

# **SUSTAINABILITY AND GREEN BUILDING**

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## **CLIMATE, CODES, AND CONSTRUCTION**

**Supported by Los Alamos County**

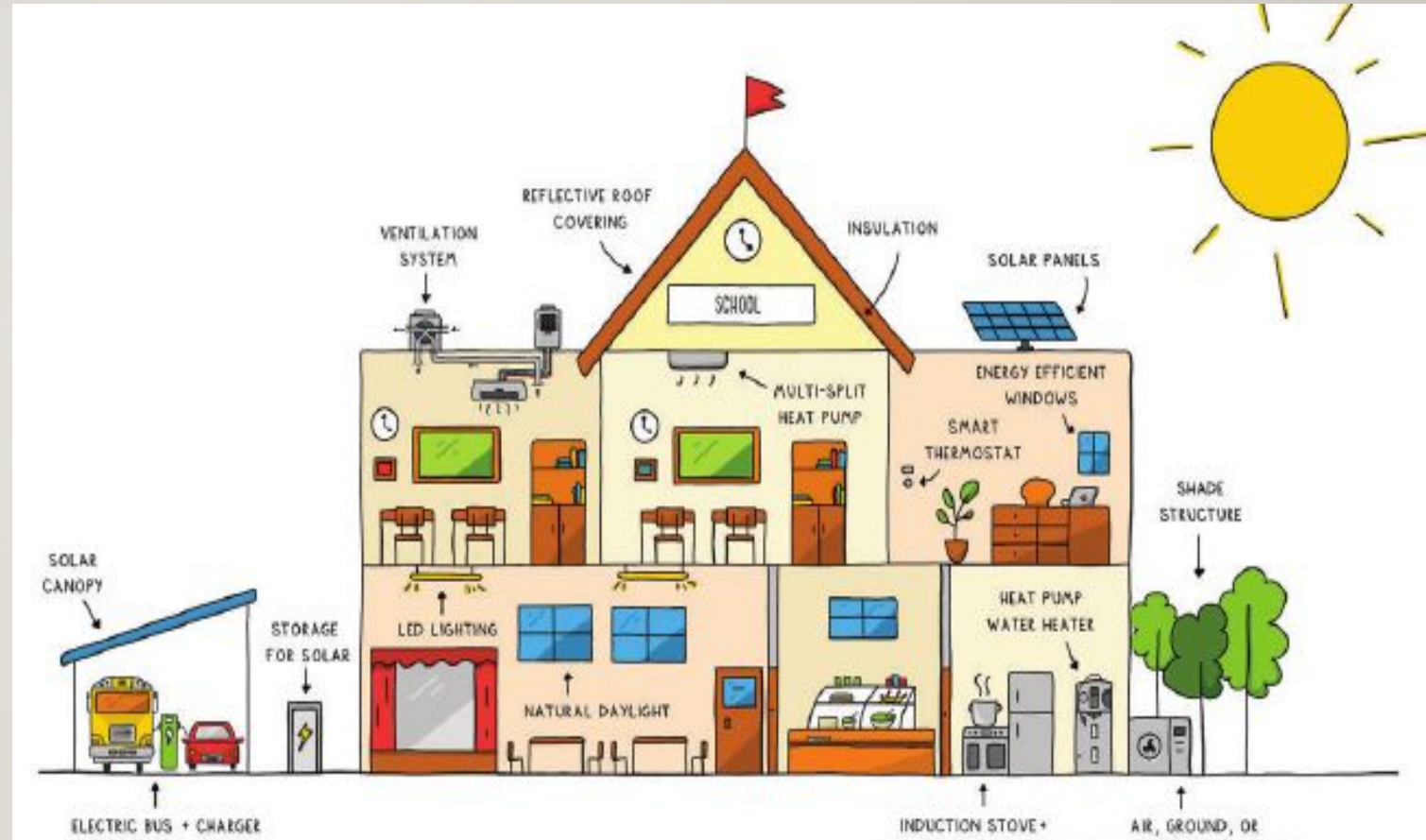
**November 18, 2024**



**LOS ALAMOS**

# LOOSE AGENDA

- 2
  - Background – Sustainability, Buildings, and Energy Codes– Massoud Mogadham, Sandra McCardell & Steven Shaw
  - Utility Goals and Resources – Abbey Hayward
  - Discussion
  - Tabletop Specifics



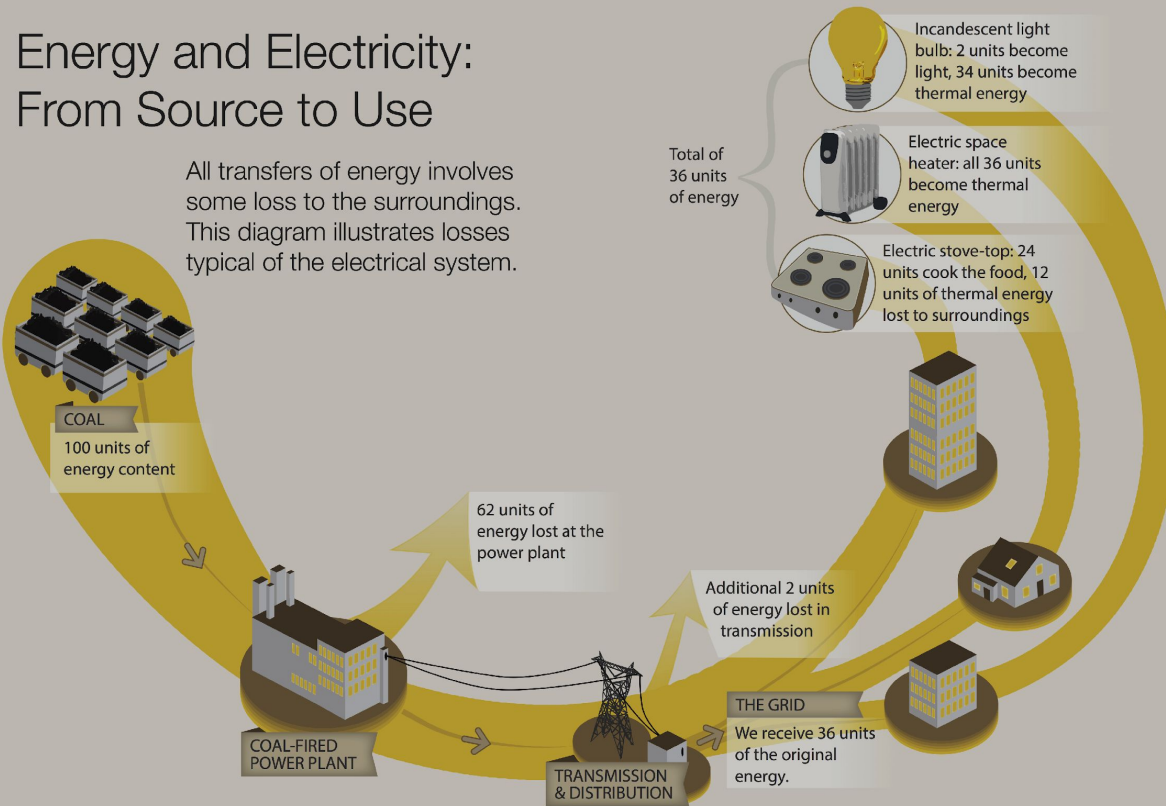


# ACCOMPLISH YOUR GOALS USING ONLY THE ENERGY (AND OTHER INPUTS) YOU NEED



## Energy and Electricity: From Source to Use

All transfers of energy involves some loss to the surroundings. This diagram illustrates losses typical of the electrical system.



## • Why be efficient?

- Save money over the long run for heating, cooling, lighting
- More robust construction
- Reduced greenhouse gas emissions & pollution
- Reduced demand for energy imports & leaving more energy in the ground for the future
- Increased Resilience

Energy Efficiency (less energy, same task) / Energy Conservation (reduce consumption by using less) / Energy Effectiveness (Produce desired effect using only energy needed)

- Lowered costs, more thoughtful design... Etc.

# REMEMBER THAT WHEN DESIGNING & BUILDING (RETROFITTING MAKES THINGS MORE COMPLICATED!)

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## 7 Principles:

1. Be built with local, low-energy materials and methods, and designed no bigger than needed, and follow the codes.
2. Have an envelope capable of isolating or buffering it from heat, cold and humidity, consistent with the climate zone.
3. Face south with sufficient glazing to passively collect solar gain in the heating season, and have appropriate shading of south and west glass during the cooling season.
4. Have sufficient mass to store solar gain and to act as a thermal flywheel, radiating warmth in the heating season and absorbing it in the cooling season.
5. Work with the land, use landscaping, and be open to and induce natural ventilation when cooling is needed.
6. Be adaptable over time, with materials and components recycled or reused at the end of their useful lives.
7. Employ the first six principles preferably in urban settings and in ways that are site-specific, context-sensitive and that do not conflict with common sense or prevent other buildings from employing them.





# ENERGY COMES FROM “HARNESSING” THE POWER OF NATURE

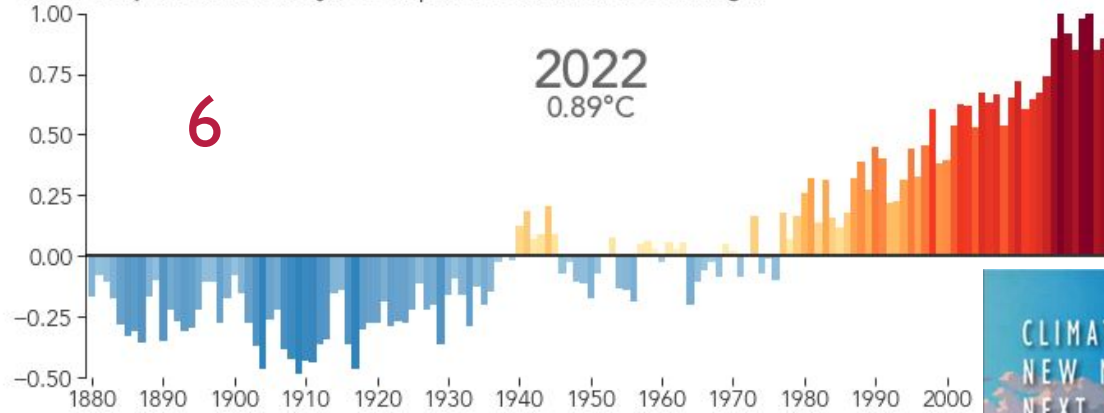
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## Last 9 Years Warmest on Record

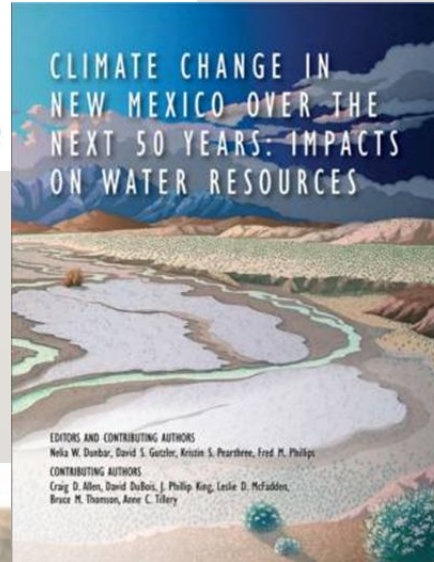
Global Temperature Anomaly (°C compared to the 1951-1980 average)



# CLIMATE CHANGE

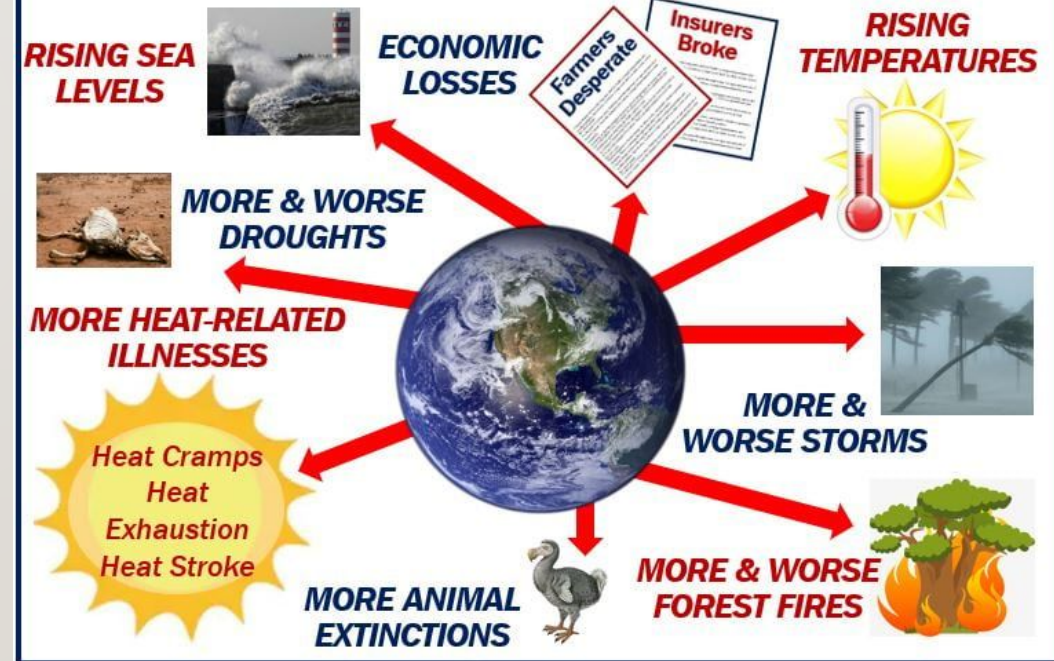
<https://earthobservatory.nasa.gov/world-of-change/global-temperatures>

<https://350newmexico.org/confronting-climate-change-in-new-mexico/>



## Climate Change

### Some Effects of Climate Change



<https://marketbusinessnews.com/financial-glossary/climate-change/>

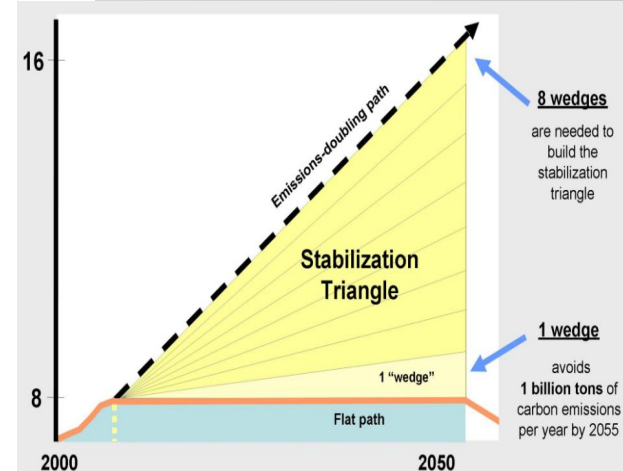
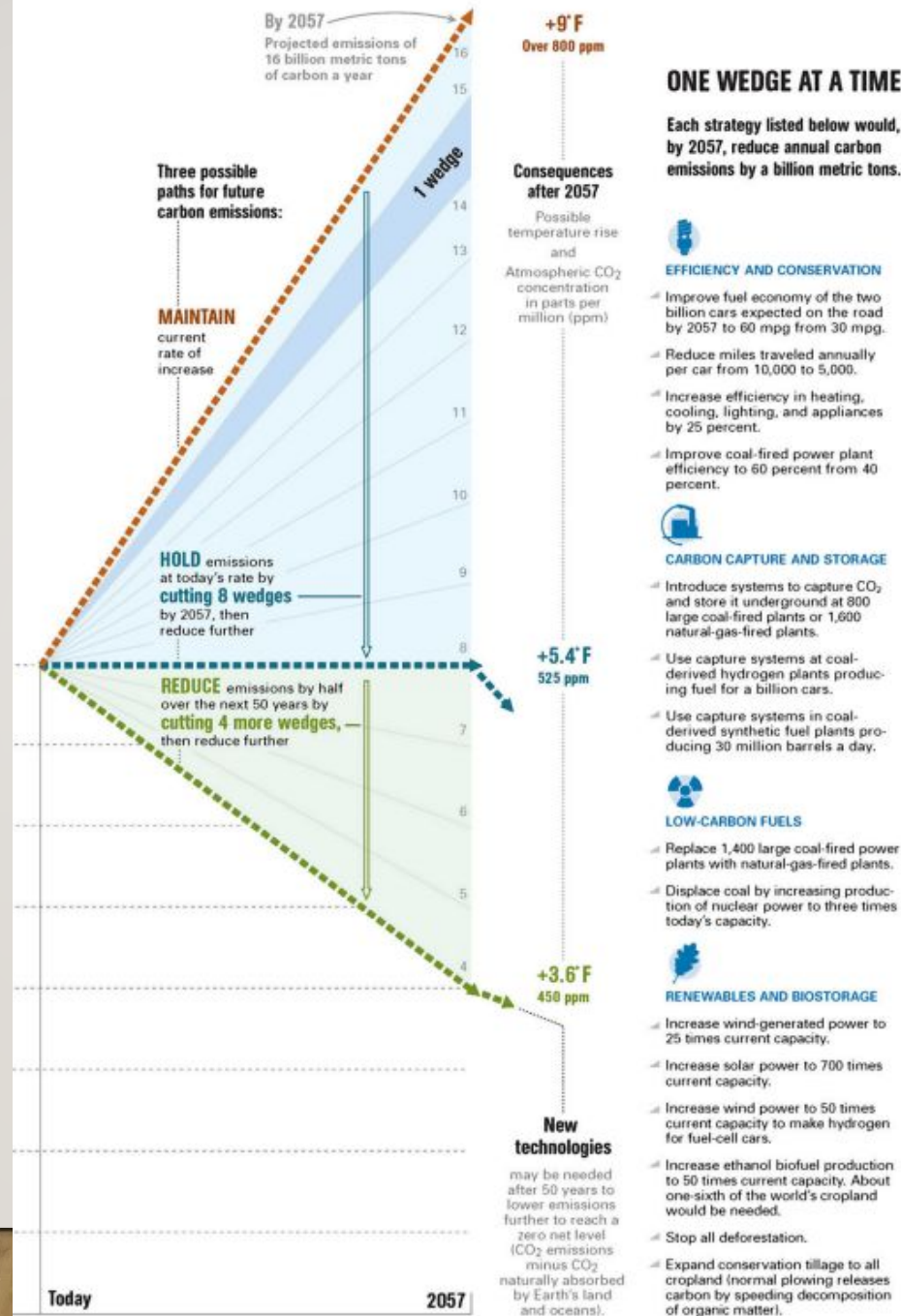


# BUILDINGS ARE PART OF THE PROBLEM AND PART OF THE SOLUTION

## PROJECT DRAWDOWN

SOLUTION	SECTOR(S)
Abandoned Farmland Restoration	Land Sinks
Alternative Cement	Industry
Alternative Refrigerants	Industry / Buildings
Bamboo Production	Land Sinks
Bicycle Infrastructure	Transportation
Biochar Production	Engineered Sinks
Biogas for Cooking	Buildings
Biomass Power	Electricity
Bioplastics	Industry
Building Automation Systems	Electricity / Buildings
Building Retrofitting	Electricity / Buildings
Carpooling	Transportation

<https://drawdown.org/solutions/table-of-solutions> Project Drawdown



[https://cmi.princeton.edu/wp-content/uploads/2020/01/Wedges\\_Figure\\_2\\_8-scaled.jpg](https://cmi.princeton.edu/wp-content/uploads/2020/01/Wedges_Figure_2_8-scaled.jpg)

<https://cmi.princeton.edu/wp-content/uploads/2022/09/Carbons-New-Math.pdf>

# SUSTAINABILITY AND THE IMPORTANCE OF THE BUILDING SECTOR

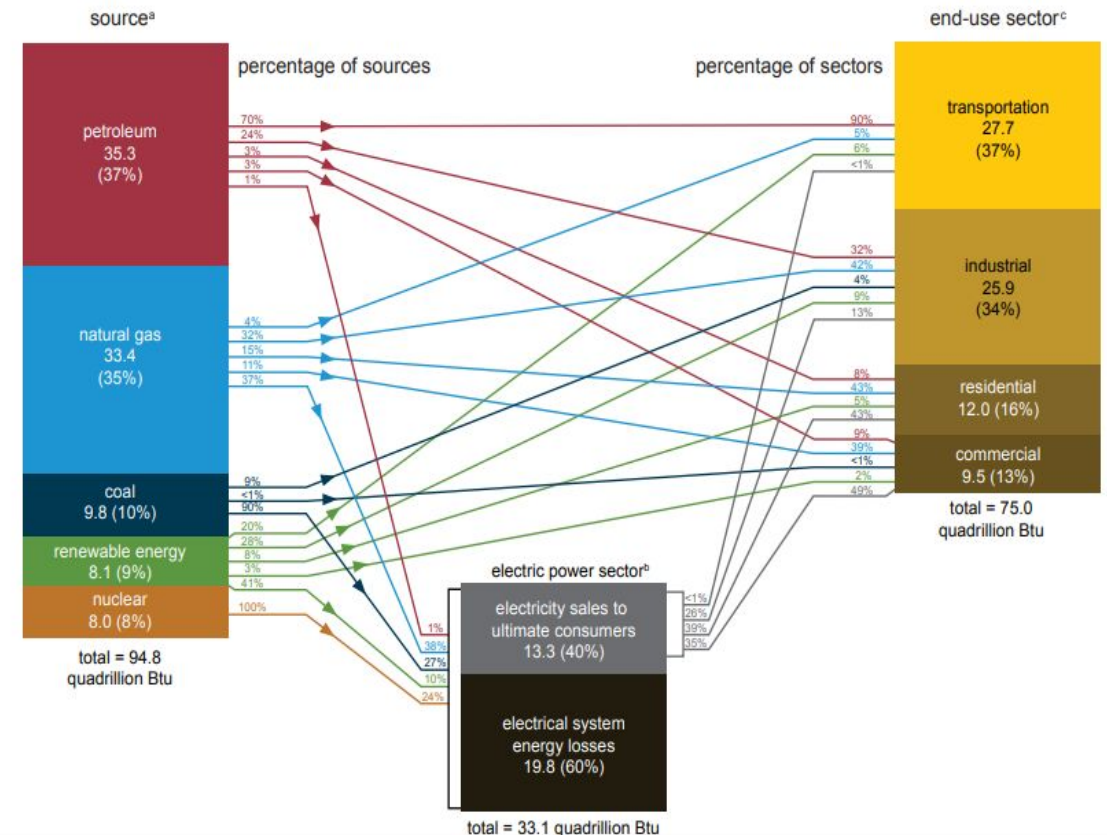
- SUSTAINABILITY:
- Ability to maintain or support process continuously over time
  - Should not negatively affect the environment, neighbors, or people in the building
  - Minimize the use of non-renewable resources AND long-term operating costs
  - Goes beyond energy

- Buildings:
  - 40% of total energy use in US
  - 75% of electricity use
  - 35% of carbon emissions

[https://www.eia.gov/totalenergy/data/monthly/pdf/flow/total\\_energy\\_2022.pdf](https://www.eia.gov/totalenergy/data/monthly/pdf/flow/total_energy_2022.pdf)  
<https://www.prel.gov/news/features/2023/nrel-researchers-reveal-how-buildings-across-the-united-states-do-and-could-use-energy.html#:~:text=Buildings%20are%20responsible%20for%2040,building%20stock%20is%20also%20essential.>

## U.S. energy consumption by source and sector, 2022

quadrillion British thermal units (Btu)



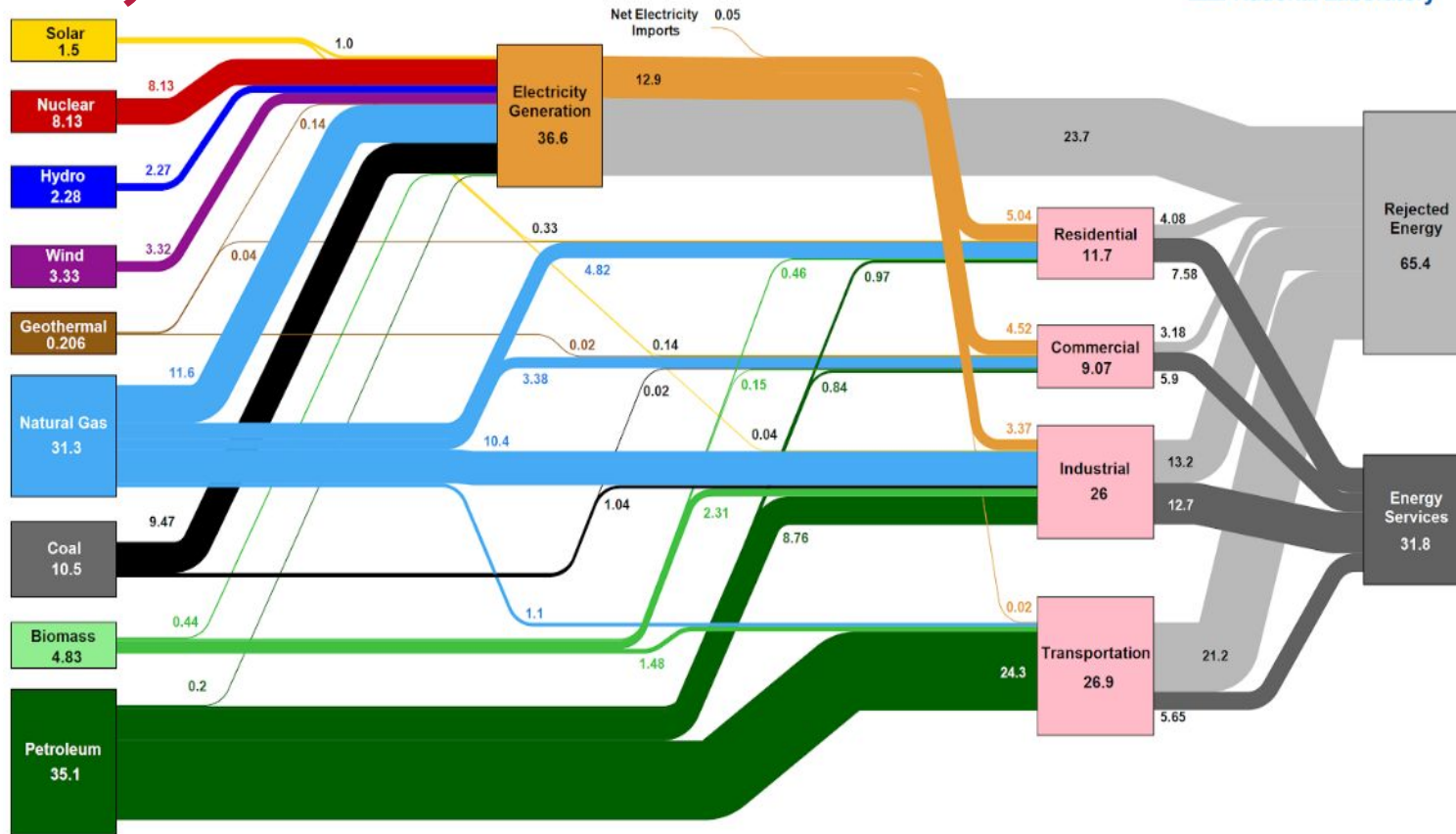


# WHERE IS ENERGY USED?

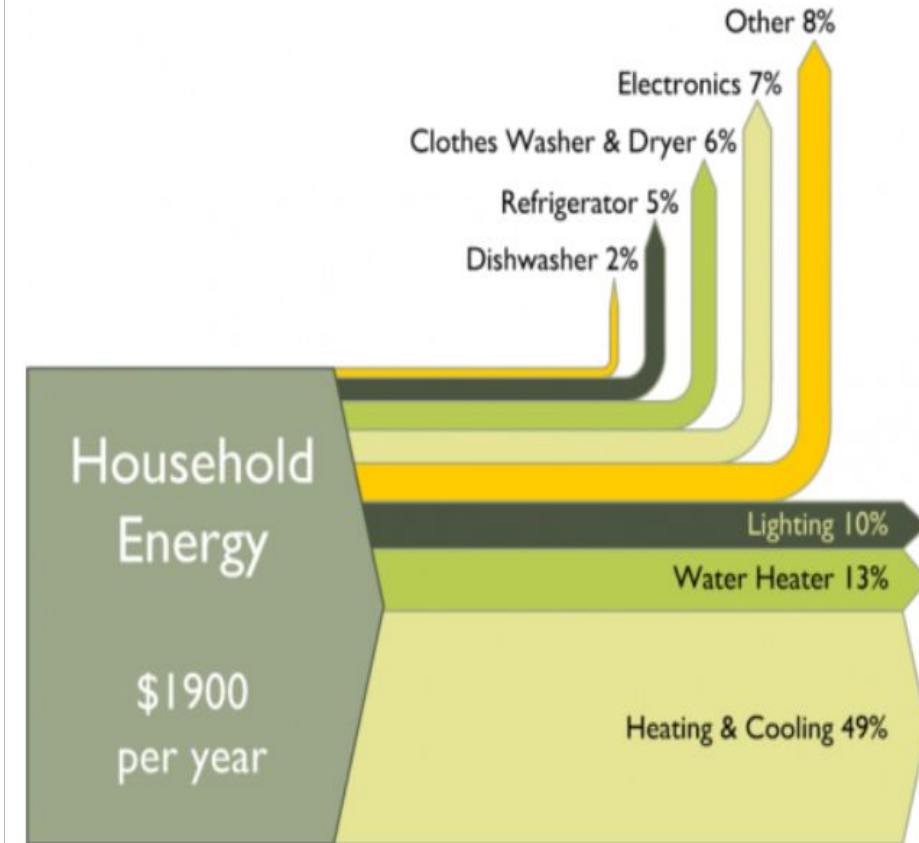
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Estimated U.S. Energy Consumption in 2021: 97.3 Quads

Lawrence Livermore  
National Laboratory



Source: LBNL March, 2022. Data is based on DOE/EIA MER (2021). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 21% for the Transportation sector and 49% for the industrial sector, which was updated in 2017 to reflect DOE's analysis of manufacturing. Totals may not equal sum of components due to independent rounding. LBNL-MI-410527



<https://www.sankey-diagrams.com/household-energy-costs-sankey/>

<https://www.vox.com/energy-and-environment/2017/4/13/15268604/american-energy-one-diagram>



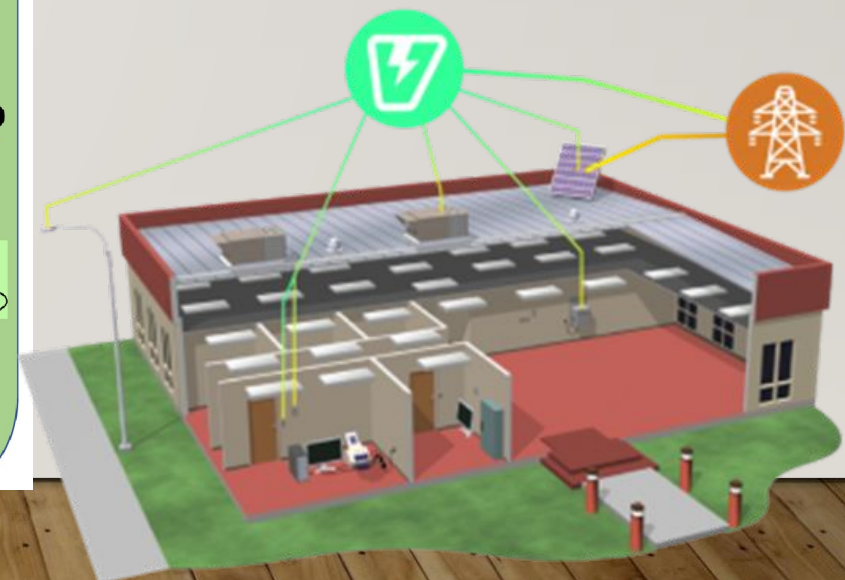
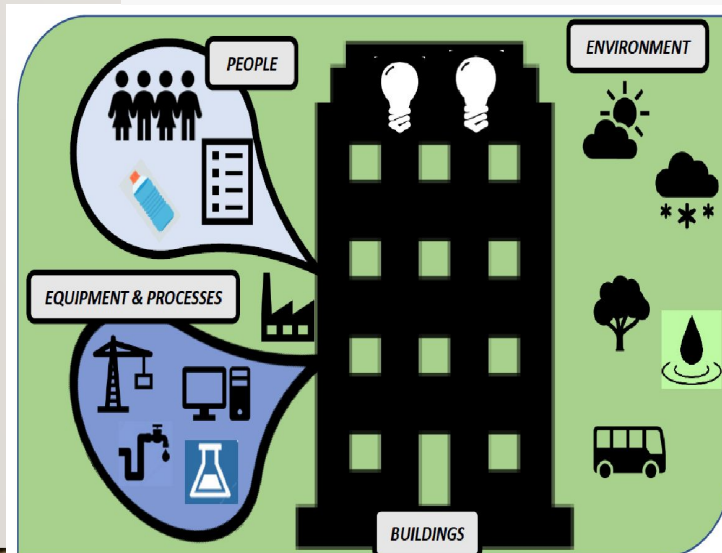
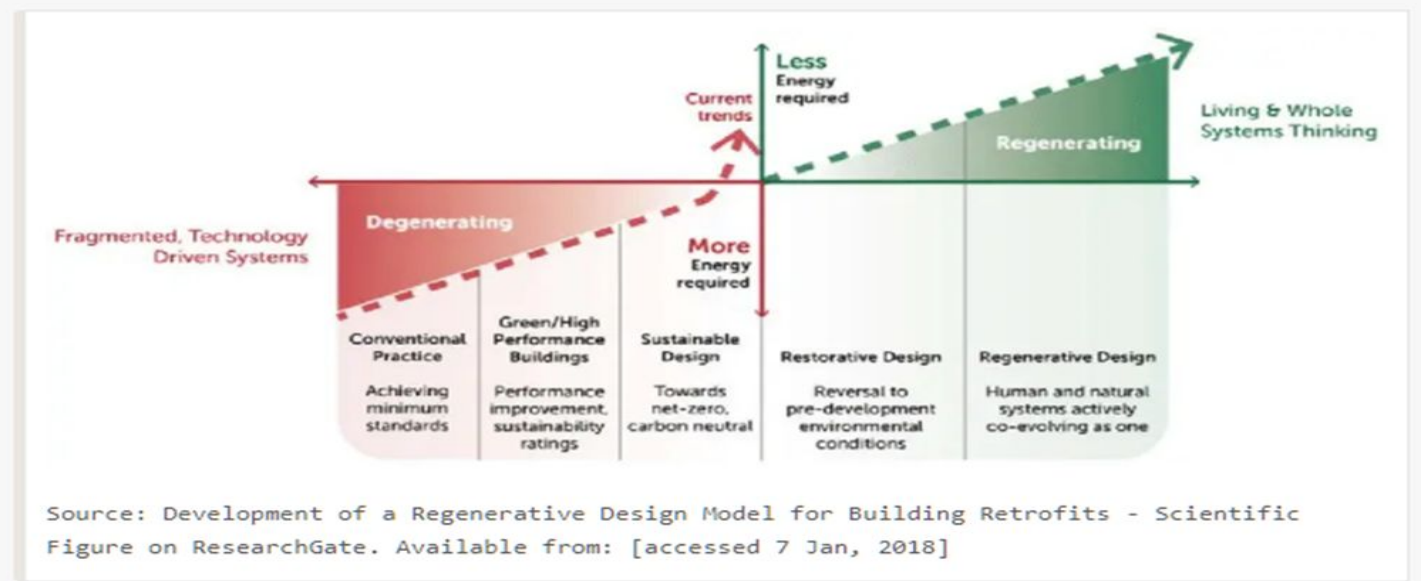
# COMPARISON – BUYING A CAR



		Purchase Cost	Miles driven/year	Fuel Cost / gal	MPG	Fuel \$ /yr	Mtce Costs	Depreciation/yr, yrs	5 Operations Cost / year incl. dep Cost / 5 years
Base scenario									
"Standard" vehicle		\$ 30,000	\$ 15,000	\$ 3.25	18	\$ 2,708	\$ 5,000	\$ 6,000	\$ 13,708
"Efficient" vehicle		\$ 35,000	\$ 15,000	\$ 3.25	40	\$ 1,219	\$ 5,000	\$ 5,833	\$ 12,052
High fuel cost scenario									
"Standard" vehicle		\$ 30,000	\$ 40,000	\$ 4.75	18	\$ 10,556	\$ 5,000	\$ 6,000	\$ 21,556
"Efficient" vehicle		\$ 35,000	\$ 40,000	\$ 4.75	40	\$ 4,750	\$ 5,000	\$ 5,833	\$ 15,583
Decreased cost for newer technology									
"Standard" vehicle		\$ 30,000	\$ 40,000	\$ 4.75	18	\$ 10,556	\$ 5,000	\$ 6,000	\$ 21,556
"Efficient" vehicle		\$ 31,000	\$ 40,000	\$ 4.75	40	\$ 4,750	\$ 3,000	\$ 5,167	\$ 12,917



# WHOLE BUILDING APPROACH – BUILDINGS AS SYSTEMS



# WHAT ARE ENERGY CODES AND WHAT DO THEY DO?

- Enforceable law
- Move the bar forward
- Set of requirements for constructing a building legally
  - Minimum consistent levels
  - Holistic
  - Addresses all aspects:
    - Building Envelope
    - Mechanical
    - Service Water Heating
    - Lighting
    - Electric Power
- Improve resilience, improve ability to shelter in place
- Interpreted by code officials
- IECC 2021 applicable as of 7/30/2024
- ANSI/ASHRAE/IES Standard 90.1-2019



<https://codes.iccsafe.org/>

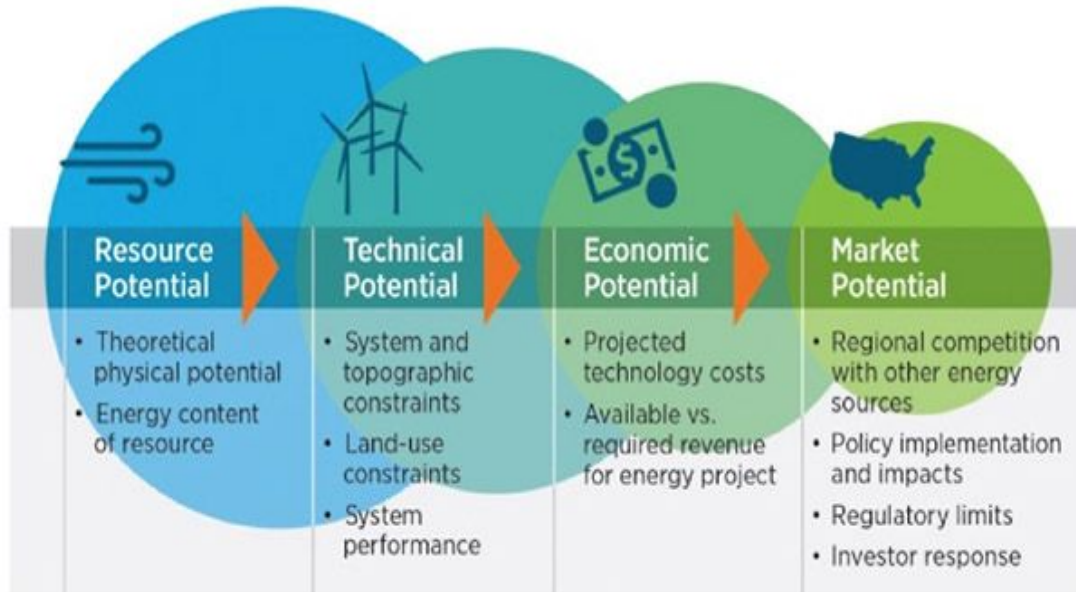




# SOME REASONS FOR REGULATION = CODES AND STANDARDS

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- Response to external forces
- Public safety
- Fairness
- Policy Objectives



<https://www.nrel.gov/gis/re-econ-potential.html>



# CODE OVERVIEW: 14 OTHER CODES (NOT PART OF NM ENERGY EFFICIENCY CODE)

- International Green Construction Code, IGCC
  - Adopted by some cities
- Water Conservation Code
  - Used in many parts of the SW
- Green Plumbing & Mechanical Code
  - Models for adoption, though many local jurisdictions create their own
- Air quality ordinances
- Americans with Disabilities Act
- Ground water protection laws
- Zoning laws
- See UPCODES for other codes, <https://up.codes/codes/general>

**The Family of I-Codes**

Pacific Northwest  
NATIONAL LABORATORY  
Proudly Operated by **Building** Since 1963



- ✓ International Building Code
- ✓ International Mechanical Code
- ✓ International Fuel Gas Code
- ✓ International Property Maintenance Code
- ✓ International Fire Code
- ✓ International Zoning Code
- ✓ International Plumbing Code
- ✓ International Existing Building Code
- ✓ International Private Sewage Disposal Code
- ✓ International Performance Code
- ✓ International Residential Code
- ✓ **International Energy Conservation Code**
- ✓ International Wildlife-Urban Interface Code



ICC INTERNATIONAL CODE COUNCIL

## Everyone Needs Water

**The Issues**

- Water Demand** – 2.1 billion people lack access to safely managed drinking water services.
- Water Availability** – Around 1.9 billion people live in potentially severely water-scarce areas.
- Water Quality** – Over 80% of the wastewater generated by society flows back into the environment without being treated or reused.
- Natural Disasters** – The number of people at risk from floods is projected to rise from 1.2 billion today to around 1.6 billion in 2050 – nearly 20% of the world's population.

**Modern codes and standards incorporate the latest technologies and:**

- Lead to safe plumbing systems in residential and commercial buildings.
- Provide the safest, most resilient structures to protect against floods, hurricanes and other modern-day disasters.
- Facilitate the quick adoption of new water-efficient products into homes and structures and promote the need for smart water use.

**Building Codes Save Lives**

I-Code Essentials

## 2018 I-Code Essentials

Explore code fundamentals using non-code language

**IBC • IRC • IFC • IEBC just arrived: IPC**

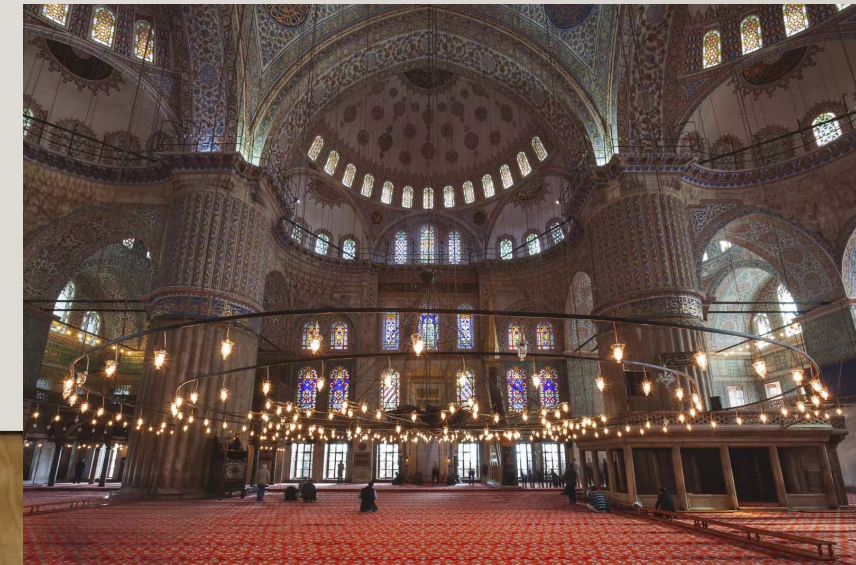
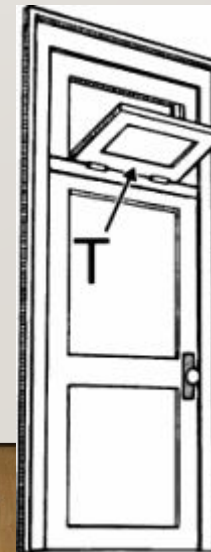


**Purchase Now**



# (SHORT) HISTORY OF CONSTRUCTION & CODES

- 15  
• Shelters for brief habitation
- Settled communities, agriculture
- Specialized structures
- Adaptations to climate & geography
- Increasing size, height, span, material durability
- Energy available for construction & interior environment





# ANOTHER APPROACH TO CODES....

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## Code of Hammurabi – 1754 BC

**Almost 3800 years old!**  
**(3775 to be exact)**

Contained 282 Laws – contract, wages, inheritance, construction...

- Code #229. If a builder build a house for some one, and does not construct it properly, and the house which he built fall in and kill its owner, then that builder shall be put to death. #230. If it kill the son of the owner the son of that builder shall be put to death.

Code of Hammurabi



A side view of the stele "fingertip".



# IMPACT OF ENERGY CODES GOES BEYOND ENERGY

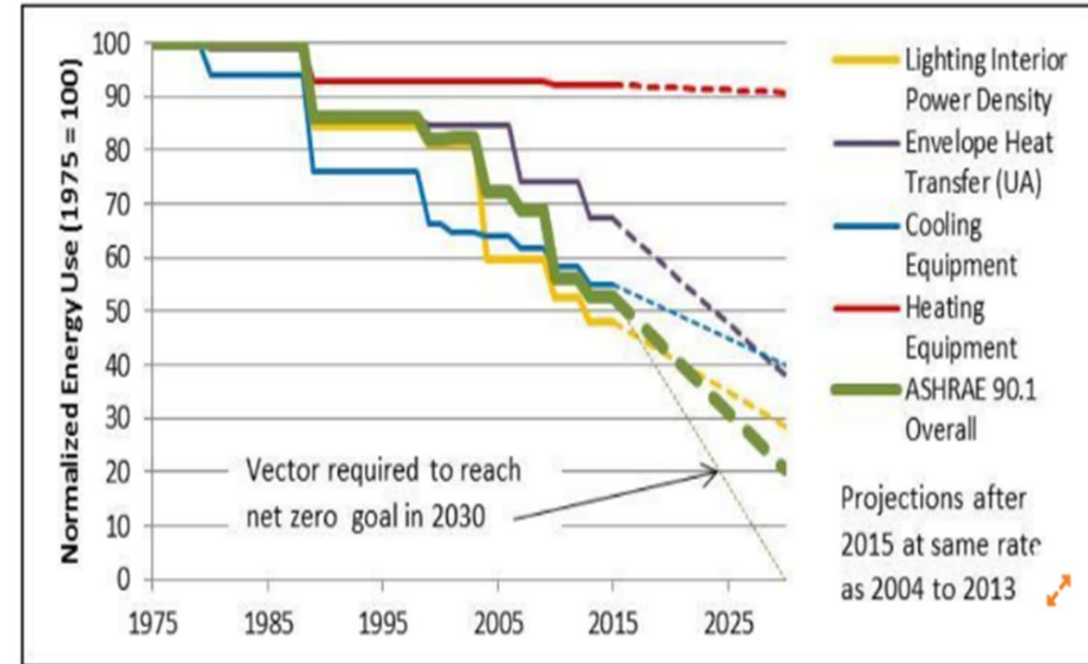
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- 2010 – 2040:
  - \$138 Billion Saved
  - 900 MMT Avoided CO<sub>2</sub>e
  - 13.5 Quads Energy Reduced
- Over next 30 years, energy codes expected to save \$126 billion nationwide.
- Early design focus on energy creates longstanding savings & reduces environmental impacts.
- From <https://www.pnnl.gov/building-energy-codes>

## Energy Codes are a Resilience Strategy



[https://www.iccsafe.org/wp-content/uploads/19-18078\\_GR\\_ANCR\\_IECC\\_Resilience\\_White\\_Paper\\_BRO\\_Final\\_midres.pdf](https://www.iccsafe.org/wp-content/uploads/19-18078_GR_ANCR_IECC_Resilience_White_Paper_BRO_Final_midres.pdf)



Improvement in ASHRAE Standard 90/90.1 (1975-2013) with Projections to 2030. Courtesy of Pacific Northwest National Laboratory 2015





# NM RESIDENTIAL CODE

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**TITLE 14 HOUSING AND CONSTRUCTION**  
**CHAPTER 7 BUILDING CODES GENERAL**  
**PART 6 2021 NEW MEXICO RESIDENTIAL ENERGY CONSERVATION CODE**

**14.7.6.1 ISSUING AGENCY:** Construction Industries Division (CID) of the Regulation and Licensing Department.  
[14.7.6.1 NMAC - Rp, 14.7.6.1 NMAC, 01/30/2024]

**14.7.6.2 SCOPE:** This rule applies to all residential contracting work performed in New Mexico on or after January 30, 2024, that is subject to the jurisdiction of CID, unless performed pursuant to a permit for which an application was received by CID before that date.  
[14.7.6.2 NMAC - Rp, 14.7.6.2 NMAC, 01/30/2024]

**14.7.6.3 STATUTORY AUTHORITY:** Sections 60-13-9 and 60-13-44 NMSA 1978.  
[14.7.6.3 NMAC - Rp, 14.7.6.3 NMAC, 01/30/2024]

**14.7.6.4 DURATION:** Permanent.  
[14.7.6.4 NMAC - Rp, 14.7.6.4 NMAC, 01/30/2024]

**14.7.6.5 EFFECTIVE DATE:** January 30, 2024 unless a later date is cited at the end of a section. From the date of publication of this rule in the New Mexico register, until month July 30, 2024, permits may be issued under either the previously-adopted rule, or this rule. After month July 30, 2024, permits may be issued only under this rule.  
[14.7.6.5 NMAC - Rp, 14.7.6.5 NMAC, 01/30/2024]

**14.7.6.6 OBJECTIVE:** The purpose of this rule is to establish minimum standards for energy conservation for residential construction in New Mexico.  
[14.7.6.6 NMAC - Rp, 14.7.6.6 NMAC, 01/30/2024]



- <https://www.rld.nm.gov/wp-content/uploads/2024/01/2021-New-Mexico-Residential-Energy-Conservation-Code-NMAC-14.7.6-effective-7.30.24.pdf>



# NEW MEXICO RESIDENTIAL ENERGY CONSERVATION CODE

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- Based off 2021 International Energy Conservation Code (IECC)  
<https://codes.iccsafe.org/content/IECC2021P3/chapter-4-re-residential-energy-efficiency>
- Adjusted for the State of New Mexico  
<https://www.energycodes.gov/status/states/new-mexico>
- 





# SIGNIFICANT IECC 2021 RESIDENTIAL CODE ELEMENTS – MODEL & NM

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## Model Code:

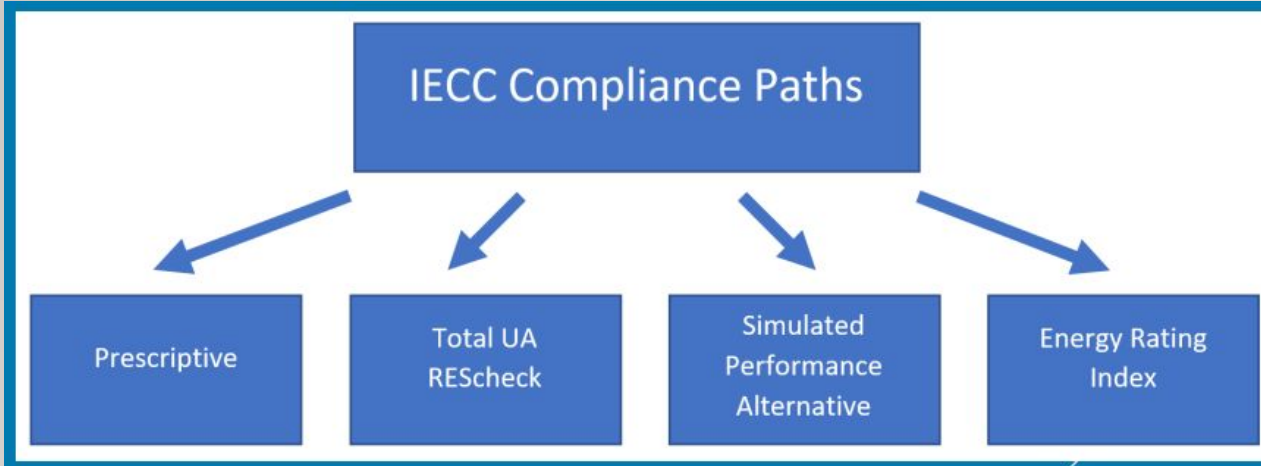
- 9% improvement
- Additional efficiency package (dropped for NM)
- Insulation value requirements increased and changes for cavity floors, basements, sunrooms / heated garages
- Changes to Air leakage requirements and connection boxes
- Changes in duct leakage and duct requirements
- Testing for mechanical ventilation systems
- Changes to lighting efficiency / controls requirements

## NM Code:

- Code official can approve documentation
- Lower burden of construction requirements
- Space definitions changed
- Climate Zones substituted
- Specified Code programs recognized by NM: Build Green NM, LEED-H, or others
- U-factors and fenestration requirements adjusted
- Insulation R-values and fenestration requirements adjusted
- Visual Inspection Option added
- Thermal Bypass Inspection Checklist & Duct Sealing Visual Inspection Checklist added
- Add E/V charging stations



# 2021 IECC PATHWAYS AND TRADEOFFS FOR PRESCRIPTIVE PATHWAY



Trade-Off	2018 IECC	2021 IECC
Envelope Air Leakage	$\leq 3$ ACH50 in cz 3-8 $\leq 5$ ACH50 in cz 1-2	$\leq 3.0$ ACH50 $\leq 5.0$ ACH50 in cz 1-2 Or for small units (<1500 sq. ft.), $\leq 0.30$ cfm/sq.ft. enclosure area
Duct Tightness	Exemption for system with all ducts & air handler inside conditioned space	Maximum leakage limit for all systems: $\leq 8.0$ cfm/sq.ft.

## 2021 IECC: Prescriptive

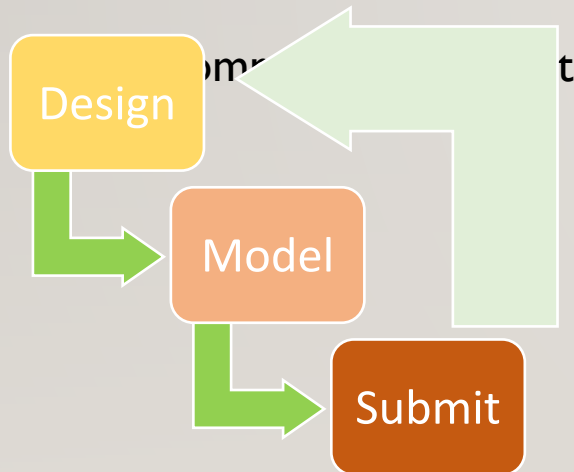
### Prescriptive: (pick one)

- 5% improved envelope UA and SHGC
- Improved heating and cooling equipment
  - $\geq 95$  AFUE nat. gas + 16 SEER air conditioner
  - $\geq 10$  HSPF/16 SEER air source heat pump
  - $\geq 3.5$  COP ground source heat pump
- Improved water heating equipment
  - $\geq 82$  EF fossil fuel water heater
  - $\geq 2.0$  EF electric water heater
  - $\geq 0.4$  SF solar water heater
- Ducts inside conditioned space
  - 100% ducts/air handler entirely within thermal envelope
  - 100% ductless system or hydronic system entirely within thermal envelope
  - 100% thermal distribution system inside conditioned space (per R403.3.7)
- Air leakage  $\leq 3$  ACH50 + ERV/HRV

# 22 THE ENERGY CODE “ECOSYSTEM” - KEY PLAYERS & GENERAL RESPONSIBILITIES:

- Design Team / Project Team (Applicant):

- Owner
- Architectural team
- Engineering team
- Modeler



- Program Administrator / Regulatory Authority (CID)

- Code Official (CID or local jurisdiction)

- Plan Checkers
- Building Officials

- Building Inspector





# ADDITIONAL RESOURCES

- Whole Building Design Guide <https://www.wbdg.org/>
- NM <sup>23</sup> Home Builders Association Codes Summary  
<https://www.nmhba.com/building-code-information/>
- 2023 Lighting Controls Association  
<https://lightingcontrolsassociation.org/2021/02/26/iecc-2021-decode/>
- Unirac <https://unirac.com/certified-installer/>
- B Public Prefab  
<https://bpublicprefab.com/new-events/high-performance-prefab-rocky-mountain-installer-training-4af4j-2684c-xhka2-7jhed-b298h> and  
<https://www.bpublicprefab.com/livecontent>
- Mitsubishi <https://www.mitsubishicomfort.com/commercial/training>
- Responsible Energy Code Alliance 2021 Residential Code  
<https://www.mwalliance.org/sites/default/files/Lacey%20-%20Introduction%20to%202021%20IECC%20Residential%20Changes%2010-15-20%20draft.pdf>
- State of NM Energy Conservation & Management  
<https://clean.energy.nm.gov/>
- State Incentives for Renewables & Efficiency  
<https://www.dsireusa.org/>
- New Mexico Decarbonization Roadmap  
<https://gridworks.org/initiatives/new-mexico-building-decarbonization-roadmap/>
- EMNRD  
<https://www.emnrd.nm.gov/ecmd/energy-code-for-buildings/>
- Energy.gov Efficient Home Design  
<https://www.energy.gov/energysaver/efficient-home-design>
- Energy.gov funding opportunities  
<https://www.energy.gov/eere/funding/eere-funding-opportunities>
- RMI Why Efficiency Matters: Unlocking Benefits Beyond Climate for All  
<https://rmi.org/why-efficiency-matters-unlocking-benefits-beyond-climate-for-all/>
- Solar Tax Credit for homeowners  
<https://www.seia.org/research-resources/25d-solar-tax-credit-what-homeowners-need-know>



# THANK YOU! DISCUSSION

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