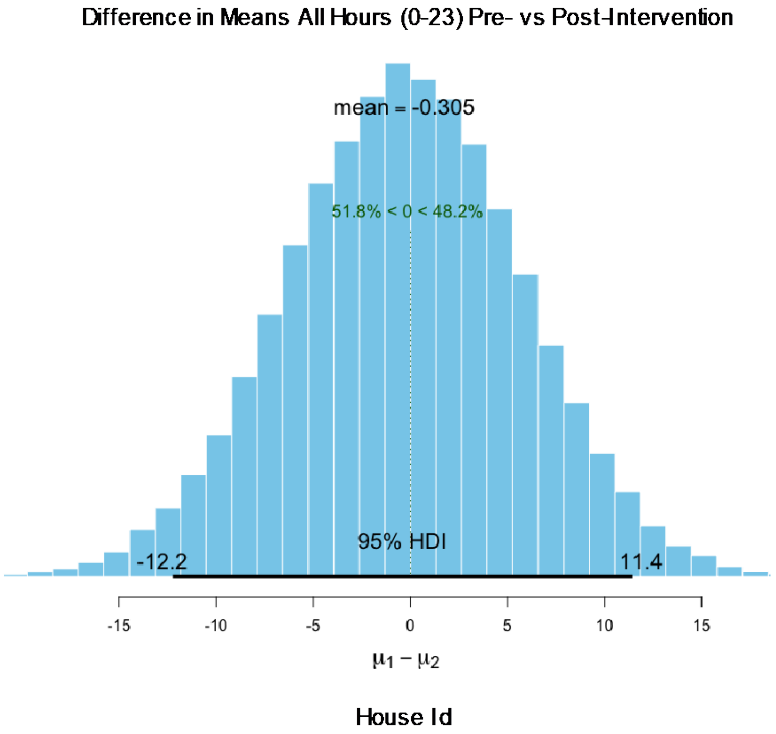
5% /month ~ $US 5/month , $60/year



2 million people (1/3 population):
$US 29 million using average market prices ~ savings for homes & country

Flexible Demand





78 Watts per Flexible Demand Hour

2 Million People (1/3 population): $US 18 million/year (peak prices)

Top-down Opportunities & Challenges

- Small investments could have large returns
- Leapfrogging through pilots and demonstration projects

- Absence of decoupling
- Absence of mechanisms to support best practices

Bottom-up Opportunities & Challenges

- Community and sharing, existing intrinsic motivation
- Empowerment, increased literacy – beyond energy
- Opportunities for new business models

- Poorly designed financial instruments
- Scarcity

Presentation Highlights: Threestone Analytics (1 of 2)

- **There is a great potential for residential energy savings in Nicaragua, as electricity expenses are significant** and place a great strain particularly on low and middle-income homes.
- Threestone Analytics's neighborhood pilot in the city of Managua showed that controlling energy use for appliances that consume the most energy, like refrigeration and cooling, can generate significant savings.
  - A sensor network technology attached to home refrigerators enabled the appliances to run when less costly.
  - Residents participated in 80% of all demand response events.
  - Implemented at scale throughout Nicaragua, this effort could save $20 million a year.
  - The neighborhood pilot benefited from having a close-knit community that was exchanging information and tips to save more energy.

Presentation Highlights: Threestone Analytics (2 of 2)

- **Matching the needs of consumers with local policies and other requirements in place would enable them to benefit from energy efficiency.**
  - In Nicaragua, for example, access to financial services for energy efficient upgrades can be a burdensome process (e.g., Nicaraguans need three recommendation letters to apply for loans for energy efficiency). Access to financial services in Latin America overall is limited.

- **Utility rate decoupling in Latin America would offer more incentives for utilities to pursue effective energy efficiency programs**, including flexible demand. Currently, Latin American countries do not have decoupled utilities.

Explore the Residential Program Solution Center

Resources to help improve your program and reach energy efficiency targets:

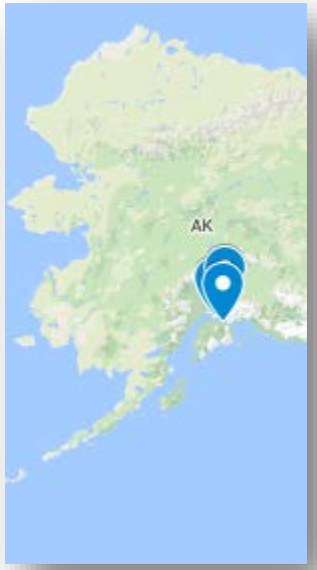
- Handbooks - explain *why* and *how* to implement specific stages of a program.
- Quick Answers - provide answers and resources for common questions.
- Proven Practices posts - include lessons learned, examples, and helpful tips from successful programs.
- Technology Solutions NEW! - present resources on advanced technologies, **HVAC** & **Heat Pump Water Heaters**, including installation guidance, marketing strategies, & potential savings.

https://rpsc.energy.gov

Addenda: Attendee Information and Poll Results

U.S. DEPARTMENT OF ENERGY

Call Attendee Locations



Call Attendees: Network Members

- American Council for an Energy-Efficient Economy (ACEEE)
- California Hub for Energy Efficiency Financing (CHEEF)
- City of Cambridge
- CLEAResult
- Earth Advantage Institute
- Efficiency Nova Scotia
- Energize New York
- FMC Facility Management Consultores
- International Center for Appropriate and Sustainable Technology (ICAST)
- Maryland Energy Administration (MEA)
- Milepost Consulting, Inc.
- New York State Energy Research & Development Authority (NYSERDA)
- Rocky Mountain Institute
- TRC Energy Services
- Wisconsin Energy Conservation Corporation (WECC)

Call Attendees: Non-Members (1 of 2)

- Air Vent Inc.
- Augusta Technical College
- Bank of Montreal
- C2E2 Strategies, LLC
- Cadmus
- Canadian Home Builders' Association (CHBA)
- Carolina Smart Homes
- City of Edmonton
- Colorado Code Consulting
- DNV GL
- domestic Tranquility (Resilient Eugene)
- E4TheFuture
- Educational Service District 112
- Enbridge Gas Distribution, Inc.
- Environmental Design / Build
- Essense Partners
- Florida Department of Agriculture and Consumer Services
- Globetrotters (GEC): Architectural Engineering Firm Chicago
- Greenbanc
- Home energy Consultants
- International Energy Agency
- LL Catey Engineering Services, LLC
- Marx Okubo
- Mercy Housing Management Group

Call Attendees: Non-Members (2 of 2)

- Mid Michigan Community Action Agency
- National Housing Law Project
- Natural Resources Canada
- New Hampshire Electric Cooperative
- New York State Division of Housing and Community Renewal
- Opportunity Council
- Power Integrations
- Proctor Engineering
- PV Blue
- Quadlogic Controls
- RCS Enterprises
- Red Rocks Community College
- Salt Lake City
- Sierra Club
- Solar Habitats, LLC.
- Sustainable Performance
- Therma-Stor LLC
- Timber Block USA
- U.S. Department of Justice
- U.S. Energy Information Administration (EIA)
- UC Berkeley
- University of Cambridge
- University of Kansas
- Washington River Protection Solutions
- Willdan

Opening Poll

- **Which best describes your organization's familiarity or experience with global approaches to energy efficiency?**
  - Some experience/familiarity – ***46%***
  - Limited experience/familiarity – ***21%***
  - Very experienced/familiar – ***15%***
  - No experience/familiarity – ***15%***
  - Not applicable – ***3%***

Closing Poll

- **After today's call, what will you do?**
  - Seek out additional information on one or more of the ideas – ***84%***
  - Make no changes to your current approach – ***12%***
  - Consider implementing one or more of the ideas discussed – ***4%***
  - Other (please explain) – ***0%***