

# HOME AND BUILDING ELECTRIFICATION:

## OPPORTUNITIES FOR NEW MEXICO

Dr. Patricia Sullivan

Dr. Olga Lavrova

Klipsch School of Electrical and Computer  
Engineering

Electric Utility Management Program



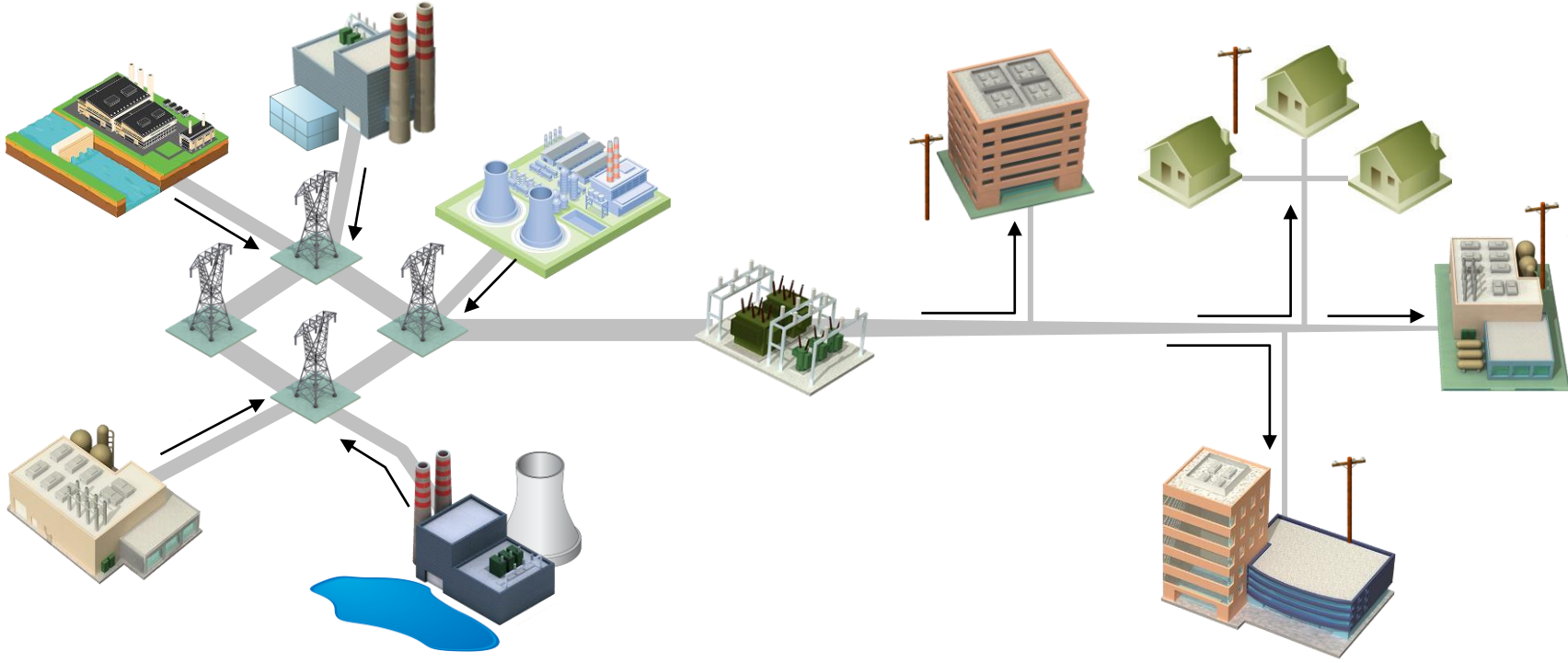
**BE BOLD.** Shape the Future.

# Motivation

- The United States has a long-term goal to decarbonize the electric grid<sup>1</sup>. This will require several market transformations across multiple sectors, including renewable power generation and storage options, increased electrification of end-use energy consumption and transition to demand-side management of residential and industrial loads.
- Electrification of multiple sectors (residential, commercial, industrial, transportation, etc) will require ubiquitous applications of power electronics of various ratings

[1] The White House. 2021. "President Biden Signs Executive Order Catalyzing America's Clean Energy Economy Through Federal Sustainability." <https://www.whitehouse.gov/briefing-room/statements-releases/2021/12/08/fact-sheet-president-biden-signs-executive-order-catalyzing-americas-clean-energy-economy-through-federal-sustainability/>

# Yesterday's Power System ... One Way Power Flow

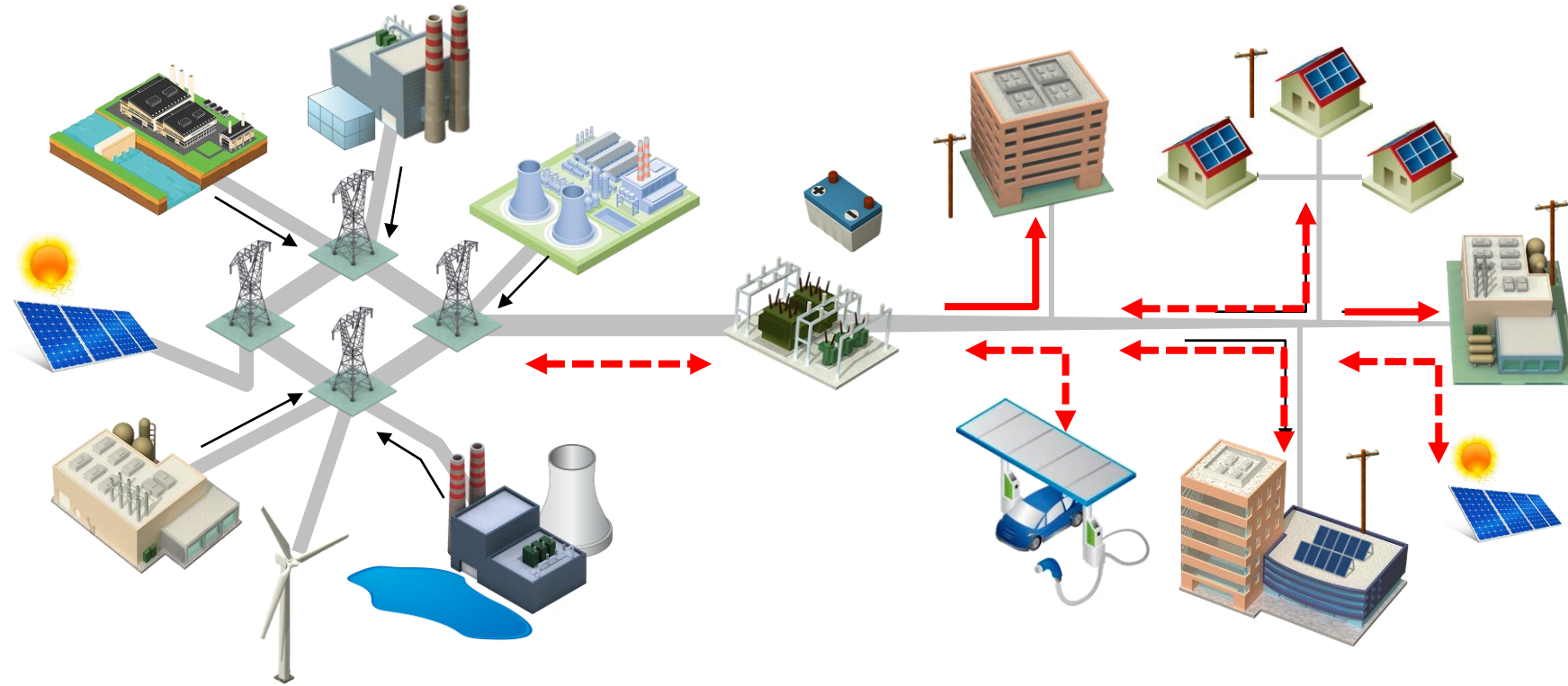


**Generation-Transmission**

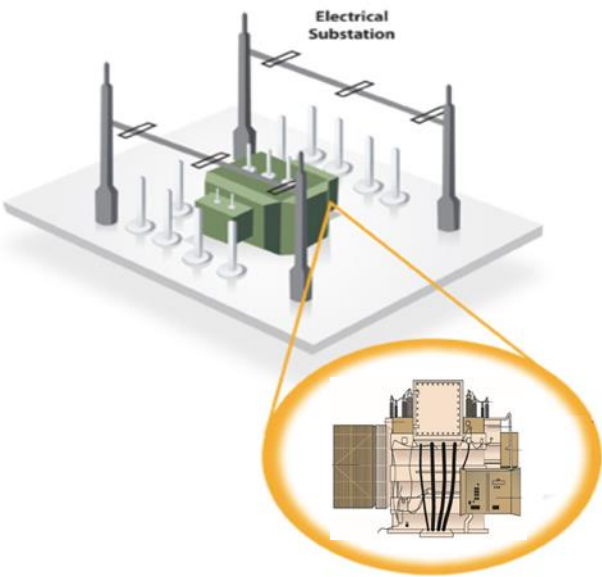
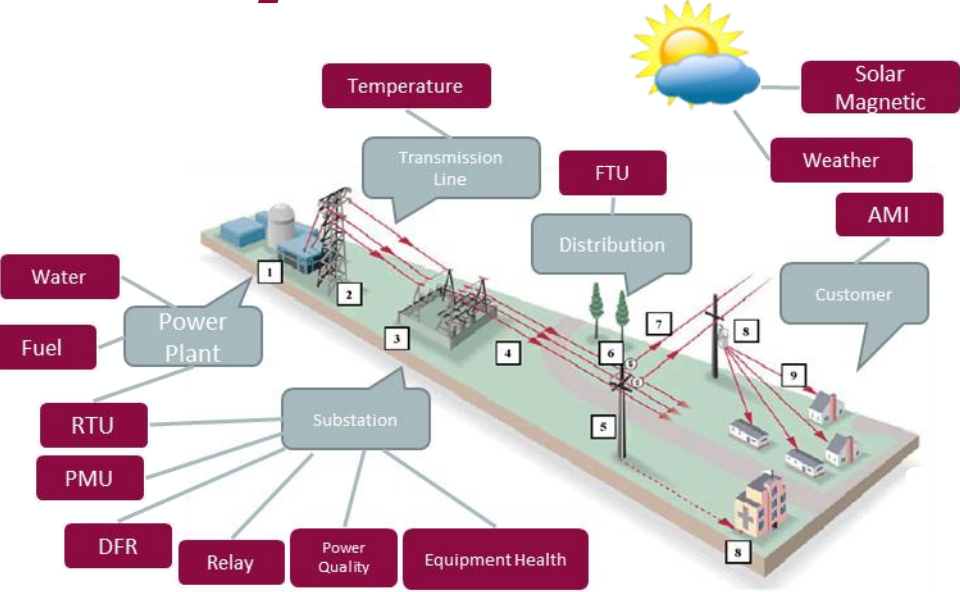
**Substation**

**Distribution System**

# Today's Power System ... Two Way Power and Information Flow



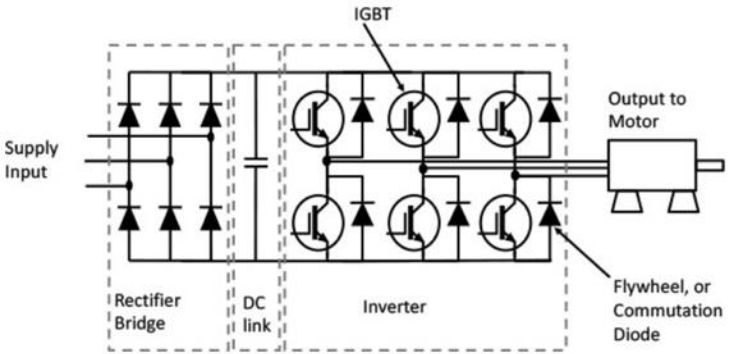
# Where to Electrify : System-Wide Application Space



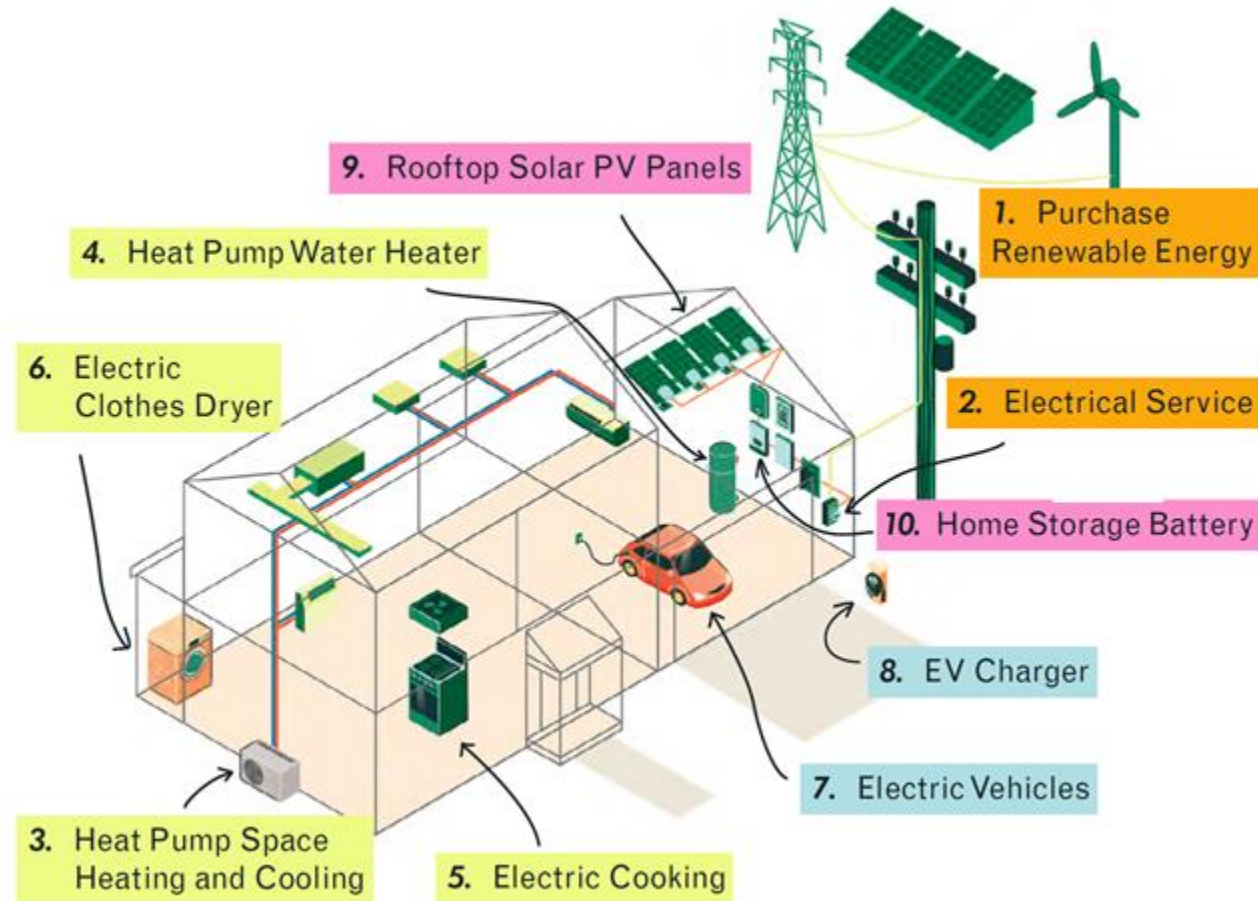
Miele showcases a washing machine that knows when electricity is cheap  
 By Bridget Borgobello  
 12:16 September 1, 2010  
 2 Comments  
 9 Pictures



Modified from Duke Energy  
<https://www.progress-energy.com/florida/home/safety-information/storm-safety-tips/restoration.page?>



# Where to Electrify: Residential Applications



“Electrify Everything in Your Home: A Guide to Comfy, Healthy, Carbon-Free Living”, Rewiring America,  
<https://www.rewiringamerica.org/electrify-home-guide>

# Electrification of Buildings

US DOE in May 2021 issued A National Roadmap for Grid-Interactive Efficient Buildings <https://gebroadmap.lbl.gov>

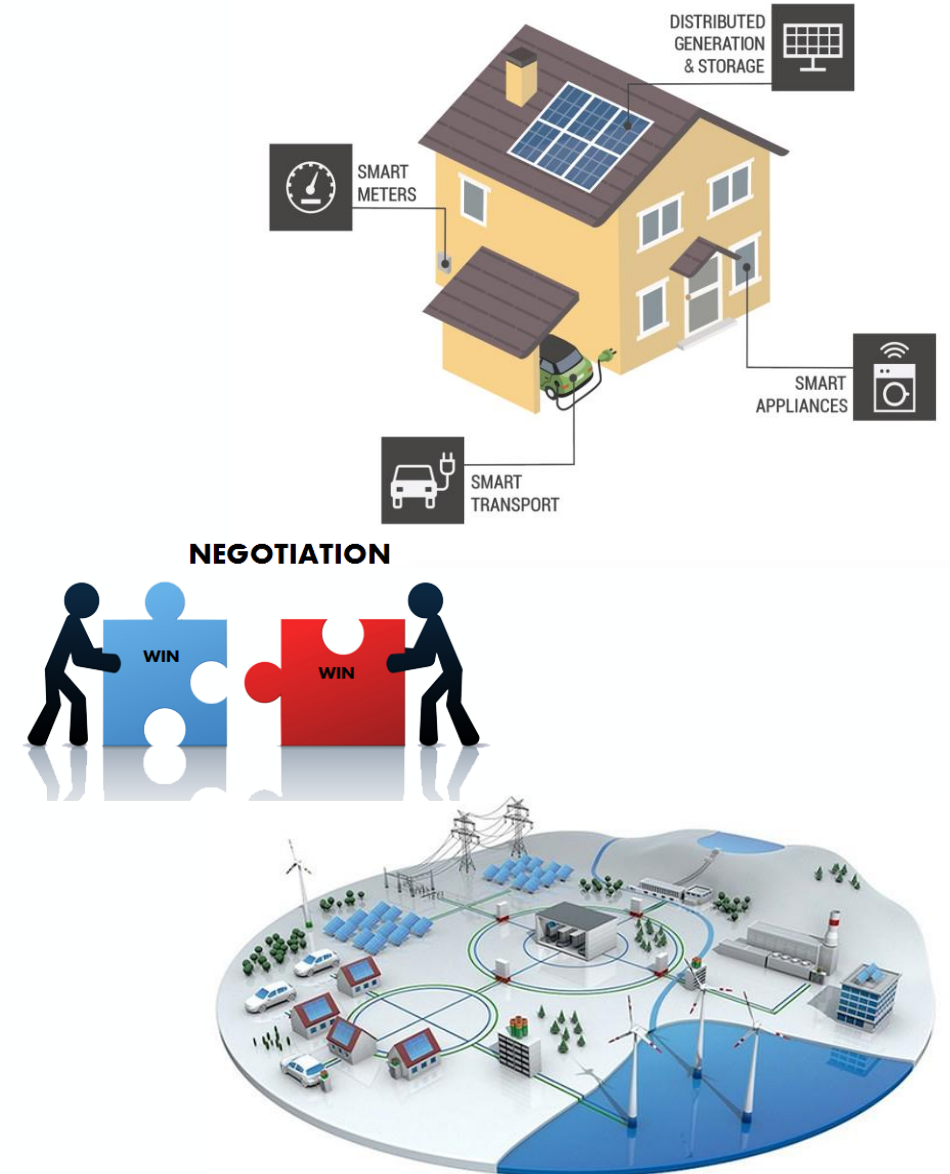
- Buildings that are not only efficient but also flexible.
- DOE estimates that with only mid adoption of GEB technologies (Adoption based on middle of the range of achievable adoption estimates) the US power grid can realize the following by 2030:
  - 284 TWHs in annual electricity savings;
  - 78 GWs in peak electricity demand savings;
  - \$13B in annual system value.

ENERGY: The Power to TRANSITION NM's Economy, Grid Alternatives, iWest 2022

<https://www.nmenergymanufacturing.com/wp-content/uploads/2021/09/Energy-The-Power-to...-.pdf>

# Benefits of smart and electrified buildings?

- Safety !
- Well paying jobs !
- Reliability and longer lifetime of equipment
- Resiliency to natural and man-made threats
- Higher efficiency of energy utilization
- Higher efficiency of Renewables utilization
- Customer flexibility and customer choice
- Energy savings, therefore energy bill savings
- Better quality of life for consumers





# Electrification as a new efficient and flexible resource for energy demand:



Illustration of a commercial Grid Efficient Building ( GEB ), or, for residential HAN), efficient components and communications

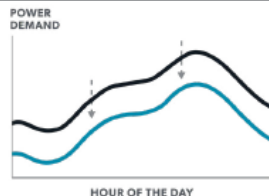
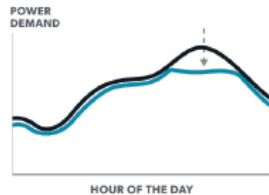
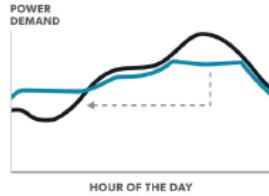
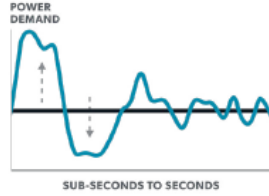
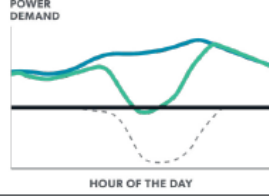
[Ref: Satchwell, Andrew, Mary Ann Piette, Aditya Khandekar, Jessica Granderson, Natalie Mims Frick, Ryan Hledik, Ahmad Faruqui et al. "A National Roadmap for Grid-Interactive Efficient Buildings." (2021).

# Electrification of building energy controls

## California 2019 Residential Compliance Manual

### Appendix H - Demand Responsive Controls

- Demand response is an increasingly important function of buildings as distributed energy resources become more common and customers have access to time of use electricity rates and incentive programs designed to encourage demand side optimization.
- Demand response occurs on a range of timescales, from seconds to seasons, and represents any demand change in response to grid or economic needs.
- In addition to current time of use electricity rates, utilities in the future will likely connect electricity costs to high frequency fluctuations in both the supply and demand for electricity.
- Appropriate demand responsive controls allow building operators to maintain the quality of services a building provides and reduce the total cost of energy by automating a building's response to changes in electricity rates.

	LOAD IMPACT	EXAMPLE MEASURE	EXAMPLE BENEFIT
Efficiency		Building has an insulated, tight envelope and an efficient HVAC system to reduce heating/cooling energy needs	Reduced costs of burning fuel to satisfy energy demand, and reduced emissions associated with lower fuel use
Shed Load		Building dims lighting system by a preset amount in response to grid signals while maintaining occupant visual comfort levels	Reduced investment in generation and transmission capacity due to lower peak demand
Shift Load		Connected water heaters pre-heat water during off-peak periods in response to grid signals	Reduced energy costs due to shifting consumption to cheaper hours of the day; avoided curtailment of renewables during off-peak periods
Modulate		Batteries and inverters autonomously modulate power draw to help maintain grid frequency or control system voltage	Reduced ancillary services costs, improved integration of variable generation resources (e.g., wind, solar)
Generate		Rooftop solar PV exports electricity to the grid	Reduced T&D losses due to on-site consumption; avoided need for grid-scale generation

[Ref: Satchwell, Andrew, Mary Ann Piette, Aditya Khandekar, Jessica Granderson, Natalie Mims Frick, Ryan Hledik, Ahmad Faruqui et al. "A National Roadmap for Grid-Interactive Efficient Buildings." (2021).

# NM Building Electrification: market potential

## Savings Summary Tables

Capacity of Net-Metered Energy 2018 in MW for All Technologies

Investor-Owned Utility	Residential	Commercial	Industrial	Total	Solar Only Total	Solar Percent of
						Total
Public Service Co of NM	81.6	50.4	0.0	132.0	132.0	100.0
El Paso Electric Co	16.2	3.9	0.0	20.1	20.1	99.9
Southwestern Public Service Co	0.6	7.0	0.5	8.1	8.1	100.0
<b>Cooperatives</b>						
Central New Mexico El Coop, Inc	1.5	0.4	0.0	1.9	1.8	92.8
Central Valley Elec Coop, Inc	0.1	0.0	0.0	0.1	0.1	99.3
Columbus Electric Coop, Inc	0.2	0.1	0.2	0.5	0.5	99.6
Continental Divide El Coop Inc	-	-	-	-	-	-
Farmers Electric Coop, Inc - (NM)	0.2	0.1	0.0	0.3	0.2	64.3
Jemez Mountains Elec Coop, Inc	1.1	0.3	0.0	1.4	1.4	100.0
Kit Carson Electric Coop, Inc	2.0	0.7	0.0	2.6	2.5	95.9
Lea County Electric Coop, Inc	-	-	-	-	-	-
Mora-San Miguel Elec Coop	0.6	0.0	0.0	0.6	0.6	100.0
Navopache Electric Coop, Inc	0.0	0.0	0.0	0.0	0.0	86.0
Otero County Electric Coop Inc	3.5	1.3	0.0	4.8	4.8	99.8
Rio Grande Electric Coop, Inc	-	-	-	-	-	-
Roosevelt County Elec Coop Inc	-	-	-	-	-	-
Sierra Electric Coop, Inc	0.2	0.0	0.0	0.3	0.3	100.0
Socorro Electric Coop, Inc	0.4	0.4	0.0	0.8	0.8	100.0
Southwestern Electric Coop Inc - (NM)	0.1	0.0	0.0	0.1	0.1	50.0
Springer Electric Coop, Inc	0.0	0.0	0.0	0.1	0.1	100.0
Tri-County Electric Coop, Inc	-	-	-	-	-	-
<b>Public Utilities</b>						
City of Farmington - (NM)	0.5	0.1	0.0	0.7	0.7	100.0
City of Gallup - (NM)	0.1	0.1	0.0	0.2	0.2	100.0
Los Alamos County	0.6	0.0	0.0	0.6	0.6	100.0
Navajo Tribal Utility Authority	-	-	-	-	-	-

Region	HVAC	Water Heating	Lighting	Electronics	Refrigeration	Appliances	Total
Southwest	3,500	1,141	1,143	668	1,285	1,094	8,831
California	7,620	2,516	2,841	1,338	3,777	1,709	19,801
Texas	15,068	4,831	3,780	1,340	3,379	2,472	30,870
Southeast	43,105	19,430	12,579	4,350	12,495	7,593	99,551
Upper Midwest	6,207	2,939	2,509	1,275	2,660	2,204	17,794
Northeast	6,153	2,772	3,423	1,508	4,036	1,838	19,730
Northwest	5,543	2,261	1,934	1,173	2,446	1,693	15,049
Lakes / Mid Atl.	18,963	8,359	9,087	3,740	9,116	4,751	54,015
Rocky Mountains	1,589	483	559	280	599	458	3,968
Lower Midwest	6,398	2,322	1,858	746	1,791	1,394	14,509
<b>TOTAL</b>	<b>114,145</b>	<b>47,053</b>	<b>39,712</b>	<b>16,417</b>	<b>41,584</b>	<b>25,205</b>	<b>284,117</b>

TABLE 10: ENERGY SAVINGS BY REGION AND END USE IN 2030

[Ref: Satchwell, Andrew, Mary Ann Piette, Aditya Khandekar, Jessica Granderson, Natalie Mims Frick, Ryan Hledik, Ahmad Faruqi et al. "A National Roadmap for Grid-Interactive Efficient Buildings." (2021).



**BE BOLD.** Shape the Future.

# Savings potential for real customers

	LIFE IN YEARS	ELECTRICAL UPGRADE	UP FRONT COST BEFORE REBATES	ANNUAL OPERATING SAVINGS	HARDER	% HOME EMISSIONS	IMPROVES AIR QUALITY	RENTER CONTROLS
<b>1. Purchase Renewable electricity</b>			\$0					R
<b>2. Electrical Service</b>	20-25 YRS 		\$750-4,000		✓			
<b>3. Heat Pump Space Heating and Cooling</b>	15-20 YRS 	AT INSTALL	\$1,000 DIY, TO \$20,000+	\$\$\$	✓	25%		R
<b>4. Heat Pump Water Heater</b>	10-15 YRS 	MAYBE	\$1,500 DIY, \$4,000 INSTALLED	\$		10%		
<b>5. Electric Cooking</b>	13-15 YRS 	YES	\$2,000-3,000			5%		R

<b>6. Electric Clothes Dryer</b>	10-13 YRS 	MAYBE	\$1,000-2,000	\$\$		3%		R
<b>7. Electric Vehicles</b>	20-25 YRS 		\$10K (USED) AND UP	\$\$\$		50%		R
<b>8. EV Charger (240V EVSE)</b>	10-15 YRS 	YES	\$500-2,500					R
<b>9. Rooftop Solar PV Panels</b>	20-30 YRS 	AT INSTALL	\$15,000-30,000	\$\$\$	✓	HELPS ALL		
<b>10. Home Battery Storage</b>	5-15 YRS <sup>6</sup> 		\$10,000-20,000	\$	✓	HELPS ALL		

**KEY:**

- \$ SAVE \$50+ PER YEAR
- \$\$ SAVE \$200+ PER YEAR
- \$\$\$ SAVE \$500+ PER YEAR
- INDOOR & OUTDOOR
- OUTDOOR

“Electrify Everything in Your Home: A Guide to Comfy, Healthy, Carbon-Free Living”, Rewiring America, <https://www.rewiringamerica.org/electrify-home-guide>

# Smart Home options

- Well paying jobs
  - Manufacturing opportunities for NM
  - Installation and maintenance jobs
  - R&D potential
- Higher efficiency of energy utilization
- Customer flexibility and customer choice
- Energy savings, therefore energy bill savings
- Better quality of life for consumers



July 6<sup>th</sup>, 2021

## New Mexico Energy Manufacturing

### Non-Wires Grid Alternatives: Behind-The-Meter

Olga Lavrova, NMSU

Daren Zigich, EMNRD

“Deploying an Advanced Metering Infrastructure (AMI) is a fundamental early step to grid modernization. AMI provides the framework for meeting one of the Modern Grid’s Principal Characteristics – Motivation and Inclusion of the Consumer”

From: Strategy, NETL Modern Grid, “Advanced metering infrastructure.”  
US Department of Energy Office of Electricity and Energy Reliability (2008).

#### Contents

Introduction .....	2
1.1 NM demand side energy management potential .....	2
1.2 Demand side energy management .....	3
1.3 Demand side management technologies .....	3
1.4 Opportunity statement and value proposition .....	6
2 Technology Overview .....	6
2.1 Technology readiness level (TRL) and deployment readiness .....	6
2.2 What energy supply/demand solutions does this technology address .....	6
3 Technology Opportunities .....	7
3.1 Opportunities space .....	7
3.2 Required improvements in cost and performance to make this commercially deployable .....	7
3.3 Examples of technology and manufacturing opportunities for NM: .....	7
3.3.1 Smart meters and intrinsic sub-components .....	7
3.3.2 Micro energy storage systems, (Thermal, Mechanical, Electrical, Electrochemical) .....	9
3.3.3 Communications infrastructure .....	10
3.3.4 Front-of-the-meter (FTM) DERs and controls .....	11
3.3.5 DC microgrid infrastructure .....	12
4 Relevance to New Mexico .....	13
5 Technology Challenges .....	14
6 Summary .....	15
6.1 Key takeaways .....	15
7 References .....	16

# In conclusion

- New Mexico and Southwest have a significant potential for electrification of broad range of industrial and residential sectors;
- Economic, societal and technological benefits will contribute to energy equality and can specifically benefit LMI and underserved populations;
- Electrification of residential and industrial applications will accelerate achievement of the New Mexico's Energy Transition Act goals.

# Thank you