Re-Scaling Housing / Energy, Economy and Policy

Columbia University
The Graduate School of Architecture, Planning and Preservation (GSAPP) and The Climate School
Architecture 4678 / Spring 2025 / Tuesdays
7 - 9 PM / Buell Hall, Morningside Campus, Room - 300 South

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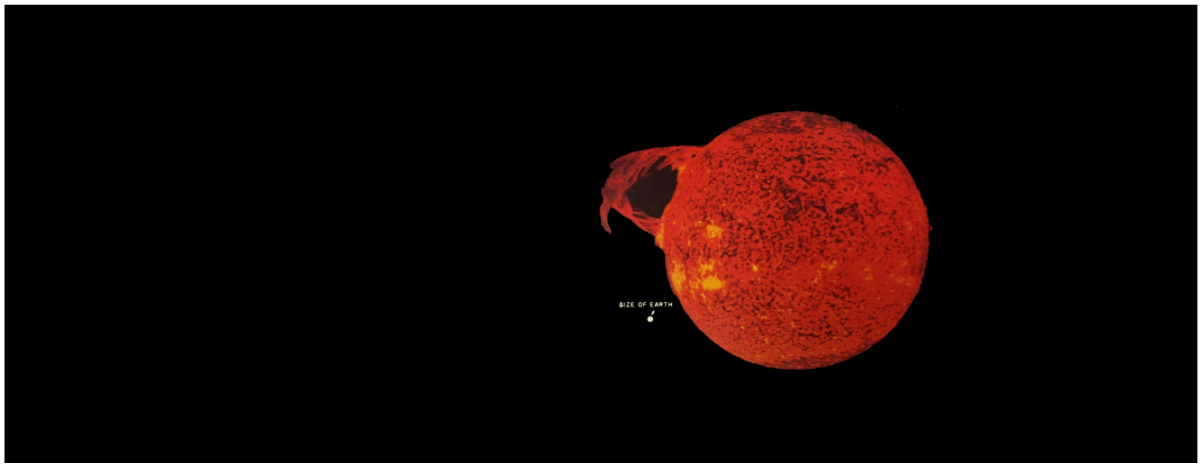
*This seminar expands and re-frames a GSAPP seminar titled **Housing After Scarcity** that was offered between 2017 and 2023. The Final Syllabus outline will be posted December 1, 2023*



December 19, 1973: The Naval Research Laboratory's spectroheliograph was in orbit aboard Skylab.

It captured a "unique electronic photograph of the sun in the extreme ultraviolet radiation from ionized helium (304 angstrom wavelength)."

"One of the most spectacular solar flares ever recorded, spanning more than 588,000 kilometers (365,000 miles) across the solar surface." "Theoretically, if it were possible to harness the energy of this eruption, it would have provided for all of mankind's power needs for the year 1 A.D. to the present – perhaps the next 2000 years."

Image source - the Naval Research Labs, Naval Research Labs Solar Spectroheliograph

Over the past five decades, the ebb and flow of urbanization and its pressure on housing valuations, particularly on land in regions rich with jobs, have turned housing markets into a casino. A market that excludes entry to vast numbers of people.

This seminar will examine historical instances where the demands of climate change merge with other long-standing factors that shape settlement. We will collectively ask where housing and development systems that have been dominant seem increasingly fragile or even obsolete. The seminar will explore where we can forecast new and unique convergences—to imagine re-scaling housing.

We will ask: is it possible to explore how what we have called housing would be effectively re-scaled. Re-cast in the foundational economic terms but also within new parameters—emerging new factors that shape development.

Climate, Automation: How do we fund climate change if labor is diminished?

As governments, industry, and society begin to grapple with new forms of digital, mechanical, and AI driven automation and their impacts on labor and jobs, a critical query and correlation becomes urgent. The jobs most susceptible to automation and displacement are in the realm of opportunity employment. There are professions available to those without a college degree that allow a household to afford housing within the area median income. Automation of every kind threatens these jobs.

When governments enact legislation to measure and protect affordability, they frequently frame access to housing around area median income. We will explore where urban and architectural history can help us project new relations between climate, jobs and automation, place and region. And where they fail to help us see need or action.

Projections about automation are by necessity speculative and diverse; they emerge with political motives, yet regional Federal Reserve Banks and private industry all imagine extreme vulnerability in lower skilled and less specialized professions. In Phoenix, Arizona, for example, "opportunity occupations" accounts for 31 percent of the region's 2,116,640 jobs, according to the Federal Reserve Bank of Atlanta. Their research correlates opportunity employment with a range of cities, offering a window into how labor automation relates to housing costs and the potential loss of housing. It is likely, if not inevitable, that the next stages in addressing climate change will take place in an increasingly automated labor environment—in a less employed and in some cases jobless society.

The science of climate change and growing awareness of a need to more aggressively take mitigation actions is on course to coincide with newly advanced forms of automation in labor and a wide range of the economic processes that underpin development. With artificial intelligence and with machine learning. With labor displacement. A steep rise in computational power as well as a decrease in its cost coupled with access to large data sets will inevitably disrupt labor markets and private income.

We know that climate migration has already instigated a shift in the last century's nexus of housing, mobility, and energy—of settlement worldwide. But addressing climate change and migration is likely to occur without a vast number of the jobs that funded the real-estate mechanisms through which housing and shelter emerged. Mechanisms that constitute the nexus of development and through which government tries to adjudicate social equity and security—for better for worse.

This seminar will study an array of past and possible new ways that housing development can be imagined both at literal large, territorial, scale but also in the economics sense of the term scale. How it is managed as an enterprise and the economics of its manifestation.

1973: A Case Study: Housing and Geo-Spatial Scale

The Solar Energy Research, Development, and Demonstration Act of 1974 provides a moment when the normal economics of settlement and development were put into flux—by the potential of renewable energy—but also by a newly imagined team and matrix of development potentials.

Fifty years ago—in 1974—a relatively small new program addressing solar energy was passed by Congress. The eight-page document created the Solar Energy Research Institute—SERI—but the Congressional document in its spare form allocated a substantial portion of its directive to an immediate call for SERI to launch an initial project.

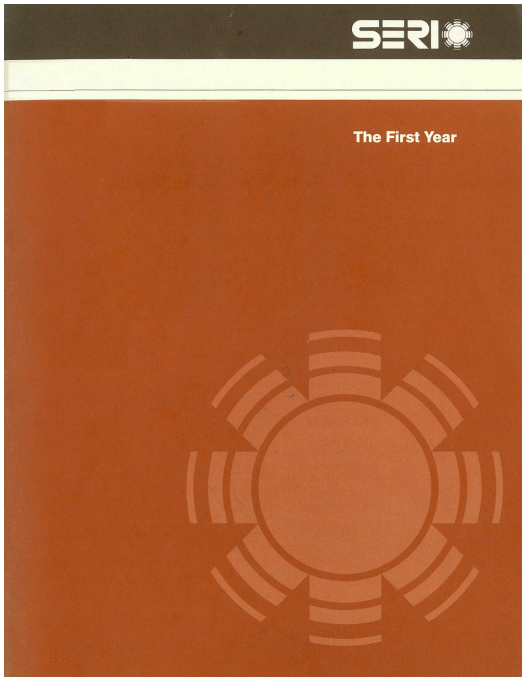
The Act, sprawling in its implications, is also concise. It barely defines the research means but does highly define the research team's leadership. This was a remarkable moment of imagining the team before the actual project. Under the auspices of renewable energy research, it created an interagency team that had the potential to imagine a new means of development—to alter and re-scale how we develop housing.

The title of the project was The Solar Energy Coordination and Management Project (the Project). It was to span six federal agencies from the National Aeronautics and Space Administration (NASA) to the then 9-year-old Department of Housing and Urban Development (HUD).

The evolutions from Congressional Act to Institute to Project formed the foundation for what later became the National Renewable Energy Laboratory (NREL). The transition is rapid: NREL is formed in 1977—just a few short years later. The ramping up and scaling of these steps gives a reader today a sense of entrepreneurial imagination and follow thru. The language and initial project is immediate and tangible—Congress calling for focused work on solar energy but doing so with leadership of six federal agencies. The Project was to be framed by its team.

The Solar Energy Coordination and Management Project was to have one member designated by the President of the United States.

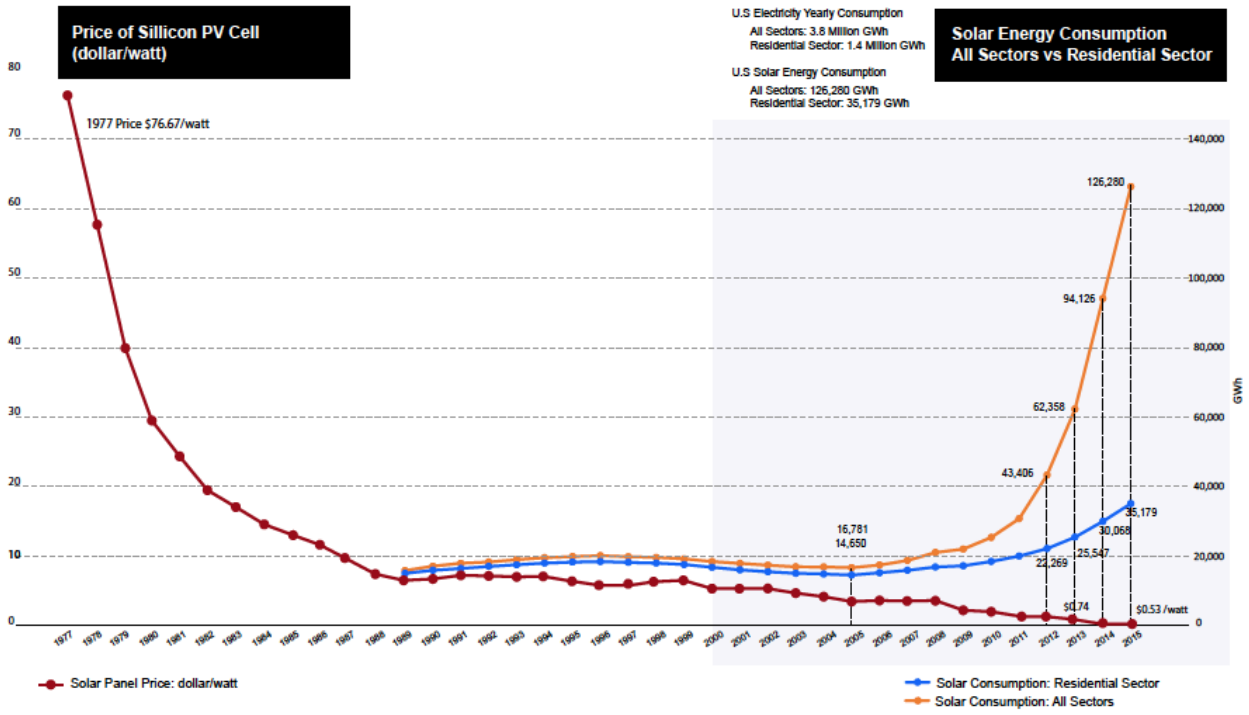
Filling out five other seats was both scope and diverging expertise. It is still today startling in its ambition.
- the Assistant Director of the National Science Foundation (NSF);
- an Assistant Secretary of Housing and Urban Development (HUD);
- a member of the Federal Power Commission (FPC);
- an Associate Administrator of the National Aeronautics and Space Administration (NASA);
- and the General Manager Atomic Energy Commission (AEC, also newly formed in 1974).



SERI: The First Year shared research and goals of the Solar Energy Research Institute. Paul Rappaport, Director, wrote: "The role of solar energy in meeting the future energy requirements of the United States and the world is not without controversy. There are those who envision solar energy as the ultimate energy alternative - a benign, democratic resource with enormous near-term potential. Others regard solar as something of an energy curiosity - a resource outside the mainstream of energy development with significant applications probable only in the next century." Rappaport wrote the future of solar energy was bound by "necessarily limited knowledge about our economic, social, and energy future, but there's no question in my mind that solar can emerge, in the next 15 or 20 years, as an important commercial energy resource." Fifty years later we must do more to model a future of alternative energies and in particular where they challenge entire settlement patterns and their economies.

1977 – 2015: Renewable Energy and its Costs.

Renewable energy in the form of solar energy has declined exponentially in cost since the 1970s. Will further cost savings assure its continued implementation? What are our options.



A declining logarithmic curve depicts Silicon PV cell pricing (dollar/watt). Lower prices are possible but they will arrive at slower pace. A rising exponential curve in consumption could accelerate but what relation will that curve have to PV panel pricing?

Scale

Scale has critical implications in financial and economic terms and is a particular focus today in computationally enabled practices where immense growth can come from relatively smaller capital investment. This seminar will explore how housing has been built at scale. Our focus will explore where housing markets and housing practices have appeared scale-able and what gains were made in these eras. Simultaneously we will focus on where it has failed, and in particular how could newly or re-scale if it is to address climate change.

We will cover a wide swath of the past 100 years of housing development—both private and public development—to better understand how housing markets are created and where government intervention of every kind has addressed need and scale. We will explore development, housing as the fusion of structure and land; income and poverty; access to leverage and uses of debt; technologies and banking —have intervened and abetted or thwarted innovation in housing.

A central aspect of this is unchanged since the 1940s: when successfully applied—an increase in scale of operations in, for example, production capability increases revenue at a rate greater than the inherent cost of increasing output. Scale changes the return on investment. It enhances it. The acceleration in scale is literal—more units of something are produced—but the capital return is greater than the stepped multipliers. This seminar will explore how housing has attempted to scale in the last century and where there is possibility of scale benefitting adaptation to climate change. A particular focus will be on where scale as we witness it or see its lack in housing has undermined the ability to address climate.

A central focus will shine light on conflicts in development and housing that both invoke and thwart scale. If applied to products and services scale is understood as a means to innovation. If applied by the government in the realm of housing it has often been castigated as federal intervention in what should be private markets. Property markets that have constitutional protections broadly afforded by the 5th Amendment—that protect the rights to property and the wealth it affords. Protection from eminent domain. The conflicts are embedded and to date have not been the most beneficial to climate demands: A landowner is understood to have the right to seek the highest and best purpose for property. Even if frameworks for energy and climate are imposed they operate in a taxis of development that assures wealth to owners in ways that are often contradictory to the demands of climate change. A Public Housing Authority owning 3.12% of New York City's housing units by the 1950s (for example) or a developer whose 1,200-acre real estate transaction approaches the scale of a small city (Levittown in the 1950s) tests these principles.

At what literal scale or business scaling does innovation become possible—indeed are housing markets as we know them even truly scaled markets. What are the parameters today that shape scale in housing and where are the terms drawn in the near and climate centric future?

Cross Disciplinary

The seminar will bring us into a wide range of disciplines and fields that constitute development practices, but we will also rely on architectural and urban planning histories legislation and policy, economics and ultimately by energy sources and

8 Minutes and 20 Seconds from the Sun

The course will pull from the forthcoming December 2024 publication ***8 Minutes and 20 Seconds from the Sun: Housing after Banking / Encrypting the Sun*** by Michael Bell and Eunjeong Seong. A study of housing in the United States over the past 100 years from the vantage of economics, finance (debt); development and geography (scale, development and density); policy and forms of structural empathy (federal housing policy for lower income housing); and energy (the post-1970s rise of renewable energy as a federal R+D and market-based concern project).

Schedule

January 21
Introduction
Re-Scaling Housing / Climate and Future of Housing

What if housing was no longer realized as a form of or adjunct of real-estate? How has real-estate scaled housing? What can we imagine as other ways to scale housing?

This is not to cancel an aspiration to titles or deeds or security but to ask a new and parallel question.

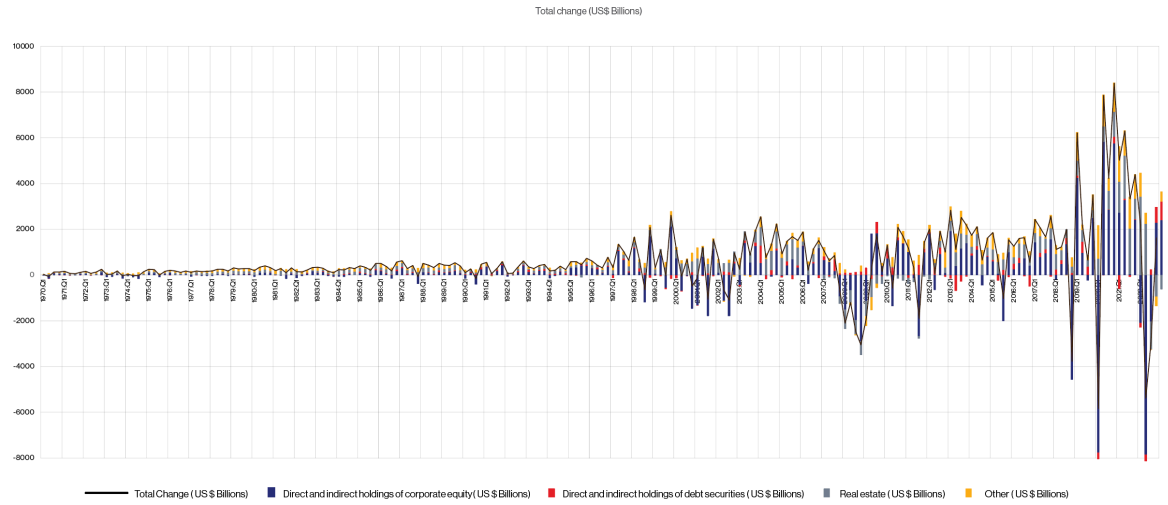
What if housing was capitalized as energy production; its valuations less secured by attendant jobs and mortgages and instead to something of profoundly different scale. Here preparing instruments that harvest renewable energy becomes not a radical rejection of wealth but by necessity a highly capitalized and even jobs source industry itself. But more importantly it forms a downstream basis for universal income in the form of shelter and energy when encrypted as a distributed renewable energy network. The role of capital migrates to a new asset class, a new product. And more people are served and sheltered than in former markets. Humans are not afforded shelter by their capacity as real-estate consumers—housing is indeed more related to geo-spatial coordinates than municipal land or tax structures.

January 28
Uses of Debt and Leverage in Housing

The two decades before and after the conclusion of World War II saw the percentage of United States households that owned their home change dramatically. Homeownership leading up to the Great Depression in 1929 peaked at 47.8% in 1930 before it falling to 43.6% by 1940. By 1965—20 years after the conclusion of the war—63% of households owned their home.

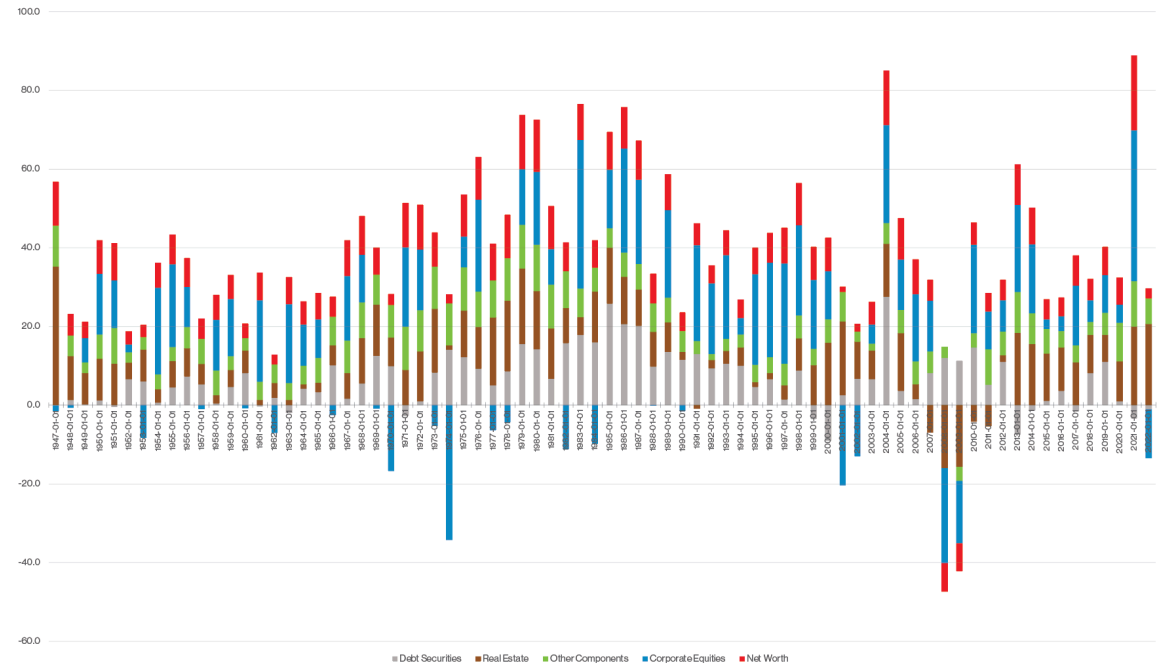
The era of homeownership and in particular single-family houses was firmly established. The Depression and World II formed the backdrop for federal intervention in mortgages and for a decentralized and dispersed population of private single-family house owners. Banks aided by federal government backed mortgages provided the nation's homeowners access to the leverage required to buy private—almost exclusively single-family—homes. The accrual of long-term household debt in the form of mortgages rose in the post war decades. Mortgage debt collateralized by incrementally, but rapidly appreciating housing assets increased. An increase in automobile debt—leverage ultimately attributed to depreciating assets rose. Eventually unsecured debt in the form of revolving credit became a common part of personal finances. Later in century newly introduced and then expanded home equity loans provided the means to move unsecured debt to mortgages—transferring expanding equity into consumption. Until the 1970s savings had steadily increased but by the 1980s it declined to an eventual low of less than $400 per capita. By 2006 households held debt that neared 100% of GDP with little savings. Economic security was almost entirely based in housing wealth. This has proved to be extraordinarily volatile in the past five decades.

In the 21st century's first two decades, housing values in the US have fluctuated violently. The increased valuations between 2000 to 2006 were unprecedented but nothing in our history has approached the fluctuations up and down that followed the credit seizure. It is reflected in household net worth and in particular if one looks at the years from 1952 to the 2023.



Changes in Net Worth: Households and Nonprofit Organizations, 1952 – 2023 Billion Dollars
Financial Accounts of the United States

https://www.federalreserve.gov/releases/z1/dataviz/z1/changes_in_net_worth/table/



Households and Nonprofit Organizations; Net Worth, Level, Compounded Annual Rate of Change, Annual - Not Seasonally Adjusted

Four distinct Federal Reserve datasets were combined and illustrated by the authors.

Source: Board of Governors of the Federal Reserve System (US), Households and Nonprofit Organizations; Net Worth, Level [TNWBSHNO], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/TNWBSHNO, July 8, 2023.

Households; Owners' Equity in Real Estate, Level, Compounded Annual Rate of Change, Annual

Board of Governors of the Federal Reserve System (US), Households; Owners' Equity in Real Estate, Level [OEHRENWBSHNO], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/OEHRENWBSHNO, July 7, 2023.

Households and Nonprofit Organizations; Directly and Indirectly Held Corporate Equities; Asset, Market Value Levels, Compounded Annual Rate of Change, Annual

Board of Governors of the Federal Reserve System (US), Households and Nonprofit Organizations; Directly and Indirectly Held Corporate Equities; Asset, Market Value Levels [BOGZ1LM153064475Q], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/BOGZ1LM153064475Q, July 7, 2023.

Households and Nonprofit Organizations; Directly and Indirectly Held Debt Securities; Asset, Market Value Levels, Compounded Annual Rate of Change, Annual

Board of Governors of the Federal Reserve System (US), Households and Nonprofit Organizations; Directly and Indirectly Held Debt Securities; Asset, Market Value Levels [BOGZ1LM154022375Q], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/BOGZ1LM154022375Q, July 7, 2023.

Households and Nonprofit Organizations; Other Components of Net Worth, Excluding Real Estate and Direct and Indirect Holding Holdings of Corporate Equities and Debt Securities, Level, Compounded Annual Rate of Change , Annual

Board of Governors of the Federal Reserve System (US), Households and Nonprofit Organizations; Other Components of Net Worth, Excluding Real Estate and Direct and Indirect Holding Holdings of Corporate Equities and Debt Securities, Level [BOGZ1FL152090045Q], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/BOGZ1FL152090045Q, July 7, 2023.

February 04
The Future of Standard Housing Heuristics

How do we measure and quantify housing development and when government intervenes or addresses markets what are it means?

February 11
Density: Where did we build housing over the past century; what does this tell us about future potentials.

As the U.S. economy began to recover from the Covid19 pandemic financial and real-estate news reported that the southern areas of the nation were rapidly advancing in renewed housing starts. They also reported and sought to demonstrate migration of the U.S. population to southern states and cities. The motivations, described as larger homes, lower cost housing and lower taxes (than Northeast Region for example) portrayed a new version of a tendency that has been in place for decades. The Census demarcated Southern Region has been outpacing the North, Midwest and West Regions for decades and the delta of completed housing units has increased virtually every year since 1968 (as far back as the authors studied). It has outpaced every other region since 1968. If compared to the Northeast Region the South has built between 238% – 712% more housing each year since 1968. The peak at 712% was met in 2021. A year later in 2022 the delta declined to 647%.

While any measure of the recent past reveals immense growth in the South Region and might steel attitudes towards sustainability and its relation to land use and density, it is looking to the future that is more startling. If we constructed half the nation's recent housing stock in regions we routinely call low density sprawl what do we imagine for the next three decades? If decarbonization is the goal how do we address even our nation's recent history? Are the jobs and opportunity of higher cost, more dense cities outside the South Region durable and will they be a draw in the immediate decades ahead.

February 18
Fear of Scale

George Candilis, Candilis, Josic, Woods architects. Toulouse Le Mirail, quartier de Bellefontaine, immeubles Pergaud, chemin de Lestang, passage Louis-Pergaud. Vue des immeubles Pergaud dans le quartier du Mirail-Bellefontaine ; panneau avec plan de situation du quartier. Photograph: André Cros, 13 November 1970

An Existential Architect Begins an Exit from Scale

In 2005 the Netherlands Institute of Architecture (NAI) published archival materials from Team 10—the architectural group formed in the midst of a second generation of then younger modernist architects and planners. Team 10's members, working in the post-war period are broadly understood to have adopted and sustained a modernist project of scale but also to seek a more subtle and nuanced understanding of everyday life. Of anthropological scale and action in the context of often immense works of urban planning and architecture. The NAI publication—Team 10: 1953–1981: In Search of A Utopia of the Present—was edited by Max Risselada and Dirk van den Heuvel and shares interviews, letters, meeting photographs and texts from an array of Team 10 members. These fragments of information illuminate Team 10 confronting what was already in the 1960s a shrinking welfare state in France and Europe. The political culture that enabled works of immense scale and for large populations of people was being reevaluated. To a seeming retreat from the levels of scale we often imagine as a quality of Modern design and development. They form a parallel to events in the United States convened around architecture and scale; in particular a deconstruction of New Deal public housing policies that have since the 1960s in the U.S. laid the grounds for more privatized forms of affordable housing.

The archive covers Team 10 activities and correspondence up to 1981, but it is doubts that are revealed in the late 1960's and early 1970's that resonate today and that are still unresolved. Archival notes show Team 10 member George Candilis addressing an emerging, but overt sense of vulnerability. In the late 1960s the firm's immense housing project at Toulouse le Mirail, France—still under construction—forms a backdrop for Candilis reimagining his role in the design of works of such literal scale. Largely, but not fully realized, Toulouse le Mirail now could house 20,000 people—a significant portion of the 70,000 it was planned for. Candilis resigned from the project acknowledging a need to re-appraise the times and the "brutality and complexity" of the problems. A newly empowered conservative government has according to the archives had forced a reanalysis of the future of the project. These notes occur in a chapter that discusses a burgeoning awareness that the work had taken a decade to build and was possibly "obsolete even while under-construction. The ideas and apparatuses that propelled works of such scale—a post war reconstruction and welfare state—was waning.

Team 10: 1953 – 1981 uses archival notes to bring the reader close to Candilis thoughts and experience. Protesters called for less central control over urban development; Team 10 members who served as professors faced castigation as students asked them to disengage from work so centrally authored and controlled. Aldo van Eyck and Jacob Bakema were censured by TU Delft for acting as a "lackey of capitalism". Candilis in an interview speaks of people having more to contribute to the design of where they live and of them having some hand in building it. Candilis was asking Team 10 to face the literal scale and social ambition of their work, but also their own viability in the politically contracting welfare state that had been their patron and a proxy form of conscience. That welfare state was under duress, it was shrinking, but also Candilis was privately doubting the scale of the role he and his colleagues played in thousands of people's lives. Housing designed at scale was in effect architecture and planning enacted upon (rather than for or with) populations.

Fast Forward to Dresden, Germany: 2006

Ingolf Rossberg is the mayor of this majestic eastern German city. But watching him stride around his ballroom-size office, wreathed in smoke from his cigarillo, one could mistake him for a European real estate tycoon.

Yet he is that after a fashion. Mr. Rossberg reached a deal in March to sell Dresden's entire stock of 48,000 city-owned apartments to an American private equity firm, the Fortress Investment Group, for $1.2 billion. In a single stroke, Dresden wiped out its burdensome public debt.

"We had to move fast," he said, "because if you had 10 German cities selling their property, it would be a buyer's market."

Public Housing in Private Hands, Mark Lander, The New York Times, May 5, 2006
https://www.nytimes.com/2006/05/05/business/worldbusiness/05property.html

The New York Times

Public Housing in Private Hands

Give this article

By Mark Landler
May 5, 2006

DRESDEN, Germany, April 28 — Ingolf Rossberg is the mayor of this majestic eastern German city. But watching him stride around his ballroom-size office, wreathed in smoke from his cigarillo, one could mistake him for a European real estate tycoon.

Yet he is that after a fashion. Mr. Rossberg reached a deal in March to sell Dresden's entire stock of 48,000 city-owned apartments to an American private equity firm, the Fortress Investment Group, for $1.2 billion. In a single stroke, Dresden wiped out its burdensome public debt.

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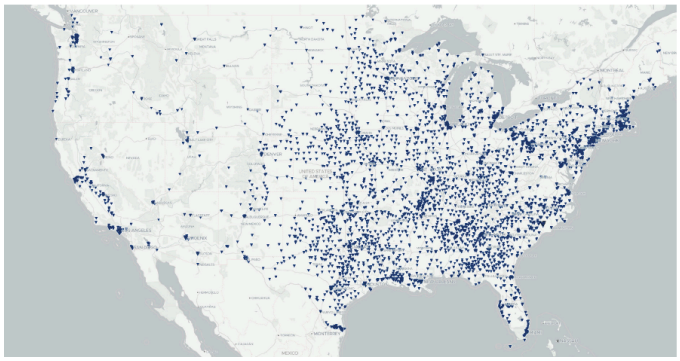
Moreover, Fortress must hold on to 34,000 of the apartments for 10 years before it sells them. And when it does, it must offer existing tenants a 15 percent reduction from the market price. Finally, it cannot renovate the apartment complexes into luxury condominiums.

A refurbished residential and office building in Dresden, Germany, evidence that urban design has come some way from post-Stalinism.
Matthias Rietschel for The New York Times

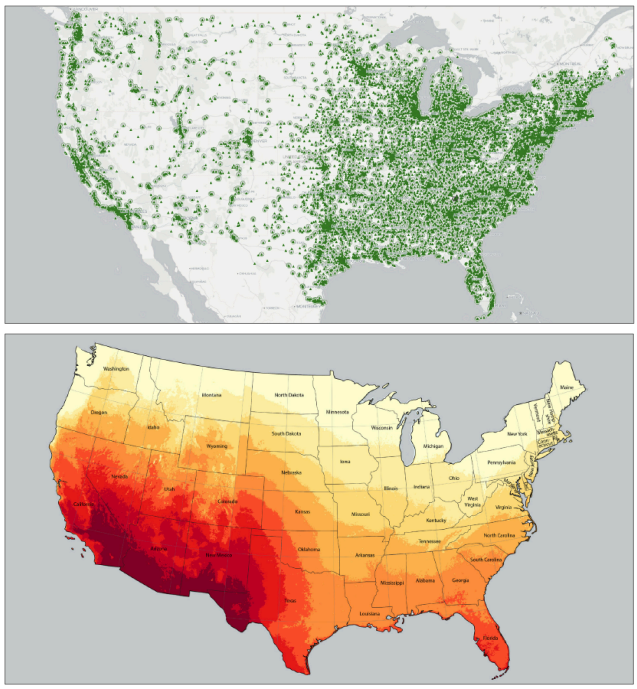
Analysts say the rights granted to the residents are not much different from those that govern Germany's highly regulated rental market. But that raises a question: How will Fortress recoup its billion-dollar investment?

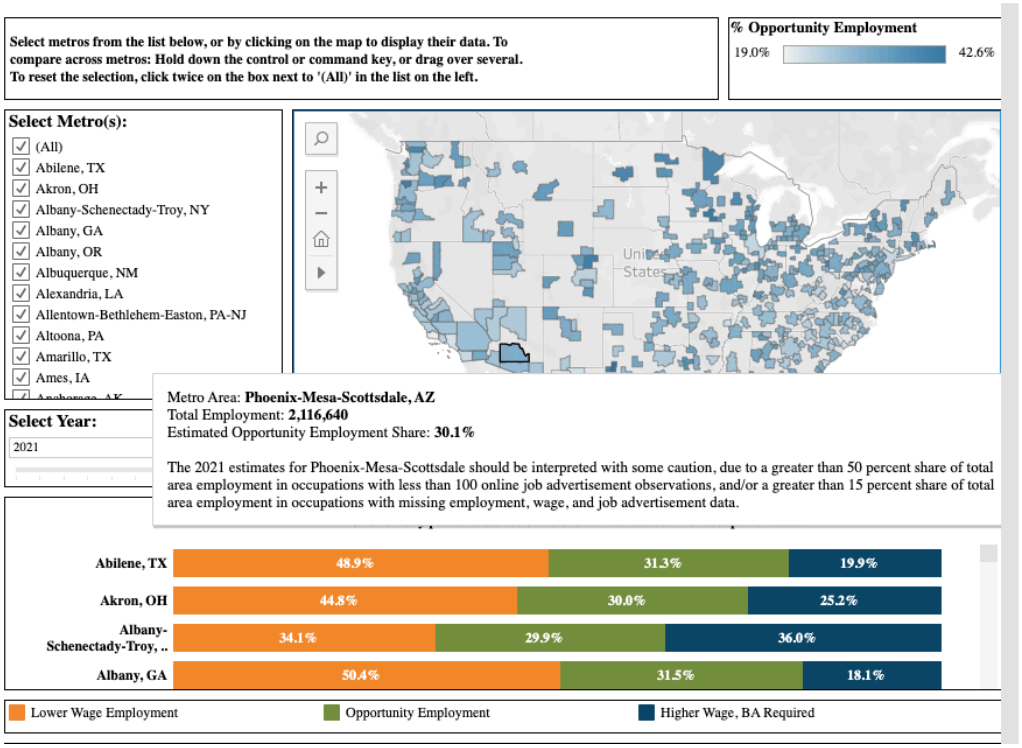
February 25
Empathy: How does government address human need when housing is a market provision?

The cartography of federally supported public and Low-Income Housing Tax Credit developments follows the population distribution. It is a per capita expenditure based on state population. The distribution of renewable energy follows no such state or legal boundaries. How will we imagine the legal framework to imagine how these two cartographies are coordinated as the source and geography of energy production shifts at a continental and geo-spatial scale. We will introduce fundamental aspects of US Public Housing legislation and design and counter this with emerging renewable energy territories.



***Above**: Department of Housing and Urban Development (HUD), **United States Housing Authority development sites**. HUD Public Housing. There are more than 3300 Public Housing sites in the United States. Each is owned and operated by a hybrid of federal, state and city governments. **Below: Low Income Housing Tax Credit developments**, 1987 to 2021. This map was prepared using Policy Map and based on data from HUD. Below: **Solar Energy capacity: NREL, National Renewable Energy Laboratory**, Billy J. Roberts, February, 2018*





Federal Reserve Bank, Atlanta, Opportunity Occupations Monitor[i]

Housing in expensive, job-rich markets in the United States has been under severe pressure for 50 years. A loss of opportunity jobs along with lack of job migration will couple with climate migration to accelerate the housing crisis. This is an opportunity for a new form of housing as renewable-energy asset to stabilize shelter, and secure income for households, while also addressing climate change and settlement patterns. Legislation addressing affordability over the past 50 years has largely incentivized small nonprofit builders, leaving little capital for research and development. Chapter four discusses this in detail. We imagine that decarbonizing development could also mean enhancing housing security and even universal income.

Source: https://www.atlantafed.org/cweo/data-tools/opportunity-occupations-monitor.aspx

**Jesse Keenan, Climate and Real Estate

March 04
Federal Sun: The United States quantifies goals for renewable energy in the 1970s.

In the early 1970s Congressional action on renewable energy provides groundwork for what would become the Department of Energy (DOE) and the National Renewable Energy Lab (NREL). When viewed in a historical lens—after the fact—the progression of research that leads to federal laws, federal research labs and Cabinet level appointments seems direct but the progress from law to action was far more circumspect even if at times bold. Whether housing laws that impact property development and private developers or federal research on alternative energy Congressional Acts often read as hedging a possible intrusion on private markets vs. a need to take or back stop economic risks incurred by research and development that private enterprise might avoid.

In October of 1974, John Nassikas, then Chairman of the Federal Power Commission, made this case in simple terms in Congressional testimony but in conversation with industry and the press—with reporters—the larger discussion of the nation's energy independence and environmental concerns were far more nuanced and showed the realpolitik of energy production and market forces. Congressional testimony is not private but in terms of calls for research and acknowledgement of needs or market resistance or inability it often is more candid.

In testimony to Congress on the Solar Energy Research, Development, and Demonstration Act of 1974.
Nassikas stated:

An evaluation of necessary funding levels for solar R&D should include an assessment of the contribution that should be made by the private sector. In general, it is my belief that Federal R&D expenditures should be concentrated in those areas where the amount of required investment is so large or the risks of commercial success are so speculative so as not to warrant substantial private investment as a matter of management responsibility.

Nassikas was discussing allocations of 600 million dollars for the first six years funding of the Solar Energy Research, Development, and Demonstration Act. More than 3.7 billion dollars in 2023.

This session will focus on 1970s legislation and action on renewable energy and its then imagined impacts on housing and development.

March 11

GSAPP Studio Travel

March 18

Spring Break

March 25

Scale-less / Non Denumerable

Energy generated by nuclear fusion within the Sun reaches the surface of the Earth in 8 minutes and 20 seconds. Massless photons transmit radiation at the speed of light—299,792,458 meters or 186,000 miles per second. If the speed of light is difficult to imagine it becomes unfathomable when coupled with the duration of a day, or the persistence of days over weeks or a year. It becomes a light year. Or thousands and millions of light years. Renewable energy in the form of solar radiation reaches Earth in quantities we can't fathom. It is not scarce. It is non denumerable. Where in our scientific and literary histories do we see concepts and facts of energy that essentially "break" markets — where something is not scarce and thereby immune to markets.

"In the United States as a whole, only about thirty per cent of the rain fall gets into the ground; the rest is lost to surface runoff or evaporation, transpiration from leaves and similar interceptors. In the Pine Barrens, fully half of all precipitation makes its ways into the aquifer, for, as the government report put it, "the loose sandy soil can imbibe as much as six inches of water per hour." The Pine Barrens rank as one of the greatest natural recharging areas in the world. Thus, the City of New York, say, could take all its daily water requirements out of the pines without diminishing the basic supply."

McPhee, John. The Pine Barrens. United States: Farrar, Straus and Giroux, 1968. The contents of this book originally appeared in The New Yorker, November 17,1967, and were developed with the editorial counsel of William Shawn and Robert Bingham.

"Clearly there are limited resources of oil, gas, copper, and clean air. Just as clearly, technological change is finding substitute processes that replace scarce resources with superabundant resources. Perhaps the best example is fiber optics (light plus silicon) as a substitute for copper wire. The quadrillion-dollar question is whether technology will outpace depletion."

William Nordhaus, Nobel Prize biographical notes. https://www.nobelprize.org/prizes/economic-sciences/2018/nordhaus/biographical/

April 01
Housing Supply Chains: Can they evolve?

What is the scale and supply chain of the Housing Industry today? How does it integrate with other supply chains and economies? In particular mobility and consumption? Are home builders capitalized in ways that could allow innovation and transformation?

The home building industry is composed of relatively small and regional companies. As of July 2023, the top ten home builders have a combined capitalization of approximately 170 billion dollars. This puts their collective value in the range of single entities such as Nike or T-Mobile. The top five builders are collectively valued at approximately 144 billion dollars. The next five companies are collectively valued at 26 billion dollars ranging from 3.8 to 8.4 billion dollars. Only five of the publicly traded companies have a market capitalization greater than 10 billion dollars. The valuations are, of course, relative but in the context of scale compared to automobile manufacturers, technology companies or industrial conglomerates they are small and often valued at their annual revenue. Tech companies can be worth as much as 35 times revenue. The market capitalization of publicly traded homebuilders has risen as Covid19 instigated increased demand for single-family houses instigating a new scope of growth and an wider awareness of what seems like longer term change in markets.

The phrase supply chain has become increasingly present in the main stream media. This week will cover key aspects of the term and how it applies to products, to commodity items and how it could be more advanced in housing. Key terms will include: Parallel Path, Capital Expenditures, Operating Expenditures, Design for Manufacturing, Bill of Materials, Engineering Bill of Materials,

April 08
Presentations

April 15
Presentations

April 22
Final Lecture

Part Two: Schematic Organization of Course Content.

The course will offer weekly lectures and discussion time.

We will follow an outline of historical time frames + major themes in development. The time frames will largely follow the past century of development and architectural and urban history but we will move in and out of history as we compare and integrate information and ideas.

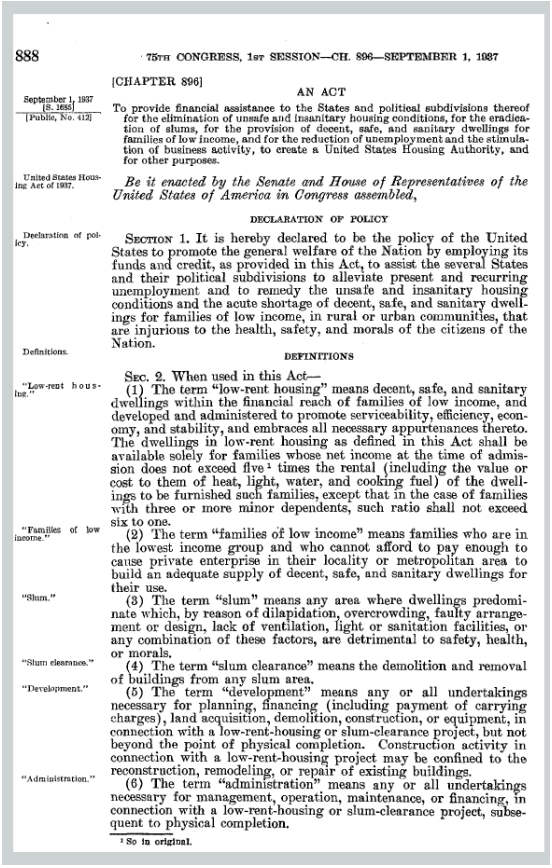
In each case we will explore architectural, urban planning, real-estate as well legal, policy and energy information examining where these merge and create what we have seen as "the possible."

Time Frames

1929 - 45

The post Great Depression era instigates immense federal programs for housing and home ownership. The impacts are physical as hundreds of thousands of housing units are realized but there is a philosophical divide: the Federal Government cannot directly complete with private markets. The shape of federal legislation portends immense investment in housing nonetheless. These policies at still at the heart of how we frame government intervention into housing markets. The seminar will focus on gaining an understanding of these policies and the form they took in urbanism and architecture.

The Housing Acts of 1934, 1937 launch what will become more than 3300 Housing Authorities and 1.3 million housing units. All operated as a hybrid of federal, state and city Housing Authorities.



888 75TH CONGRESS, 1ST SESSION—CH. 896—SEPTEMBER 1, 1937

[CHAPTER 896]

AN ACT

September 1, 1937 [S. 1685] [Public, No. 412]

To provide financial assistance to the States and political subdivisions thereof for the elimination of unsafe and insanitary housing conditions, for the eradication of slums, for the provision of decent, safe, and sanitary dwellings for families of low income, and for the reduction of unemployment and the stimulation of business activity, to create a United States Housing Authority, and for other purposes.

United States Housing Act of 1937.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

DECLARATION OF POLICY

Declaration of policy.

SECTION 1. It is hereby declared to be the policy of the United States to promote the general welfare of the Nation by employing its funds and credit, as provided in this Act, to assist the several States and their political subdivisions to alleviate present and recurring unemployment and to remedy the unsafe and insanitary housing conditions and the acute shortage of decent, safe, and sanitary dwellings for families of low income, in rural or urban communities, that are injurious to the health, safety, and morals of the citizens of the Nation.

Definitions.

DEFINITIONS

SEC. 2. When used in this Act—

"Low-rent housing."

(1) The term "low-rent housing" means decent, safe, and sanitary dwellings within the financial reach of families of low income, and developed and administered to promote serviceability, efficiency, economy, and stability, and embraces all necessary appurtenances thereto. The dwellings in low-rent housing as defined in this Act shall be available solely for families whose net income at the time of admission does not exceed five[1] times the rental (including the value or cost to them of heat, light, water, and cooking fuel) of the dwellings to be furnished such families, except that in the case of families with three or more minor dependents, such ratio shall not exceed six to one.

"Families of low income."

(2) The term "families of low income" means families who are in the lowest income group and who cannot afford to pay enough to cause private enterprise in their locality or metropolitan area to build an adequate supply of decent, safe, and sanitary dwellings for their use.

"Slum."

(3) The term "slum" means any area where dwellings predominate which, by reason of dilapidation, overcrowding, faulty arrangement or design, lack of ventilation, light or sanitation facilities, or any combination of these factors, are detrimental to safety, health, or morals.

"Slum clearance."

(4) The term "slum clearance" means the demolition and removal of buildings from any slum area.

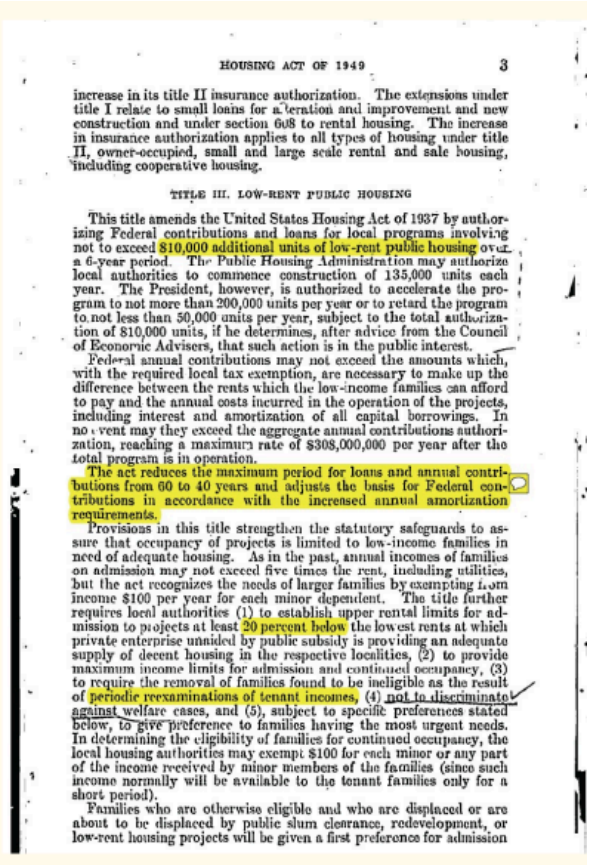
"Development."

(5) The term "development" means any or all undertakings necessary for planning, financing (including payment of carrying charges), land acquisition, demolition, construction, or equipment, in connection with a low-rent-housing or slum-clearance project, but not beyond the point of physical completion. Construction activity in connection with a low-rent-housing project may be confined to the reconstruction, remodeling, or repair of existing buildings.

"Administration."

(6) The term "administration" means any or all undertakings necessary for management, operation, maintenance, or financing, in connection with a low-rent-housing or slum-clearance project, subsequent to physical completion.

[1] So in original.



HOUSING ACT OF 1949 3

increase in its title II insurance authorization. The extensions under title I relate to small loans for alteration and improvement and new construction and under section 608 to rental housing. The increase in insurance authorization applies to all types of housing under title II, owner-occupied, small and large scale rental and sale housing, including cooperative housing.

TITLE III. LOW-RENT PUBLIC HOUSING

This title amends the United States Housing Act of 1937 by authorizing Federal contributions and loans for local programs involving not to exceed $10,000 additional units of low-rent public housing over a 6-year period. The Public Housing Administration may authorize local authorities to commence construction of 135,000 units each year. The President, however, is authorized to accelerate the program to not more than 200,000 units per year or to retard the program to not less than 50,000 units per year, subject to the total authorization of $10,000 units, if he determines, after advice from the Council of Economic Advisers, that such action is in the public interest.

Federal annual contributions may not exceed the amounts which, with the required local tax exemption, are necessary to make up the difference between the rents which the low-income families can afford to pay and the annual costs incurred in the operation of the projects, including interest and amortization of all capital borrowings. In no event may they exceed the aggregate annual contributions authorization, reaching a maximum rate of $308,000,000 per year after the total program is in operation.

The act reduces the maximum period for loans and annual contributions from 60 to 40 years and adjusts the basis for Federal contributions in accordance with the increased annual amortization requirements.

Provisions in this title strengthen the statutory safeguards to assure that occupancy of projects is limited to low-income families in need of adequate housing. As in the past, annual incomes of families on admission may not exceed five times the rent, including utilities, but the act recognizes the needs of larger families by exempting from income $100 per year for each minor dependent. The title further requires local authorities (1) to establish upper rental limits for admission to projects at least 20 percent below the lowest rents at which private enterprise unaided by public subsidy is providing an adequate supply of decent housing in the respective localities, (2) to provide maximum income limits for admission and continued occupancy, (3) to require the removal of families found to be ineligible as the result of periodic reexaminations of tenant incomes, (4) not to discriminate against welfare cases, and (5), subject to specific preferences stated below, to give preference to families having the most urgent needs. In determining the eligibility of families for continued occupancy, the local housing authorities may exempt $100 for each minor or any part of the income received by minor members of the families (since such income normally will be available to the tenant families only for a short period).

Families who are otherwise eligible and who are displaced or are about to be displaced by public slum clearance, redevelopment, or low-rent housing projects will be given a first preference for admission

The Housing Act of 1937, also referred to as the Wagner–Steagall Act established the first federal public housing.
The Housing Act of 1949.

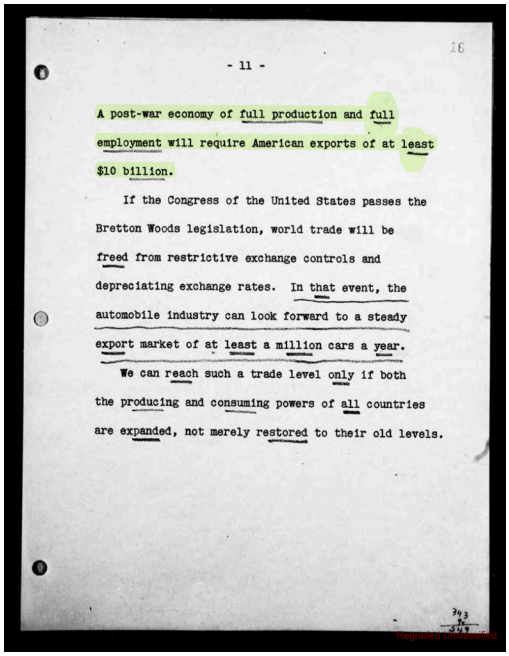
Sources:
https://www.govinfo.gov/content/pkg/COMPS-10348/pdf/COMPS-10348.pdf
https://ia800708.us.archive.org/17/items/Housingact1937/housingact1937.pdf

1945 - 71

In the post-war period the United States dramatically expanded homeownership with a myriad of federally backed mortgage programs. This expansion and the economy that allowed it required an expansion of exports to achieve full post-war employment. In the words of Henry Morgenthau Jr, Sec. Treasury, speaking in 1944, the Bretton Woods Agreement (if signed) "assures post-war full employment" by assuring export and sale of US made goods.

Federal actions in the form of legislation on housing and public housing deeply re-shape cities and accelerate the formation of suburbs. The United States becomes a nation of mass-produced speculative housing. The effect of race and racism combine with structural enactment of housing at immense and newly achieved scale. Homebuilders grow in scale but remain far smaller than other post-war corporations when analyzed according to revenue.

From the late 1950s forward the United States consumes more energy than it produces creating a six-decade window of global energy trade and imbalance. HUD is formed (1966) and largely based in urban planning, architecture and economics but so too entire reorganizations of the federal scientific research that fueled World War II — in particular around research in radio, electromagnetics and space, energy and satellite communications. The ability to observe Earth from space and outside the territorial limits of nations opens a new vantage on energy and a global view of settlement. In the post Bretton Woods era that emerges in 1971 that view becomes urgent.



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A post-war economy of full production and full employment will require American exports of at least $10 billion.

If the Congress of the United States passes the Bretton Woods legislation, world trade will be freed from restrictive exchange controls and depreciating exchange rates. In that event, the automobile industry can look forward to a steady export market of at least a million cars a year.

We can reach such a trade level only if both the producing and consuming powers of all countries are expanded, not merely restored to their old levels.

In the immediate post-war era the United States economy needed international trade. A post World War II United States economy required an increased level of exports to sustain full employment. In 1945 Secretary of Treasury Henry Morgenthau, Jr. gave an estimate with remarkable detail in a speech at the Detroit Economic Club. Morgenthau Secretary of the Treasury from January 1934 through July 1945. Morgenthau speaking at the Economic Club of Detroit to foster support for the signing of the Bretton Woods Agreements: "A post-war economy of full production and full employment will require American exports of at least $10 billion." Speaking to an audience of automobile industry leaders Morgenthau enunciated that Bretton Woods would ease the impact of fluctuating currency exchange rates on the sale of a Detroit produced car in Europe.

Source: Diaries of Henry Morgenthau, Jr., April 27, 1933-July 27, 1945; Secretary of the Treasury, Diary, Book 823, February 26-28, 1945; Franklin D. Roosevelt Presidential Library & Museum.
http://www.fdrlibrary.marist.edu/_resources/images/morg/md1124.pdf

1971 - 1990

Energy shortages and a recognition that national security is at risk instigate a urgent question: is energy scarce?

In the post-Bretton Woods era globalization of the U.S. economy placed housing debt on global markets and in new forms of "mortgage backed securities". Speculation and moral hazard enter housing markets as federal guarantees of debt and newly global markets allow a steep financialization of housing markets.

The United Nations sets out a leadership role in issuing "Our Common Future" defining terms for Sustainable Development.

Development goals at a global scale instigate and frame sustainability as a global concern—the success of which requires global action by the world's advanced economies.

Federally funded research in renewable energy is increased against real and perceived energy shortages.

National Renewable Energy Lab is formed and the DOE.

National Science Foundation, Fourth Annual Report for Fiscal Year 1974. Cover Page and Letter of Transmittal Guyford Stever, Directors Statement, Page viii https://www.nsf.gov/pubs/1974/1974-NSF-Annual-Report.pdf

Scarcity, Technology, Settlement —

In 1974, the Director of the National Science Foundation, Guyford Stever, warned in the preface to the NSF Fourth Annual Report (to the President) that the nation and its scientific community were facing profound questions about growth and the ability of technology to manifest a means to secure development. The discussion takes up the first eight paragraphs of his text and one and half pages of a seven-page document. While the overall document offers a deeply detailed (141 page) description of NSF backed research the opening is remarkably agile and poetic as it seeks to frame what Stever sees as a pivotal moment in industrialized society. Terms in the writing have become common in the intervening decades but the tone and voice chosen seem precise but also fragile when read today. The scope of his concern and the modalities of

science and social implementation of science are today as in flux as then. His introductory paragraph concludes with a warning on uses of nonrenewable sources.

Stever writes: *As our Nation approaches its third century and as Western Society approaches its third millennium, we enter an era that may be recognized as a turning point in human history. It is not difficult to realize why we have arrived at this point. The predominant reason is that through the marriage of science and technology we have created an industrially based society that up to now has been able to sustain and advance a rapidly growing world population. The shift from an economy based on agricultural subsistence to one based on modern industry has been responsible for explosive growth, not only in population size but in a spectacular rise in mankind's activities—in mobility, speed of communication, range of knowledge, production of goods and services, and in the number of interfaces within his natural and social systems. Although much of this process is based on human innovation and industriousness, it is based also on humanity's exploitation of the natural world. It draws heavily on nature's capital, particularly on the store of nonrenewable resources, and it impacts heavily on her environment and living resources.*

1990 - 2008

Privatization in Europe, China and the United States increasingly means housing innovation must come from private companies.

A rise of US Treasury based instruments such as Low-Income Housing Tax Credits or Historic Preservation Tax as the major means to develop affordable (not public) housing. Tax Credits become the predominant methods of developing affordable housing.

New Urbanism becomes the official architectural and urban design language of affordable housing and public housing via HOPE VI legislation.

Entirely new territories of digital communication, surveillance and control over information, and economies rapidly expand.

The 1990s and early 2000s see a dramatic run up in housing valuations backed by a myriad of financial securities. Housing markets become a casino.

2008 - 2020

The Great Recession unfolds in large part due to a failing transparency in securities assembled from housing mortgages.

Mortgage Backed Securities reach valuations equivalent to 45% of GDP before crashing and becoming illiquid.

As many as 3% of single-family houses end up owned by private equity firms who become the nation's largest landlords.

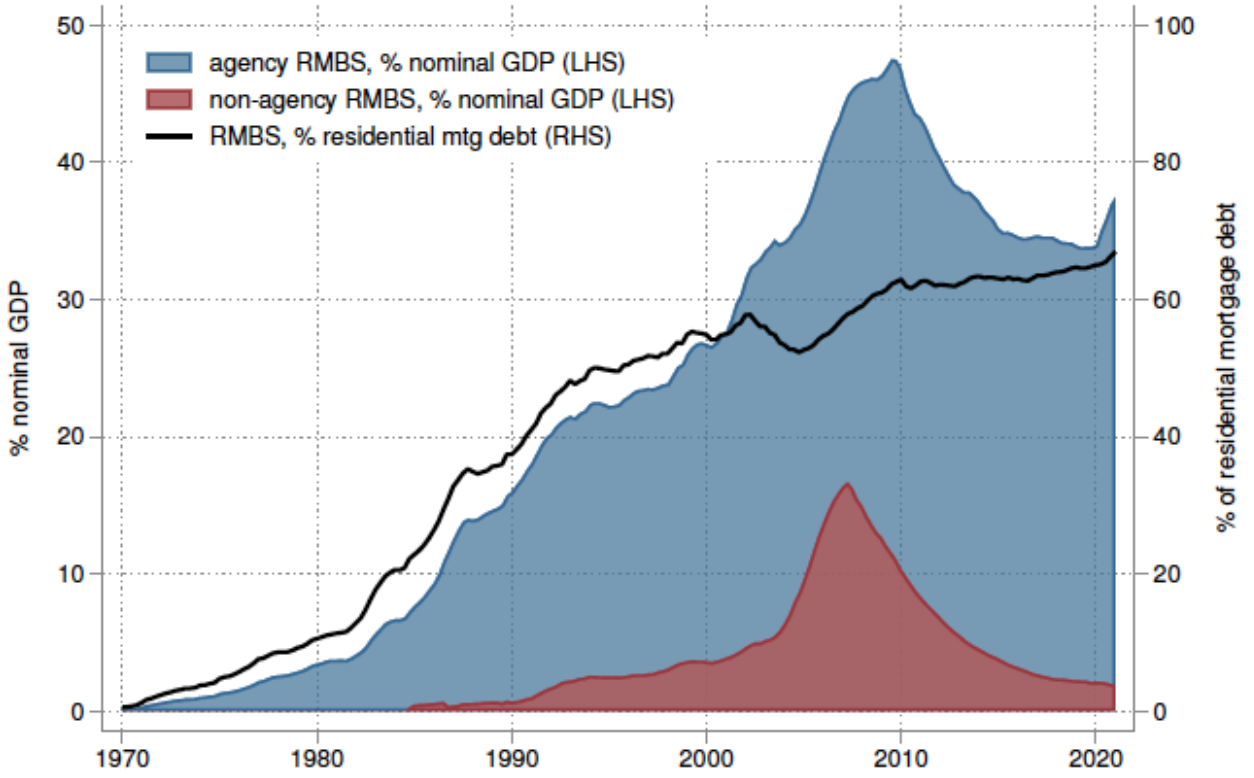
Central Banks worldwide have in this era absorbed and purchased vast sums of securities to create market liquidity.

Are Central Banks artificially shoring up assets (housing) and development that are fundamentally in need of structural change?

A global pandemic instigates remote work at scale, enabled by digital satellite enabled communications.

Networks and encryption becomes critical to infrastructure of all kinds.

Discussions of universal basic income become common as automation becomes a more realistic presence in everyday life.



Since 1970 the role of government guaranteed mortgage backed securities (agency RMBS above) has reached more than 45% of GDP. Non-government guaranteed mortgage backed securities (non-agency RMBS above are greater than 15%.

Source: Staff Reports, No. 1001; February 2022, Mortgage-Backed Securities by Andreas Fuster, David Lucca, James Vickery; Federal Reserve Bank of New York.

"Mortgage-backed securities outstanding. Shaded areas represent stock of agency and nonagency MBS as a percent of nominal GDP. Dashed line plots total MBS scaled by the relevant stock of mortgage debt. See Appendix (section A) for details of figure construction. Data sources: Financial Accounts of the United States (FAUS), Bureau of Economic Analysis (BEA)." Page 23. "Since securitization increases liquidity and broadens the set of lenders able to originate mortgages, one would naturally expect that it also leads to an outward shift in credit supply, plausibly increasing credit access for otherwise "marginal" borrowers. However, a sizeable literature has argued that securitization also reduces credit quality through an additional "moral hazard" channel: as originators offload the credit risk, they may have weaker incentives to screen borrowers, leading to lower acquisition of soft information and worse ex-post outcomes (e.g., Keys et al., 2010; Nadauld and Sherlund, 2013; Rajan et al., 2015; Choi and Kim, 2020). But the strength of the evidence, and the question of whether securitization is an important cause of the US mortgage boom and bust of the 2000s, remains debated in the literature (e.g., Bubb and Kaufman, 2014; Foote et al., 2012, 2020; Mian and Sufi, 2021)."

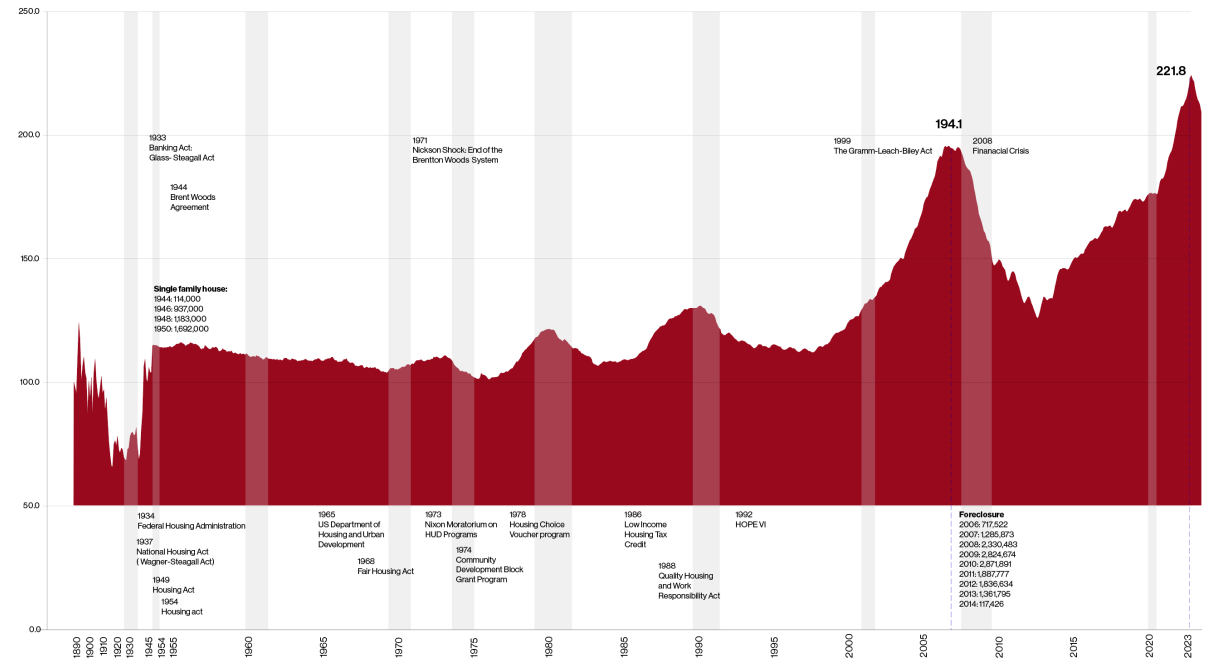
Subject Frames

Frame 1: Scale

What role does scale play in housing development. What constitutes large or small enterprise, and does it affect access to innovation?

The Housing Act of 1949. Public Law 171 (63 Stat. 413). If read without specifics of context or human need the Housing Act of 1949, enacted by the United States Congress seems immense in scale. It created a political apparatus to fund, plan and create as many as 810,000 new Public Housing Authority (PHA) units in cities across the nation. Set atop approximately 125,000 Public Housing already realized under the New Deal Housing Acts of 1934 and 1937 the 1949 Act created the potential of nearly 1 million new PHA units. A year later the 1950 Census estimated a total of 46 million housing units in the country. The Housing Acts of 34, 37 and 49—at the outer limits of their funding and authorizations—created a path for the U.S. government in partnership with states and cities to enact housing on a scale equivalent to approximately 2% of the nation's existing housing.

If measured as a private business Public Housing in 1949 had no comparable enterprise among private companies engaged in home building. Levittown, New York, begun in 1947, reached a total of approximately 17,000 units over four years at its completion in 1951. As a forerunner to the industrialization of housing William J. Levitt built housing in the hundreds of units per year in pre-war years. Levittown, realized on 1,200 acres in Nassau County, New York, brought this figure into the thousands. The New York City Housing Authority (NYCHA) in 1950 was already far larger. NYCHA's 1950s Development Data Book showed a total of 75,952 apartments under NYCHA management. 30,730 were already completed, 34,967 new units were under construction or pending construction and intended as additional permanent housing. Another 10,255 were for Temporary Veterans Emergency Projects. In 1950 NYCHA accounted for approximately 3.12% of New York City's estimated 2,433,465 housing units. Scale in the post New Deal and post-World War II eras takes on completely new denominators as housing becomes industrialized and imagined for entire populations.

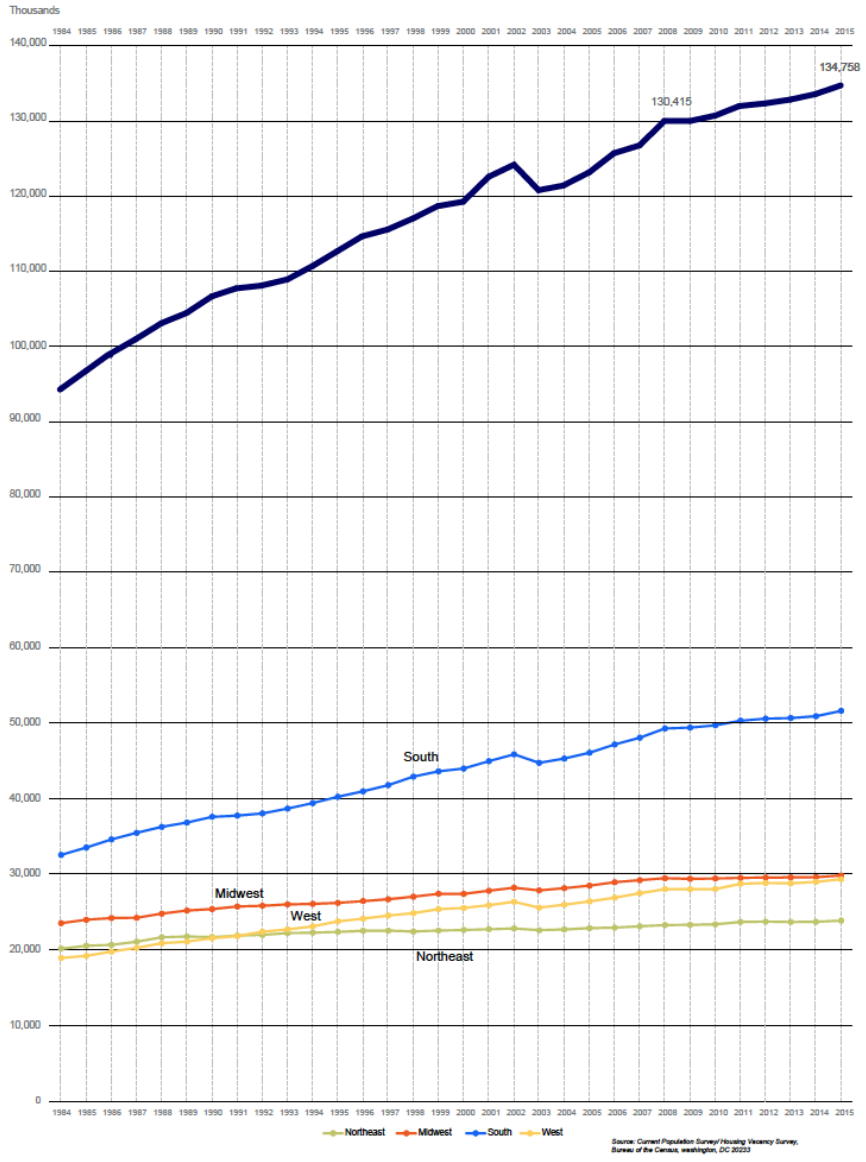


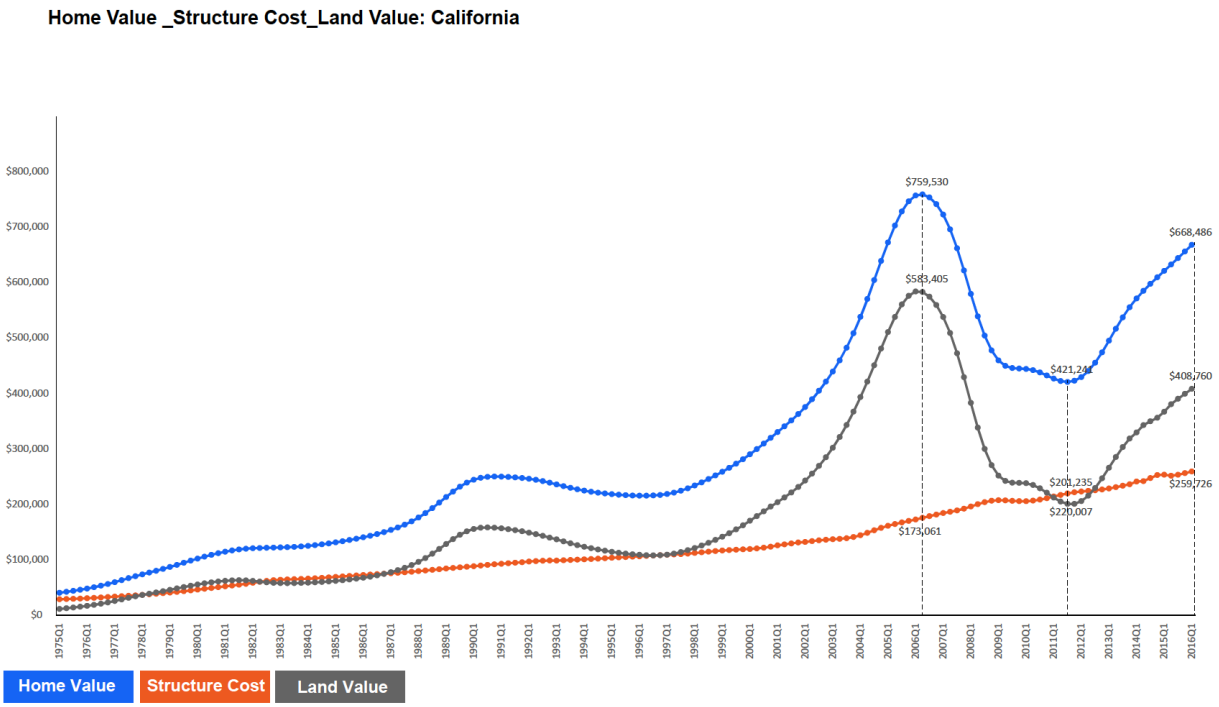
S&P Dow Jones Indices LLC, S&P/Case-Shiller U.S. National Home Price Index [CSUSHPINSA], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/CSUSHPINSA, July 6, 2023.

Frame 2: Density and Sustainability and Existing Housing Stock

What is the role or potential for density in the recent past and near future of development and climate change? The 2022 United States Census described a national total of 1.39 million privately owned housing units completed that year. Of that total, 747,000 or 54% of the units were realized in the Census' South Region. The Census divides housing starts, completions and occupancy into four regions: the Northeast, Midwest, South and West (including Alaska).

While sustainability arguments predominately point to a need for increased density in land use—especially for housing—the Census region of the United States that has grown most rapidly over the past five decades lies in the states and cities were lower density is the norm. Census data shows that the thirty-year period—between 1985 and 2015—saw the nation's housing aggregate housing stock increase from at total number of 97.3 million (1985) units to 134.7 million (2015). In just three decades new housing units added to the aggregate grew the total housing stock by 39% growth. In retrospect—approximately 28% of the nation's extant housing units in 2015 were added over just three decades. On aggregate the Census South Region alone accounts for 51% of what was added nationally in the time span. What do we build in the next thirty years?





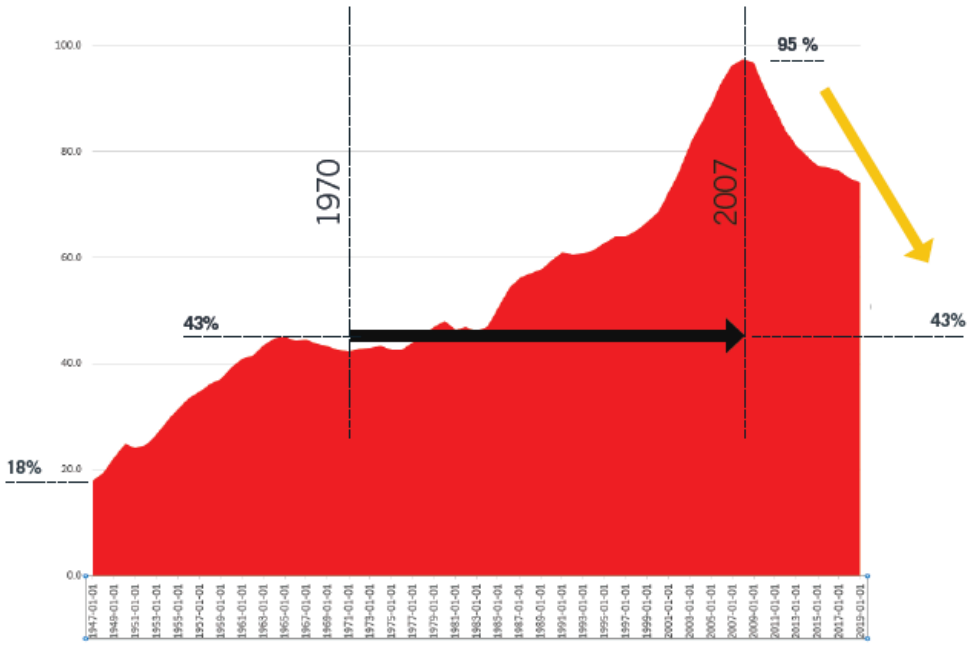
Home Value-Structure Cost-Land Value: California

California: In California in 2005–06, at the peak of the pre-Great Recession market, land accounted for 77 percent of housing costs statewide. In the pre-crash market, this meant only 23 percent of housing costs went toward actual building. Thirty years earlier, land was closer to 27 percent of housing costs in California. While land values fall in the Great Recession, they sustain high valuations compared to sister states.

Frame 3: Debt and Leverage — the Housing Lottery

How have debt and leverage shaped housing development and where has this helped or thwarted sustainability and addressing climate change in housing?

The two decades before and after the conclusion of World War II saw the percentage of United States households that owned their home change dramatically. Homeownership leading up to the Great Depression in 1929 peaked at 47.8% in 1930 before it falling to 43.6% by 1940. By 1965—20 years after the conclusion of the war—63% of households owned their home. The era of homeownership and in particular single-family houses was firmly established. The Depression and World II formed the backdrop for federal intervention in mortgages and for a decentralized and dispersed population of private single-family house owners. Banks aided by federal government backed mortgages provided the nation's homeowners access to the leverage required to buy private—almost exclusively single-family—homes. The accrual of long-term household debt in the form of mortgages rose in the post war decades. Mortgage debt collateralized by incrementally, but rapidly appreciating housing assets increased. An increase in automobile debt—leverage ultimately attributed to depreciating assets rose. Eventually unsecured debt in the form of revolving credit became a common part of personal finances. Later in century newly introduced and then expanded home equity loans provided the means to move unsecured debt to mortgages—transferring expanding equity into consumption. Until the 1970s savings had steadily increased but by the 1980s it declined to an eventual low of less than $400 per capita. By 2006 households held debt that neared 100% of GDP with little savings. Economic security was almost entirely based in housing wealth.



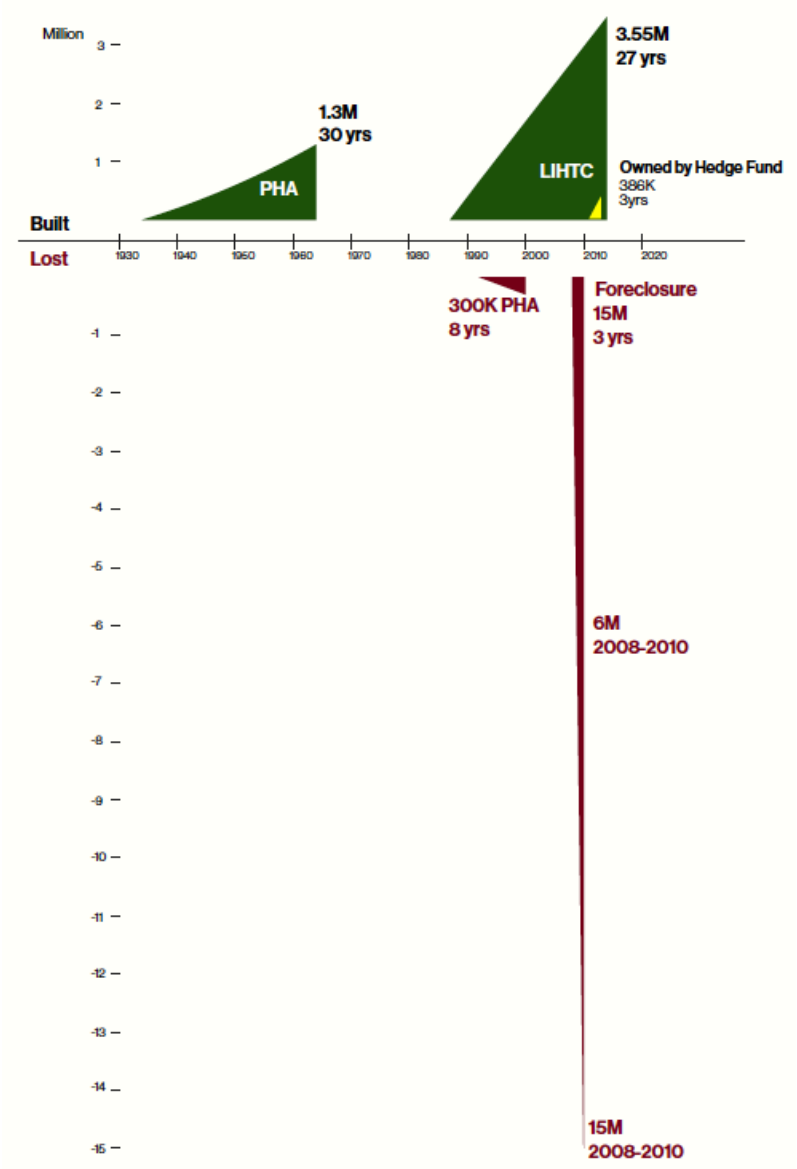
Household debt as a percentage of United States GDP since the end of World War II falls in three eras. It expanded after World War II as homeownership grew. After the Bretton Woods Agreement was dismantled in 1971 the uses of debt at the private level accelerated. Mortgages traded as derivatives and securities enabled and sustained a deeper leveraging of housing markets before it collapsed under the exploding prices between 2000 – 07 era.

Data source: Board of Governors of the Federal Reserve System (US), Households and Nonprofit Organizations; Debt Securities and Loans; Liability, Level [CMDEBT], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/CMDEBT, June 25, 2020 and U.S. Bureau of Economic Analysis, Gross Domestic Product [GDP], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/GDP, June 25, 2020.

Frame 4: Turmoil

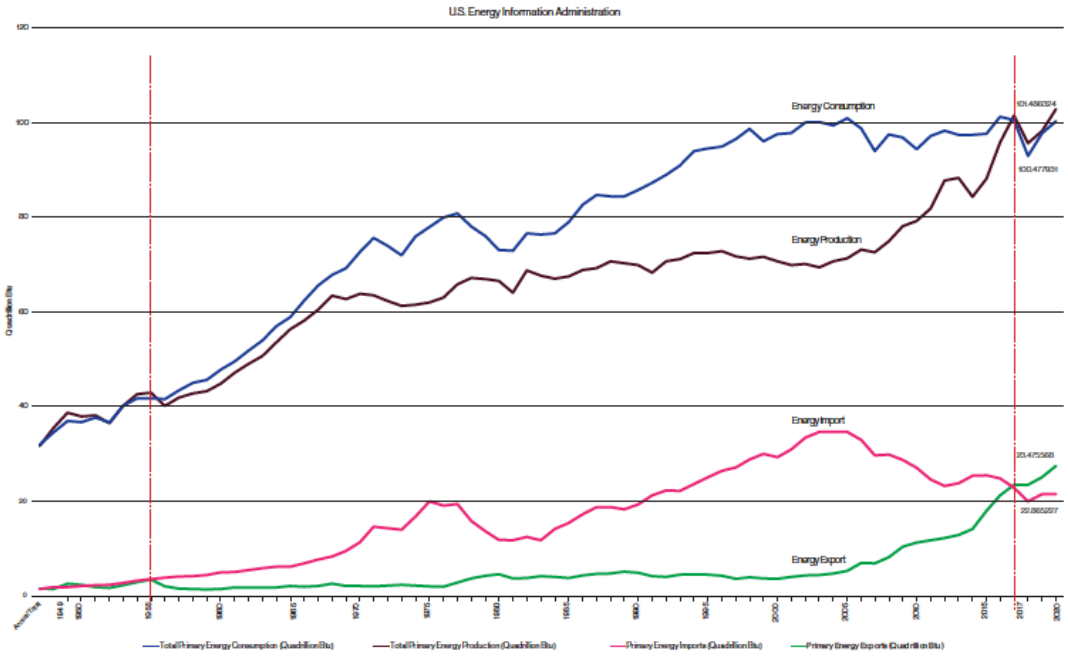
Creation of Public Housing / Federal Support to underwrite Affordable Housing

Federal, State and City based aid to housing has taken many forms in the past century but it routinely must measure empathy for human need against a constitutional protection of property. Of land its wealth. This is changing as we address climate change—where is the future wealth in an era of renewable energy. Market failures have had tremendous effect on housing stability. The Great Recession transfer more homes into foreclosure than any federal program had built in the past century.



Above: A near century of federal, state and city aid to housing affordability finds immense number of households that are "Housing Cost Burdened" or Severely Housing Cost Burdened. Official HUD terms for households that spend more than 30% of their gross income on housing costs. Renters are far more at risk of economic insecurity, but homeowners face financial demands that sustain anxiety and risk in every jobs rich region of the nation. We need to create new programs for the decades ahead.

Frame 5: Federal Energy — the 1970s launch R+D in Renewables



United States, Energy Information Administration, Primary Energy Overview 1949 – 2022, (Quadrillion Btu)

The United States primary energy production and consumption.: "The United States has been an annual net total energy exporter since 2019. Up to the early 1950s, the United States produced most of the energy it consumed.1 U.S. energy consumption was higher than U.S. energy production in every year from 1958–2018. The difference between consumption and production was met by imports, particularly crude oil and petroleum products such as motor gasoline and distillate fuel oil. Total energy imports (based on heat content) peaked in 2007 and subsequently declined in nearly every year since then. Increases in U.S. crude oil and natural gas production reduced the need for crude oil and natural gas imports and contributed to increases in crude oil and natural gas exports. The United States has been a net total energy exporter—total energy exports have been higher than total energy imports—since 2019."

The 1970s saw a dramatic increase in both the recognition of a need to address energy production and shortages but also a call to increase R+D in renewable energy. 50 years later this is still emerging and indeed we still see energy as scarce even as we consume far more every year. What are the new sources of energy today and how do we frame these in relation to the 1970s. How does development scale in regard to energy?

In 1974 the Director of the National Science Foundation, Guyford Stever, warned in the preface to the NSF Fourth Annual Report (to the President) that the nation and its scientific community were facing profound questions about growth and the ability of technology to manifest a means to secure development. The discussion takes up the first eight paragraphs of his text and one and half pages of a seven-page document. While the overall document offers a deeply detailed (141 page) description of NSF backed research the opening is remarkably agile and poetic as it seeks to frame what Stever sees as a pivotal moment in industrialized society. Terms in the writing have become common in the intervening decades but the tone and voice chosen seem precise but also fragile when read today. The scope of his concern and the modalities of science and social implementation of science are today as in flux as then. His introductory paragraph concludes with a warning on uses of nonrenewable sources. Even as his warning was severe he expressed concerns that we not see the future of energy as one of unjust or imposed societal scarcity. We will cover his writing carefully and in particular where he warns about punitive readings of how to allocate would-be scarce resources.

Stever wrote: *As our Nation approaches its third century and as Western Society approaches its third millennium, we enter an era that may be recognized as a turning point in human history. It is not difficult to realize why we have arrived at this point. The predominant reason is that through the marriage of science and technology we have created an industrially based society that up to now has been able to sustain and advance a rapidly growing world population. The shift from an economy based on agricultural subsistence to one based on modern industry has been responsible for explosive growth, not only in population size but in a spectacular rise in mankind's activities—in mobility, speed of communication, range of knowledge, production of goods and services, and in the number of interfaces within his natural and social systems. Although much of this process is based on human innovation and industriousness, it is based also on humanity's exploitation of the natural world. It draws heavily on nature's capital, particularly on the store of nonrenewable resources, and it impacts heavily on her environment and living resources.*

[i] "Opportunity Occupations Monitor," Federal Reserve Bank of Atlanta (last updated May 18, 2023), https://www.atlantafed.org/cweo/data-tools/opportunity-occupations-monitor.