COMMERCE DEPARTMENT
DIVISION OF ENERGY RESOURCES

HOME OF THE FUTURE: AUTOMATED, CONNECTED, AND SMART

Stacy Miller, Clean Energy Technologies

Terry Webster, Events & Publications

February 21, 2018 Energy Design Conference

In accordance with the Department of Labor and Industry's statute 326.0981, Subd. 11,

"This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying **1.5 hours** of credit toward **Building Officials and Residential Contractors code /1 hour energy** continuing education requirements."

For additional continuing education approvals, please see your credit tracking card.

Stacy Miller
Clean Energy Technologies Specialist

Solar experience:

Solar Research at the University of Toledo

Solar installation-small business

Solar program development

Agenda

- Solar Market Trends
- Solar Readiness
- Electric Vehicle Readiness
- Residential Standardized Structural tables
- Zoning and Permitting
- Smart Home Devices

What is a smart solar home?

Systems work together to:

- **Produce on-site solar energy**
- **Maximize comfort**
- **Be energy efficient**
- **Save money**

Why offer clients a smart, solar home option?

- Growing consumer interest
- Solar and connectivity is increasingly cost effective
- Differentiation—or keeping up with the competition

Elements of the Home of the Future

- Connected appliances, security, lighting
- Onsite energy generation like solar
- Electric vehicle charging

Goal: buildings that operate more conveniently, comfortably and in a more environmentally friendly way.

Minnesota Solar Market Today

Solar Market Transformation is Underway

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Solar Resource Is Favorable Statewide

All Minnesota communities have a solar resource

*Opportunity for businesses and residents to employ on-site solar—and other clean, smart and affordable technologies

Minnesota Solar 2016

.01%

Minnesota Solar 2017

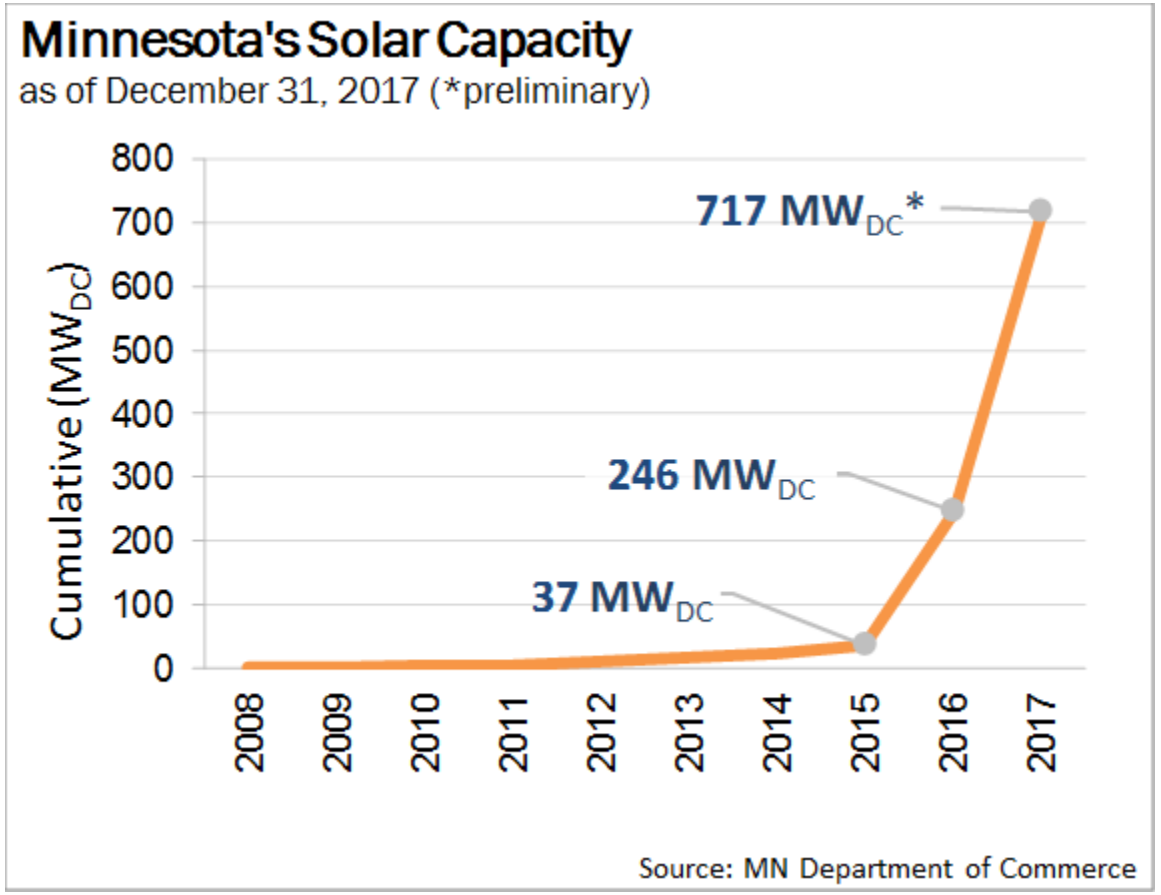
1%

Minnesota’s 2030 Solar Goal

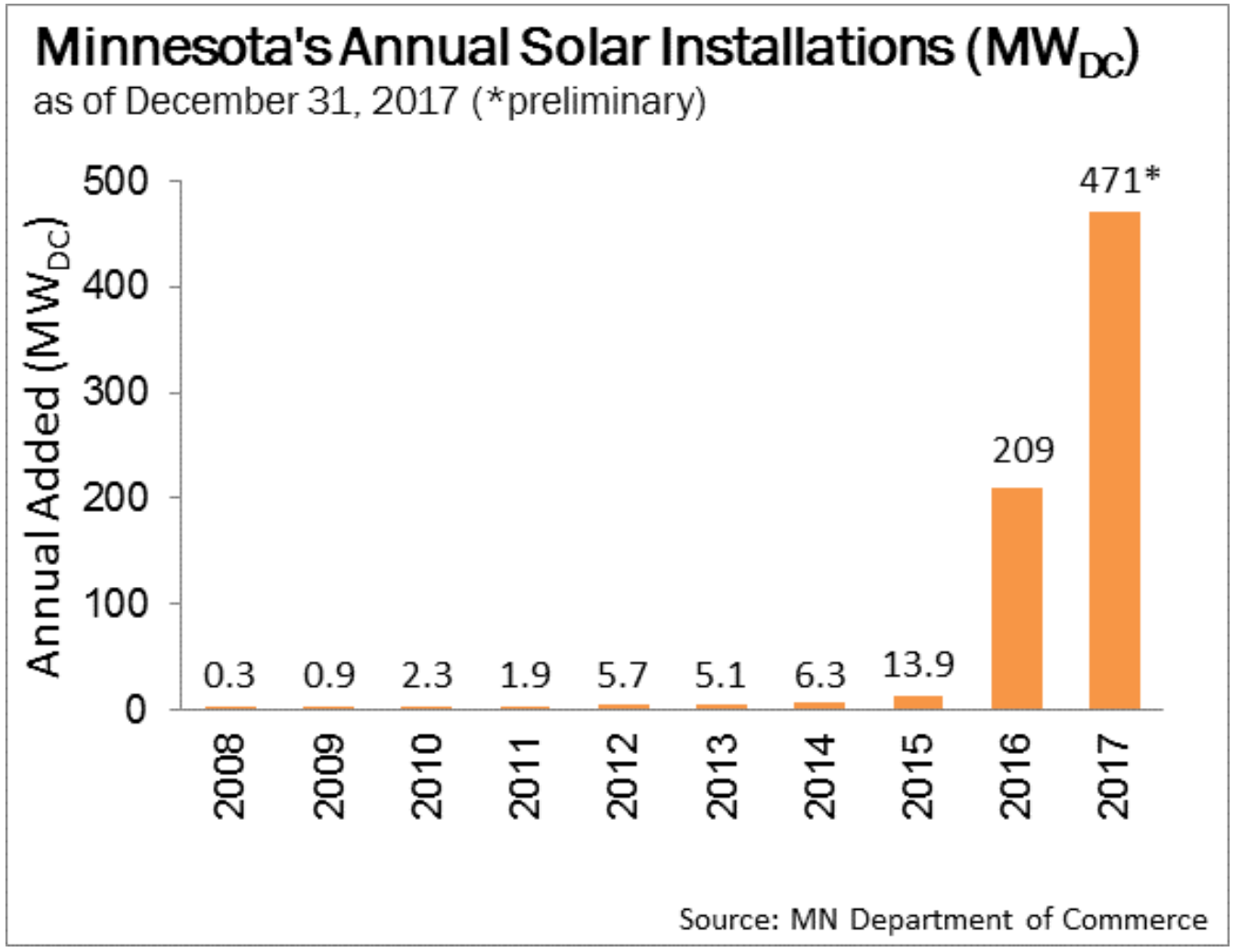
10%

Historic Minnesota Solar Statistics-Cumulative

17 MW in 2013
717 MW in 2017

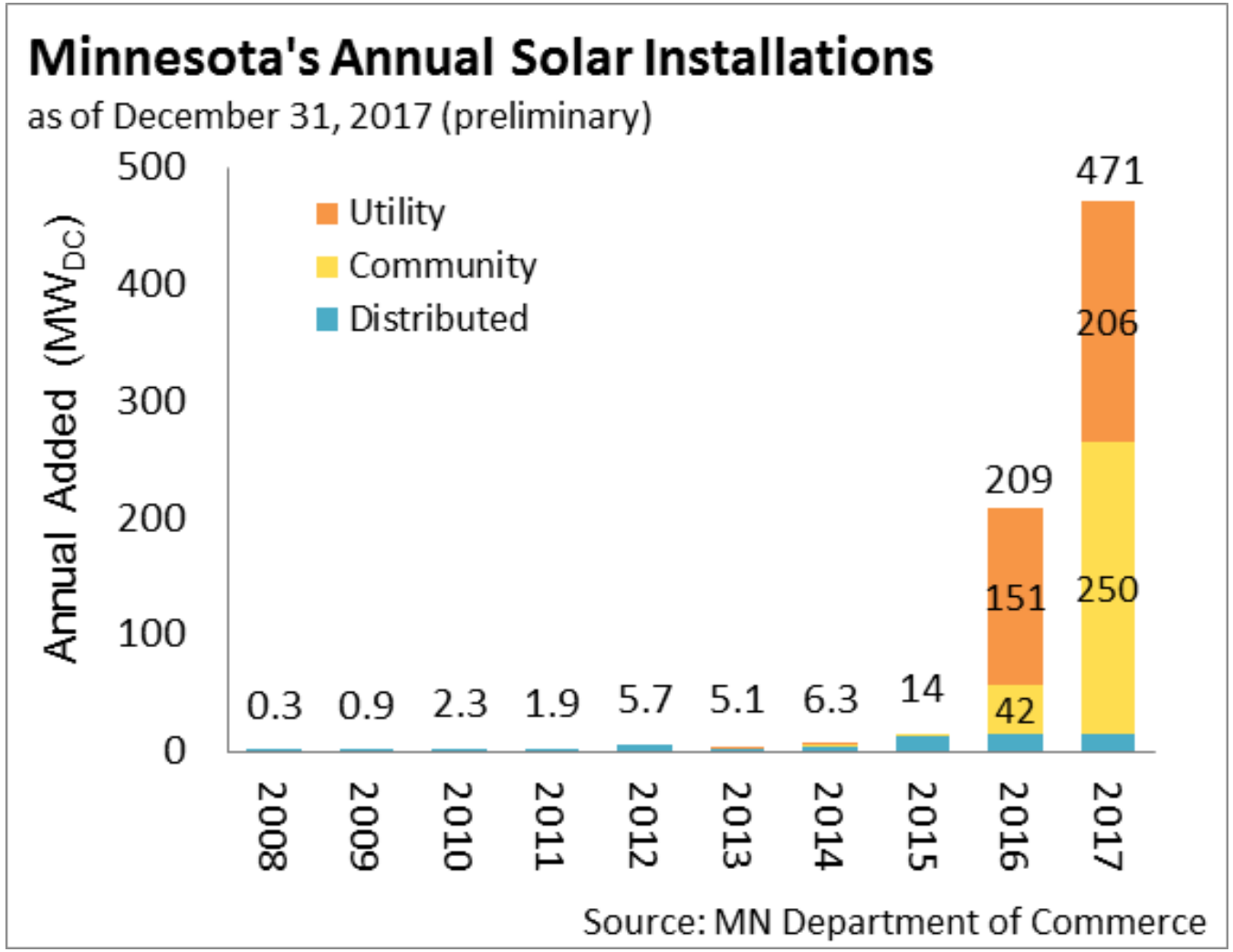


Historic Minnesota Solar Statistics-Annual



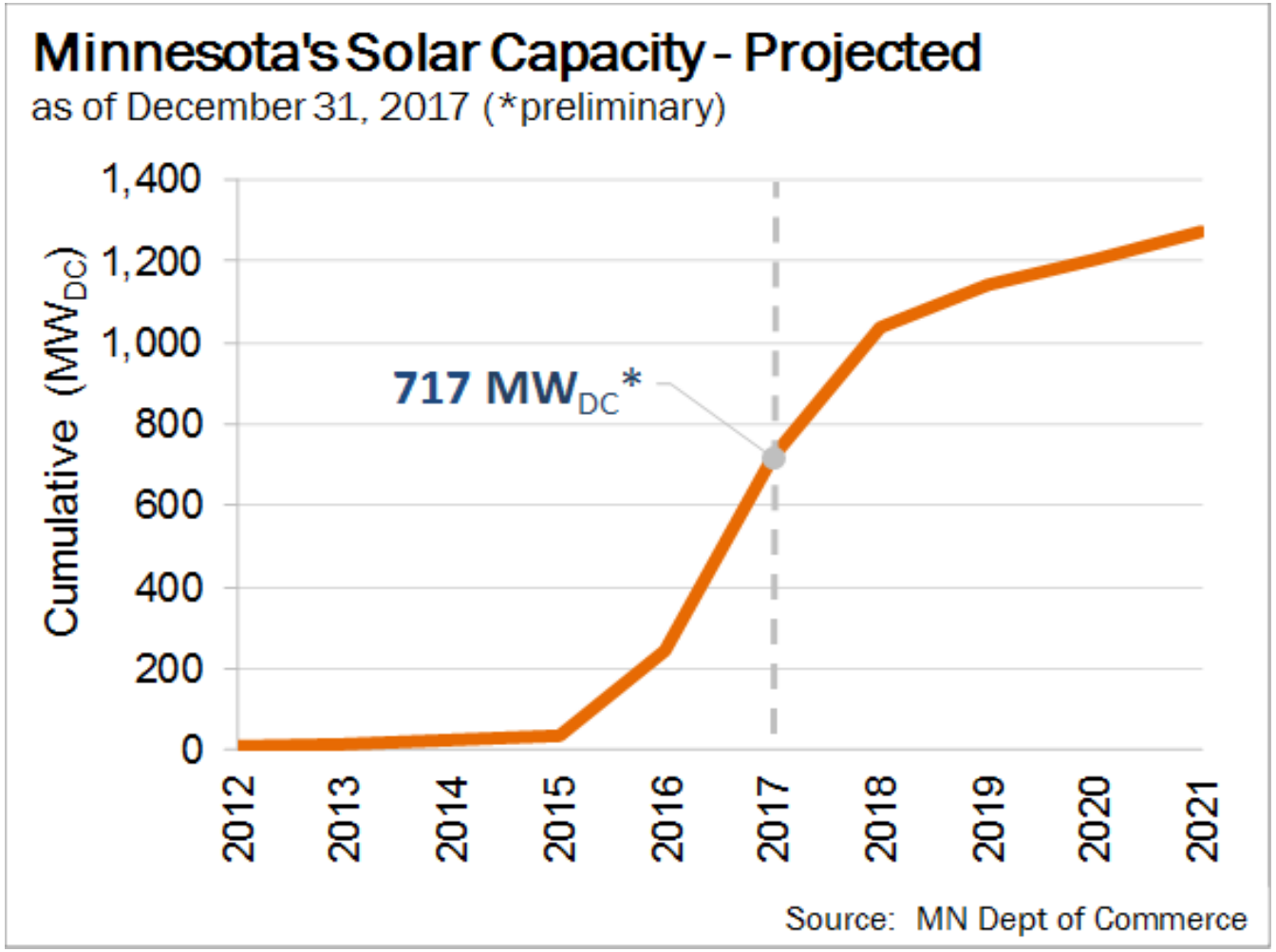
Historic Minnesota Solar Statistics-Annual by Sector

- 2/3 of total MN solar capacity was installed in 2017
- Community solar:
  - 20% of new capacity in 2016
  - 53% of new capacity in 2017
- More rooftop solar as well

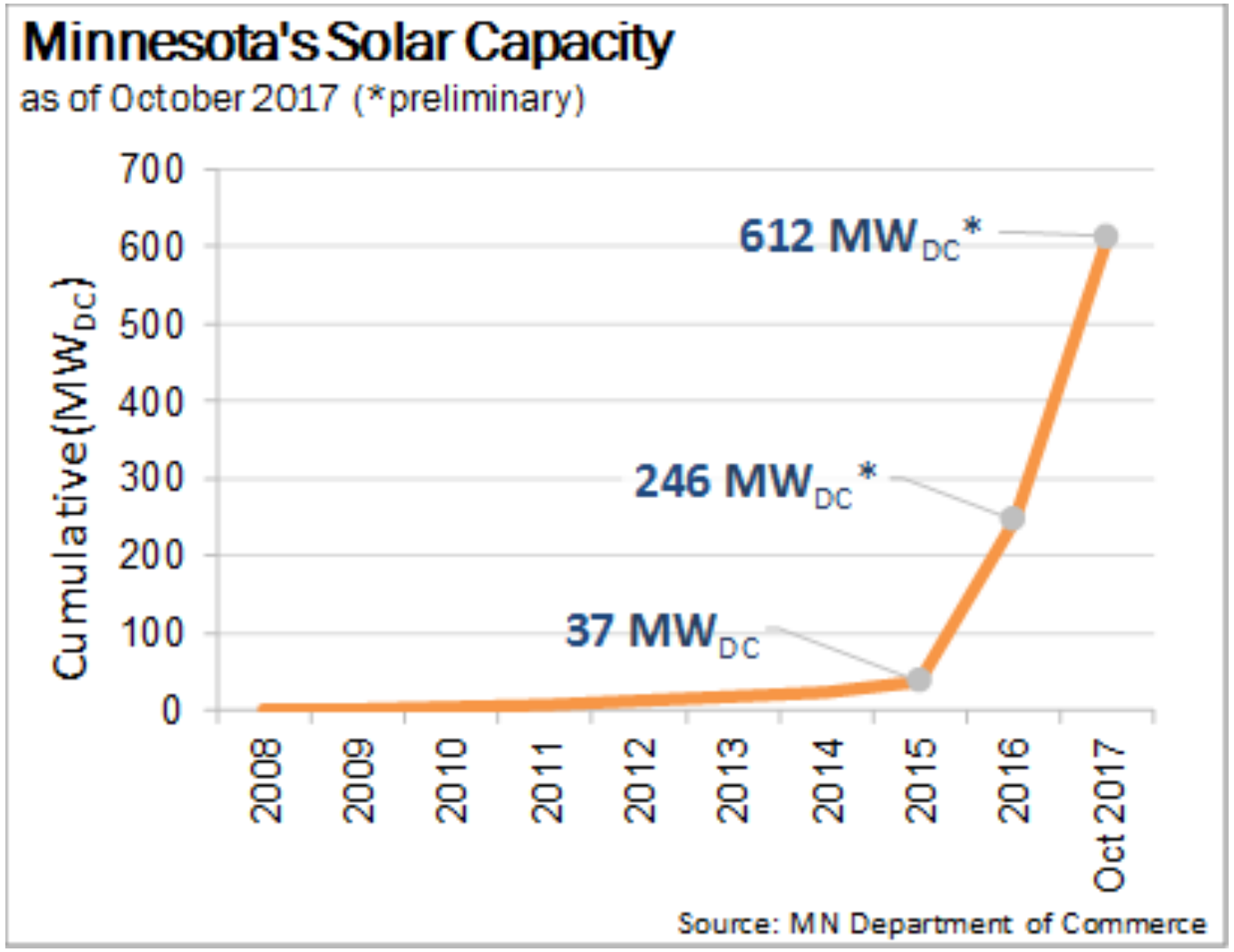


Minnesota Capacity Projection 2020

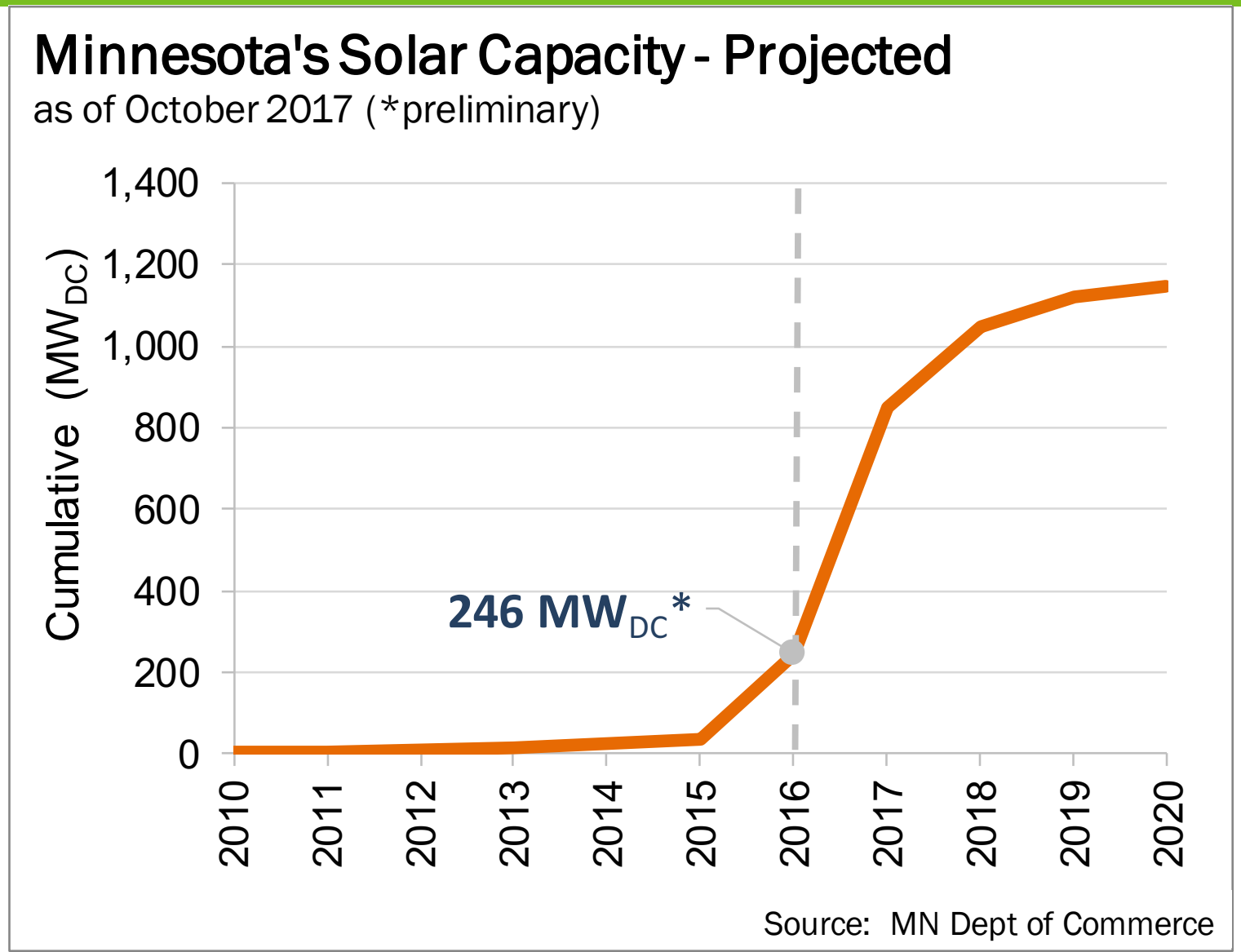
- Today Minnesota gets 1% of electricity from solar
- Goal: 10% by 2030
- ~6,000 MW (2030)



Historic Minnesota Solar Statistics

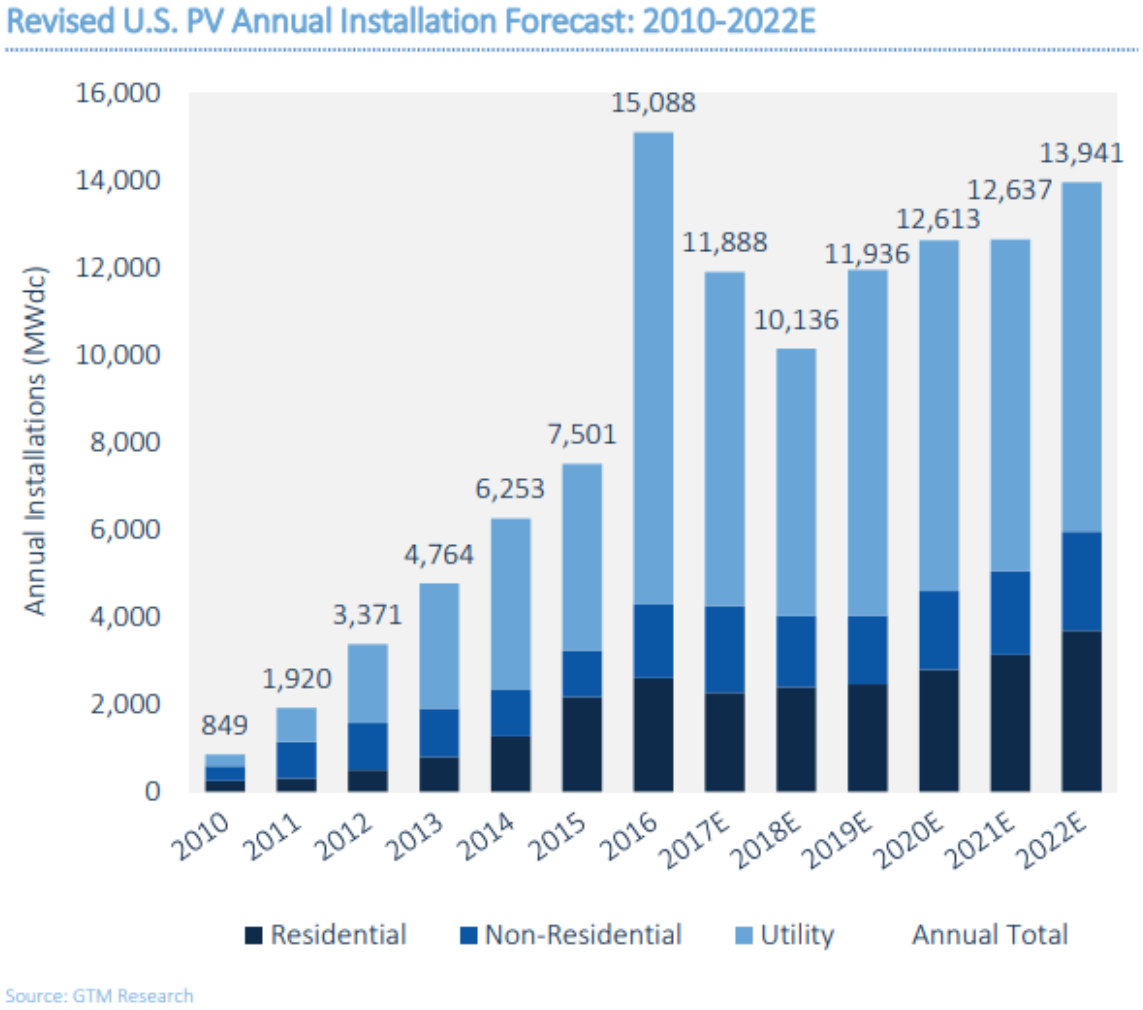


Minnesota Capacity Estimate 2020



U.S. Historic and Projected Solar

- Annual installations
- Today the US gets 2% of electricity from solar
- ~6,000 MW (2030)



Source: GTM Research

Global Historic and Projected Solar

- Cumulative installations
- 85 MW in 2017
- China leads deployment
- U.S. consistently #2
- India, Japan, Germany always among top 5

Source: GTM Research, Global Solar Demand Monitor Q1 2017

10% Statewide Solar Goal

Solar Electricity Standard

- 1.5% by 2020 (investor owned utilities)

Solar Electricity Goal

- 10 % by 2030 (~6 GW)
- 10x more solar than installed today

MN Solar Pathways over-arching goal

Collaborating to find least-risk, best-value strategies for Minnesota to achieve its 10% solar energy goal

MN **SOLAR** PATHWAYS

illuminating pathways to 10% solar

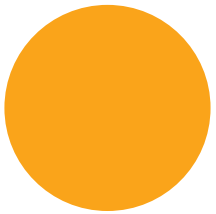
Powered by SunShot
U.S. Department of Energy

Minnesota Solar Pathways

Evaluates technical and economic potential for technologies to complement solar in future high penetration scenarios of 10% and beyond

How much land is 10% solar in MN?

= 86,943 mi²



10% Solar = 85 mi²
0.01% of MN's land

Farms = 40,625 mi²
47% of MN's land

Recap

What percentage of Minnesota's energy comes from solar today?

Recap

1%

Recap

Minnesota has a goal of __ % of the state's energy from solar in 2030?

Recap

10%

Solar Ready: Building with the future in mind

Solar Ready Building Design Guidelines

Report: Solar Ready Building Design Guidelines

- Prepared for the Minneapolis Saint Paul Solar Cities program by Lunning Wende Associates, Inc., coordinated by CR Planning, Inc. and funded by National Renewable Energy Laboratory

What is Solar Ready?

The National Renewable Energy Lab defines a solar ready building as being designed and built:

“to enable installation of solar photovoltaic and/or heating systems at some time after the building is constructed.”

Three Solar Ready Components

Place to put the modules

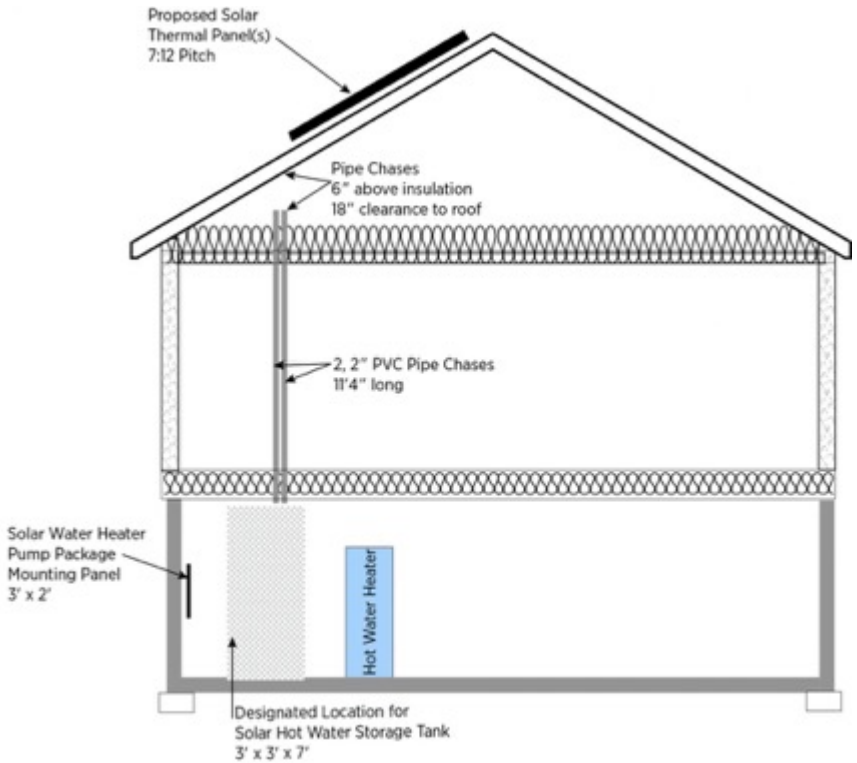
- Roof, ground, or pole

A means to get the power where you need it

- Chase
- Trench

Equipment Space

- Utility Room
- Garage



A Designated Space for Panels

Unrestricted solar access

- Shade free
- South Facing

Free of obstructions

- Roof vents
- Plumbing stacks

Structurally sound

- Weight
- Wind loads

What does a Solar Ready roof look like?

What does a Solar Ready roof NOT look like?

What does a Solar Ready roof NOT look like?

- Vent stack in middle of the roof
- Chimney placement
- Gable is not ideal
- Trees grow (and shade the roof)

Electric Vehicle Ready: Building with the future in mind

Electric Vehicles

- 5,000 Plug in Electric Vehicles in Minnesota today
- Often fueled by solar and wind
- High correlation between EV and solar ownership

What does EV Ready look like?

EV Ready Level 2 Charging

- 240V/40A outlet with dedicated circuit in garage

What does EV Ready look like?

EV Ready Level 2 Charging

- Homeowner adds charging station when ready

Standardized Residential Load Tables for Minnesota

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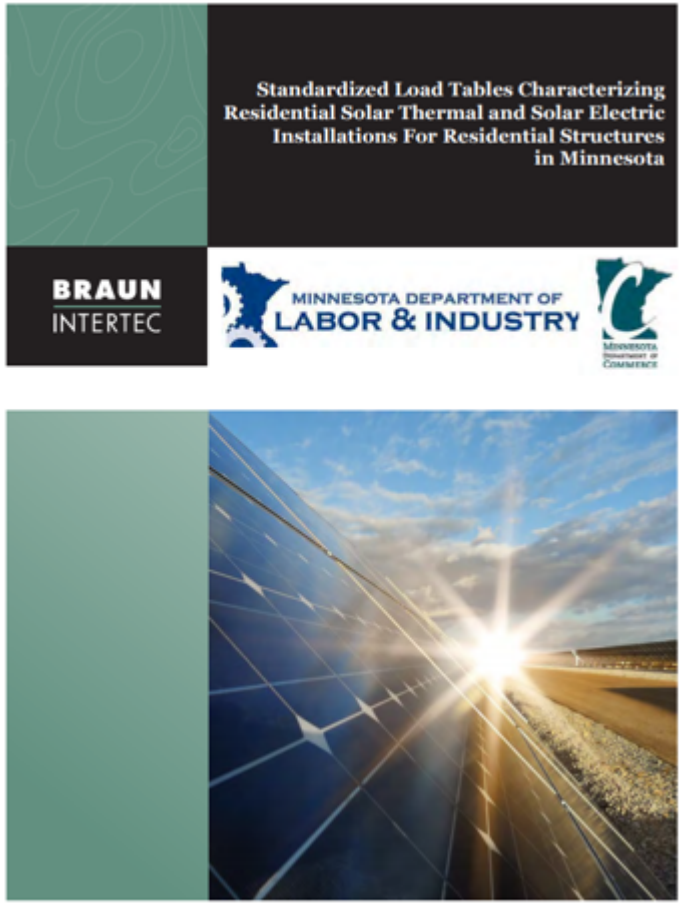
Standardized Residential Load Tables for Minnesota

- Roof pitch
- Maximum allowed distributed weight of solar energy system
- Maximum distance between the system and the roof below
- Concentrated load imposed by the panel on the roof sheathing

Standardized Residential Load Tables for Minnesota



- Minimum size of roof rafters
- Maximum spacing of roof rafters
- Maximum spans of the rafters
- Wood species and minimum grade of lumber

Solar Permitting and Zoning

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Department of Energy: Local government actions

Harmonize solar permitting across AHJs

- Use resources from Bill Brooks today

Ensure fees align with cost

Offer online permitting

Offer streamlined permitting

- Post permitting checklist online

Permitting and Zoning Best Practices

Planning

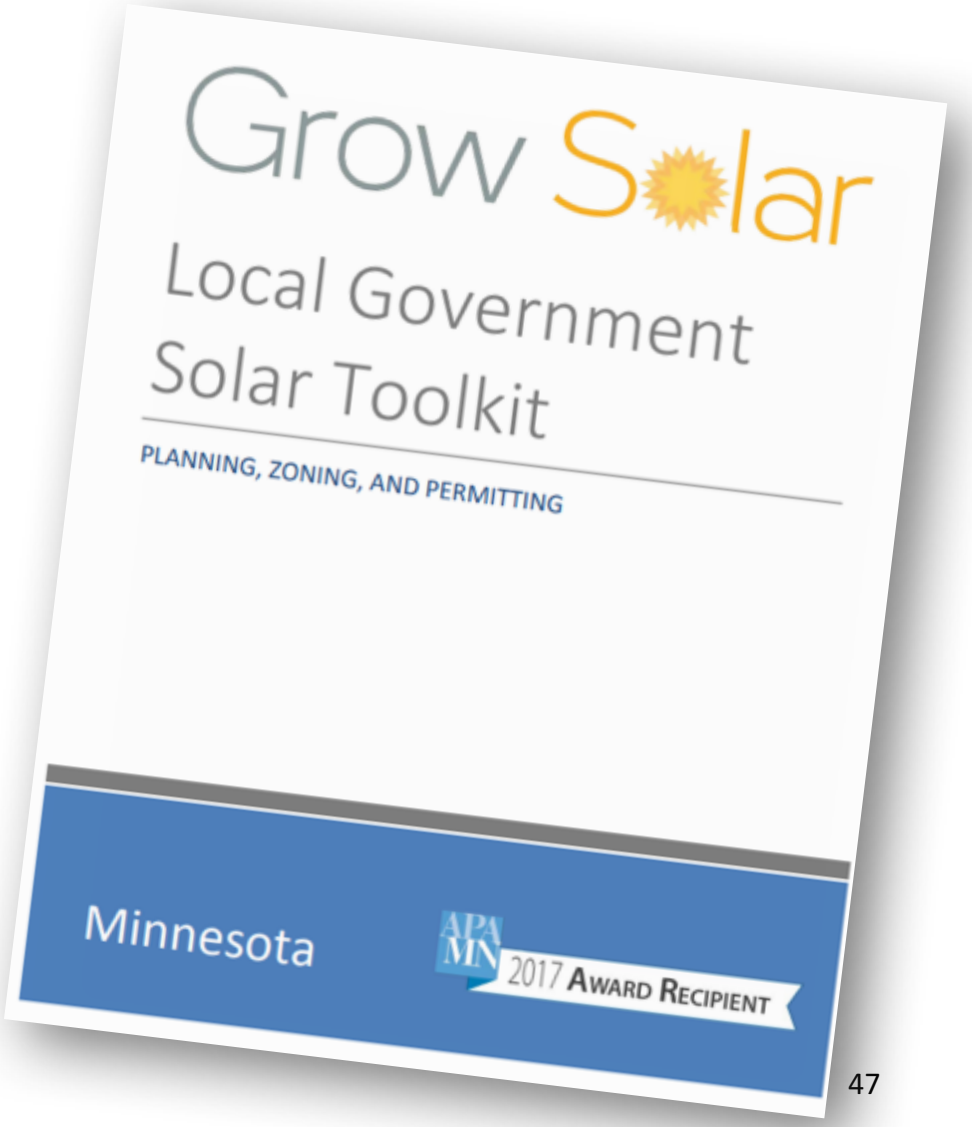
- *Comprehensive Plan Guide*

Zoning

- *Model Ordinances*

Permitting

- *Local Government Permitting Checklist*



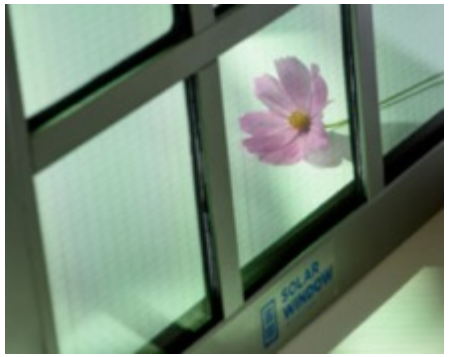
Solar Technology Trends

Building Integrated PV

- Roofing Shingles and Tiles
- Windows

Solar + Storage

- Back up power
- Demand charge management



Resources

1. Solar Ready Design Principals
2. Standardized Load Tables Characterizing Residential Solar Installations For Residential Structures in Minnesota
3. Model Expedited Permit Process and Fee Structure (Great Plains Institute)

Terry Webster
Senior Events & Publications Coordinator

- Author
- Presenter
- Designer
- Contractor

Why Do We Need Smart Stuff? And What Does it Matter to Me, Anyway?

Terry Webster | Events & Publications Coordinator

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Efficiency & Conservation

- **Efficiency:**
  - Equipment, devices, buildings that use less energy because of advancements in design, materials, operation
- **Conservation:**
  - Using less energy as a result of the *actions or behaviors of humans* to control the use or operation of equipment, devices, or buildings

Efficiency: All About Things

- **Everything is getting more efficient**
  - Furnaces, boilers, air conditioners, water heaters, lighting, electronics, appliances…
- **Efficiency is the 3rd largest source of electricity in US**
  - Coal: 27%
  - Natural Gas: 27%
  - **Efficiency: 18%**
  - Nuclear: 16%
- **Many things are nearing their maximum efficiency**

Conservation: All About People

- **Relies on people to *change* what they are doing:**
  - Turn things off
  - Use things less
  - Accept limitations on comfort, convenience, accessibility
- **Expects willingness and compliance**
- **Believes people always act in their own best self-interest**
- **Requires action in the physical world**

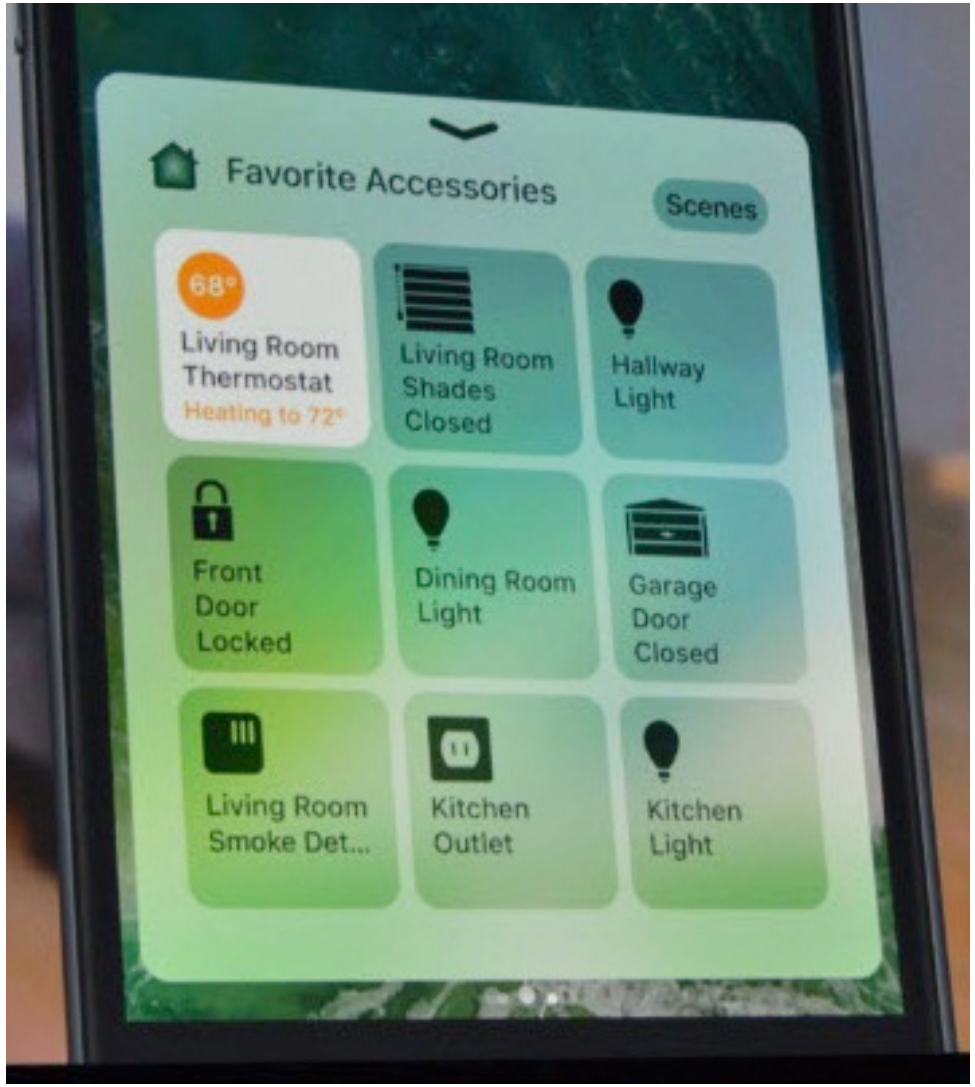
A Brief History of Human Behavior

- **Desire Paths**
  - Despite the best intentions of architects, engineers, and designers, people will still seek the path of least (perceived) resistance.

Technology that supports our Desire Paths

Available Smart Products

- LED Lighting
- Thermostats
- Appliances
- Plugs & Switches
- Leak Detectors
- Home Security
- Smart locks



LED Lighting

- **High Efficiency**
  - 90+ lumens/watt
- **Long Life**
  - 25+ years (at 3 hrs/day)
- **Wide range of brightness**
  - 100-3,000 lumens
- **Full range of color temperatures**
  - 2,500K – 6,500K

LED Lighting

- **Replacement bulbs:**
  initial market penetration
  - Best for DIY
- **Integrated LED fixtures:**
  price competiveness with buying a fixture *plus* a bulb
  - Good for new construction and remodel market
  - No replaceable parts, so at end of life requires new fixture

“Dumb” LED Fixtures

Smart LED Fixtures

- White LED Smart Color Tunable Flushmount Ceiling Light
- Wink Hub Required
- Control your lights from anywhere with no bulbs to replace
  - 1,000 Lumens
  - 2,700 K – 5,000 K
  - 14 W

Smart LED Fixtures

- Hue White Ambiance Fair Dimmable LED Smart Flushmount
- Use like a normal LED, or have full control with the Hue App
- Pair with Hue Bridge to unlock enhanced lighting experiences
  - 3,000 Lumens
  - 3,000K
  - 39W

Smart LED Fixtures

- **When integrated with Smart Home systems provide efficient lighting controls**
  - Occupancy/motion
  - Time of day
  - Length of time
  - Brightness/color temperature
  - Remote operation/programming

LED Construction Implications

- **Low profile, low heat permit innovative installations**
  - Stairwells
  - Recessed into ceilings, walls
  - Cabinets—under & on top
- **Work with electrician to plan**

Thermostats

- **Manual: Big energy wasters**
  - Not adjusted when building unoccupied
- **Programmable: Only slightly better**
  - 70% are left on factory default settings
- **Smart thermostats: Nearly effortless**
  - After initial set-up and learning time, provide effective controls of HVAC systems (10%-15% savings estimates)

From ENERGY STAR fact sheet:

- **What is the difference between a smart thermostat and a programmable thermostat?**
  - Programmable thermostats require user programming that is static until manually adjusted. **Based on the latest research, homeowners generally don't understand how programmable thermostats work and may not program them at all**, which can lead to higher utility bills. Smart thermostats, by contrast, are designed to learn user preferences and/or automatically adjust settings based on occupancy and indoor and outdoor temperature.

Connected Smart Thermostats

- **Integrated with smart home systems**
  - Alexa, Apple HomeKit, Samsung SmartThings, IFTTT, etc.
  - Remote monitoring/warnings
  - Occupancy sensing
  - Heating, cooling, humidity, ventilation

Smart Thermostat Construction Implications

- **Sufficient control wires**
  - PVC/tubing chase to thermostat location
  - Eventually all furnaces/AC/ventilation equipment will be wi-fi
- **Wireless router centrally located**
- **Work with HVAC to plan**

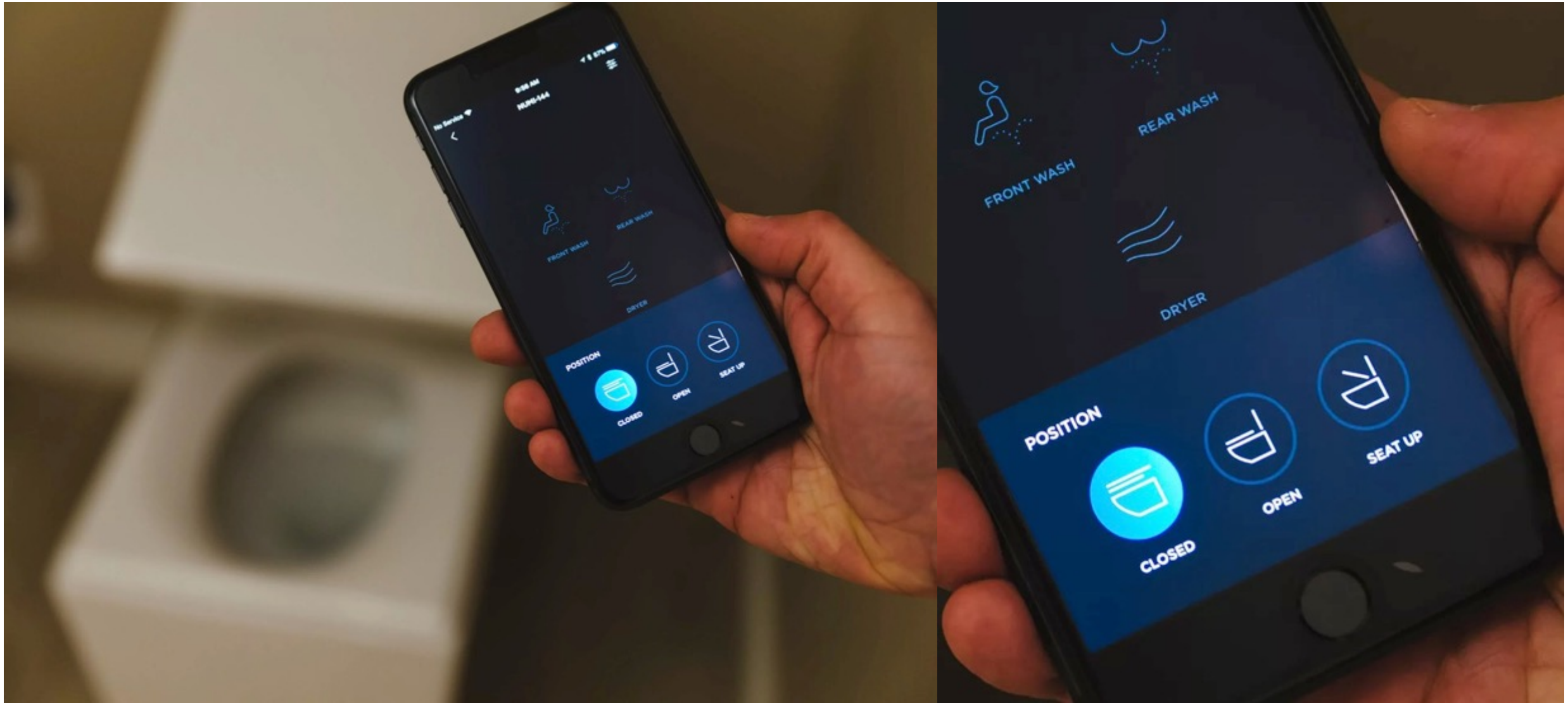
Smart Appliances

- **WIFI Refrigerator**
  - Create shopping lists—through built-in screen or remotely
    - Send to your phone when at store
    - Automatically place order with selected stores/delivery services
  - Camera allows you to look inside refrigerator and see what's there—remotely
  - 'Tag' items with use-by date

Other Smart Appliances

- WIFI Dishwasher
- WIFI Oven
- WIFI Washer
- WIFI Dryer
- Room Air Conditioner

I’m not… ah… fooling you…



Smart Plugs/Switches

- **Control anything with a plug**
  - Lights, fans, holiday decorations, electronics, blender (cats-on-counter deterrent)

- **Some will even provide energy monitoring**
- **System specific**
  - Not all plugs/switches will work with all systems

Smart Leak Detectors

- **Alarm type**
  - Connected through the smart home system, sounds audio alarm and sends alerts to smart phones
    - Mostly used in specific locations deemed susceptible to issues
      - Second floor laundry, sump pump, mechanical room
    - Requires someone to respond to limit damage

Smart Leak Detectors

- **Alarm type + Shut-off**
  - Connected through the smart home system
    - Sends alerts to smart phones
    - Can detect very small leaks, based on learned water use patterns
  - Shut-off unit installs at house side of meter
    - Catastrophic water flow initiates immediate shut down of main
    - Users can shut off water remotely for smaller issues or weather events

Smart Home Security

- **Set-up through home network systems**
  - Z-Wave/ZigBee/Alexa/Nest etc.
  - Sirens, window/door sensors, cameras, motion detectors
  - Some have contracts with security companies
  - Can alert for intruders, temperature changes, power outages
  - Can provide video/audio feeds to your phone

Smart Door Locks

- **Using existing deadbolt**
  - Simple replacement
  - Some are Bluetooth only
    - Must by within 30’
    - Allows geo-fencing, sharing unlock with virtual keys to others
  - Some can also be controlled remotely
    - Through home security or other systems

Smart Door Locks

- **Using new deadbolts/locks**
  - Some are Bluetooth only/some can also be controlled remotely
  - Some have cameras/audio
  - Some are integrated into new door installations
  - Some have keypads for granting access to others

Smart Garage Doors

- **Wi-Fi connected**
  - Remote checking on open/close
  - Geo-fencing with auto opening
  - Send temporary codes for deliveries
  - Camera to see who is entering
  - Battery-back-up

Smart Home Stuff Caveats

- **Construction Implications**
  - A few, mostly around lighting, wiring
    - Most products are easy to retrofit, but more options if planned ahead
- **Set-up & Installation**
  - Can be daunting, especially if trying to match multiple products to one home system

Smart Home Stuff Caveats

- **Energy Savings**
  - Efficiency: 0
  - Conservation: more
    - These product save energy because they automate many energy-using devices and *mostly take people out of the loop*—unless they want in.
    - Acknowledge—and capitalize on—our **Desire Paths** when it comes to controlling home functions.

Smart Home Stuff Caveats

- **Security Concerns**
  - Systems can (theoretically) be hacked
    - Companies have huge incentives to provide protection
  - Systems can (and do) provide data upstream to companies
    - So does Google. So does Amazon. So does Best Buy. So does… everyone.

Smart Home Stuff Caveats

Future Smart Home Stuff

- **Time of use energy charges will drive control of:**
  - Dishwashers, laundry, water heating, EV charging
  - This will be a **BIG DEAL**…
- **Integration with on-site solar energy**
  - Measuring production/use
  - Including electricity sales/purchase options
  - On-site storage will be a big factor

Why Smart Stuff?

- **To reduce energy-related carbon load we need every tool in the bag.**
  - Smart Stuff is one way to affect wide scale change in energy use patterns, especially when combined with high efficiency products.
- **Efficient equipment and devices are *not* enough.**

Why Smart Stuff?

- **Human behavior change is often:**
  - Slow
  - Unpredictable
  - Unreliable
  - Difficult to sustain over time
  - Requires actual caring about outcomes
  - And when it comes to significant energy savings—*largely ineffective*

Why Smart Stuff?

- **Utility bill savings**
  - Potentially lower, especially space conditioning
  - Time of use energy charges can affect costs
    - Off-peak, variable pricing based on demand
    - Smart appliances can time their operation
- **Reduced energy usage**
  - Lower carbon footprint

Why Smart Stuff?

- **It's what customers are interested in**
  - Enhanced security, safety, comfort, convenience
- **If they haven't asked yet, they *will*…**

How Might Smart Stuff Matter to You?

- **An in-house "Smart Home Expert" is a benefit**
  - Can coordinate and integrate products, installations, and work with vendors/subs
  - Can provide new—and growing—market opportunities
  - Will differentiate from competitors
  - Can help with workforce management

And FINALLY…

- **How will solar, storage, and smart stuff affect our energy future?**
  - [Stacy ties it all together here]

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Questions and Discussion

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