Scenario Results Report

Revised February 26, 2015

morpc
Mid-Ohio Regional Planning Commission

COLUMBUS 2020

ULI Urban Land Institute Columbus

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URBAN DESIGNERS, PLANNERS, ARCHITECTS

The insight2050 Scenario Results Report was prepared by Calthorpe Associates, the Mid-Ohio Regional Planning Commission (MORPC), the Columbus District Council of the Urban Land Institute (ULI), and Columbus 2020, with funding from the Federal Highway Administration as well as Columbus 2020 and ULI Columbus, with support from L Brands Foundation, Mr. and Mrs. Derrol R. Johnson, and Gertrude E. Kenney funds of The Columbus Foundation, Easton Community Foundation, Casto, and Continental Real Estate Companies. The contents of this report reflect the view of MORPC, ULI Columbus, Columbus 2020, and Calthorpe Associates, which are solely responsible for the information presented within.

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Introduction

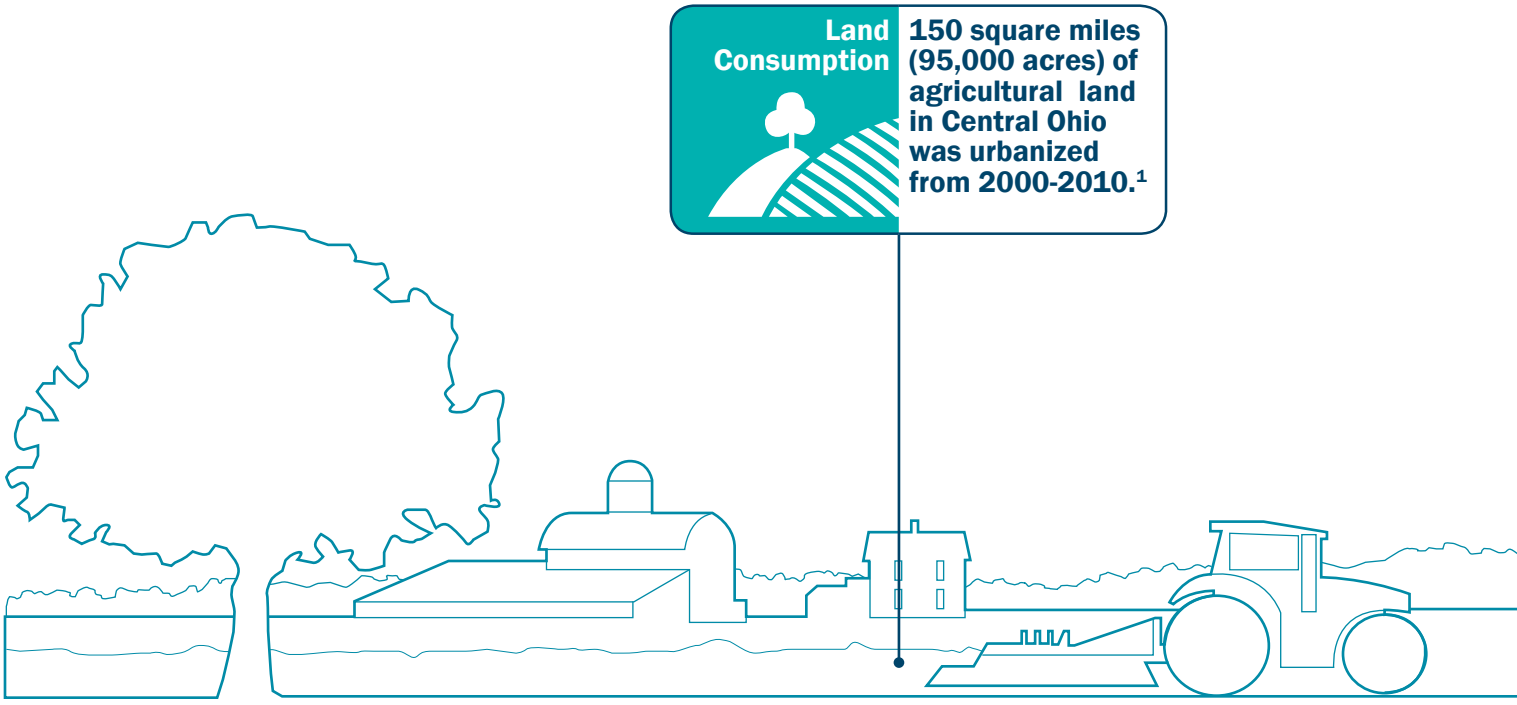
insight2050 is an effort to prepare Central Ohio for future growth. With the region slated to grow by more than 500,000 people and an additional 300,000 jobs by 2050, insight2050 is designed to provide local and regional policy makers, business leaders, developers, and public stakeholders with a clear and objective understanding of the impacts of varying growth and public investment decisions. insight2050 is not about producing a regional plan or regulating how land use decisions are made by the more than 200 jurisdictions that make up the Central Ohio region. Rather, it strives to arm decision makers and stakeholders with solid and defensible information about the fiscal, mobility, environmental, and public health impacts of development and investment choices.

The analysis behind this first phase of insight2050 relies on the RapidFire modeling platform developed by project consultants Calthorpe Associates. This model facilitates the creation of regional land use scenarios and allows for the modeling of a complete range of metrics, including land consumption, infrastructure costs, air pollution, household expenses for transportation and utilities, and public health and safety costs. While land use patterns reflect many separate local decision making processes, the objective scenarios and metrics generated by the RapidFire model provide critical insights to public and private decision makers about the impacts of key policies, while also supporting conversations about the region's future competitiveness, sustainability, and quality of life. The scenarios are intended to illustrate the impacts of varying future growth patterns, and are not meant to serve as a prescriptive vision or plan for the region.

This report describes the range of scenarios developed for the Central Ohio region, the process to build them and customize the RapidFire model for use in Central Ohio, and the analysis of the scenarios for a complete range of fiscal, transportation, environmental, public health, and other metrics.

insight2050 Steering Committee and Consulting Team

insight2050 is a collaboration among the Mid-Ohio Regional Planning Commission (MORPC), Columbus 2020, and the Urban Land Institute (ULI) Columbus. This phase of the process has been guided by a Steering Committee made up of over 30 volunteers from the public and private sectors. Most major cities and counties are represented, as are key academic, non-profit, and community stakeholders from



[1]*Source: MORPC Analysis*

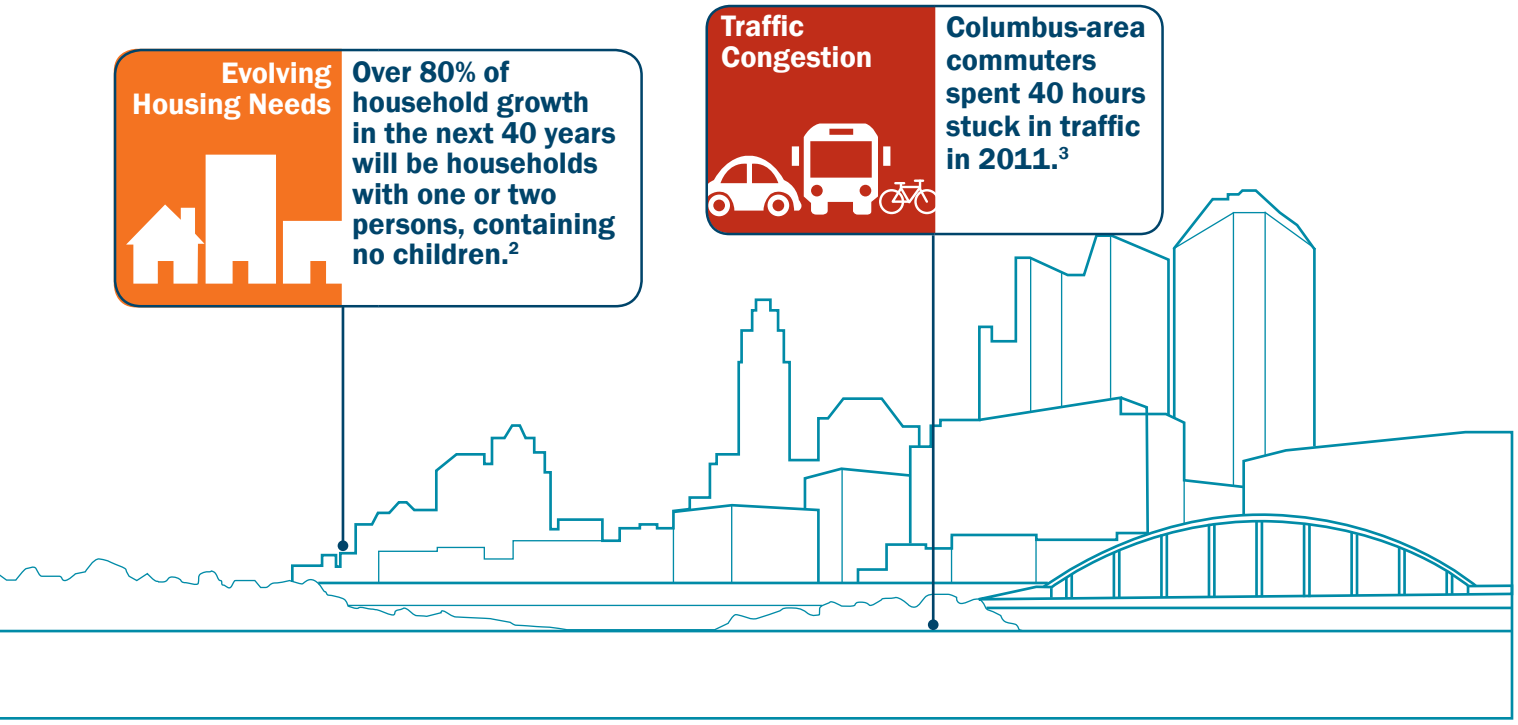
across the 7-county insight2050 study area (Delaware, Fairfield, Franklin, Licking, Madison, Pickaway, and Union counties). The Steering Committee has been critical in providing input on scenarios, modeling assumptions, and project communication. There is also a project Executive Committee made up of representatives from MORPC, Columbus 2020, the City of Columbus, the Central Ohio Transit Authority (COTA), and ULI Columbus; see Appendix D for a complete list of Steering Committee and Executive Committee members.

The insight2050 consulting team has been led by Calthorpe Associates, one of the nation's most experienced planning firms. Calthorpe Associates' work has focused on the customization and deployment of the RapidFire model for Central Ohio, and the evaluation and presentation of the impacts of future growth and development decisions. The customization of fiscal impacts assumptions was performed by market analysis experts Strategic Economics.

Scenario Planning for Central Ohio

Like other metropolitan regions across the US, Central Ohio is looking towards a future population that is significantly different than the population that drove its growth over the past decades. As a nation and a region, we are seeing an increasing proportion of aging baby boomers and young adults. Indeed, these age cohorts are slated to represent nearly 80% of the growth in Central Ohio over the next two to three decades. This changing population is expressing a demand for a broader range of housing types – more small-lot single family homes, more townhomes, and more multifamily apartments and condos – in more complete, walkable communities. In many ways, insight2050 scenarios are aimed at thinking ahead to how Central Ohio will meet these needs while keeping an eye on fiscal and environmental sustainability, the cost of living, and quality of life associated with development decisions.

The insight2050 scenarios described in this report range from a depiction of 'Past Trends' to more 'Focused Growth' and 'Maximum Infill' options. Again, the scenarios do not prescribe any specific solution, but rather lay out different ways the region can grow and accommodate projected growth. More and better information brings more people and more interests to the table, helps people understand the impacts of their choices, and leads to more sustainable decisions.



[2]*Source: Arthur C. Nelson, COLUMBUS, OHIO Metropolitan Area trends, Preferences, and opportunities: 2010 to 2030 and to 2040 (NRDC)*
[3]*Source: http://www.dispatch.com/content/stories/local/2013/02/05/commute-times-study.html*

Scenario Drivers

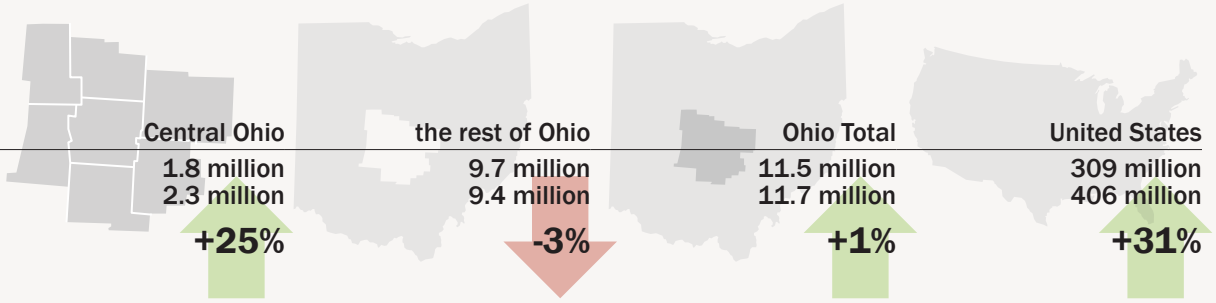
The insight2050 scenarios address important questions about Central Ohio's future growth, and the specific role that demographic changes and housing demand will play over the coming decades.

Growth

How much will Central Ohio grow between now and 2050?

Each of the insight2050 scenarios accommodates the same number of people, homes, and jobs. insight2050 uses regional projections from MORPC for population and employment through 2050, based on official projections from the state. According to these projections, the 7-county region will grow by about 500,000 people and 300,000 jobs between 2010 and 2050; about 300,000 new housing units will be needed to accommodate population growth. This rate of growth is roughly on pace with national growth rates, and far exceeds that of other cities in Ohio.

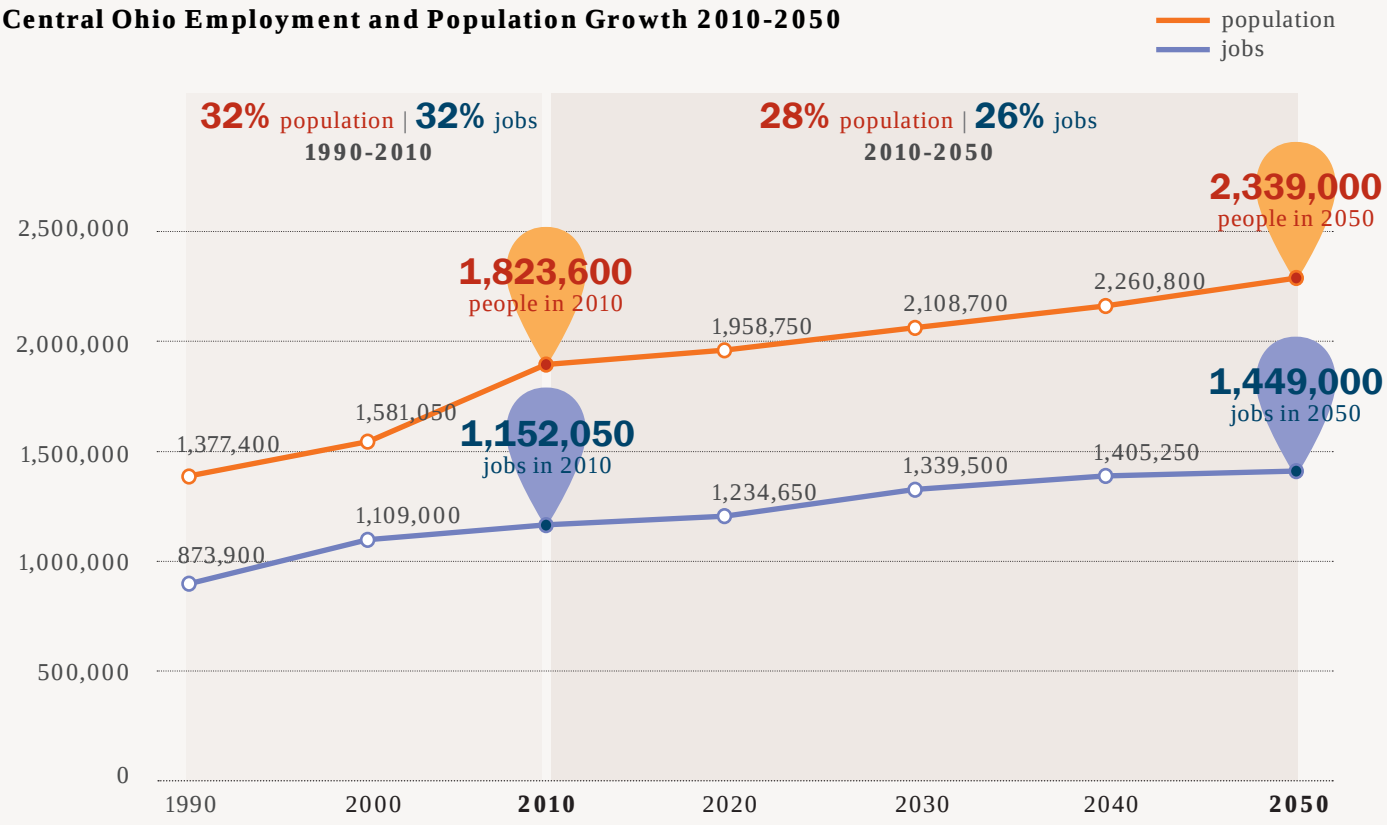
Population Growth by Regions 2010-2040



	Central Ohio	the rest of Ohio	Ohio Total	United States
2010	1.8 million	9.7 million	11.5 million	309 million
2040	2.3 million	9.4 million	11.7 million	406 million
Percent Change	+25%	-3%	+1%	+31%

Source: US Census Bureau, American Community Survey 2012

Central Ohio Employment and Population Growth 2010-2050



Source: US Census Bureau, American Community Survey 2012

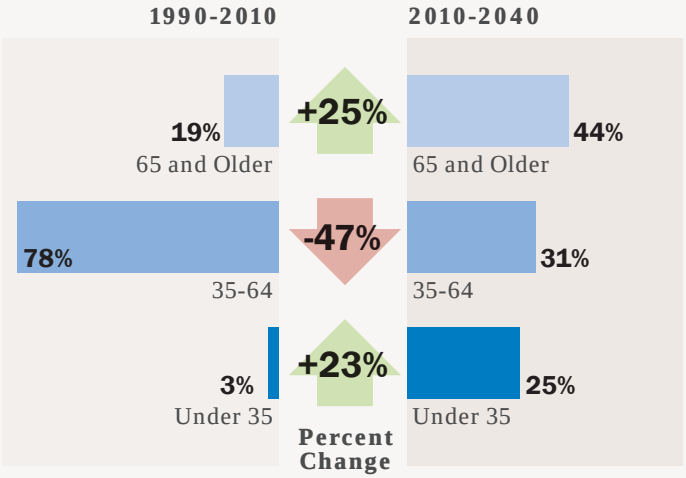
The Changing Profile of Central Ohio's Growth

Who is Central Ohio now and who will it be in the future?

The past 40 years have seen Central Ohio communities grow by more than 675,000 people, enough to fill Ohio Stadium more than six times. More than 400,000 housing units were constructed and more than 625,000 jobs were added by our region's employers. While Columbus and other historic downtowns have remained vital, growth over the past decades has been characterized, for the most part, by single family residential growth outside the outerbelt, and new suburban employment concentrations. Most growth was designed around automobile access and investments in a robust highway and roadway network. This form of growth accelerated as the Baby Boomers entered their peak wage-earning and family-raising years. Local plans and policies, and regional infrastructure investments, pivoted towards supporting this generation's demand for larger-lot single family homes and suburban lifestyles. With some ebbs and flows, the region has been fairly prosperous through the past 30 to 40 years.

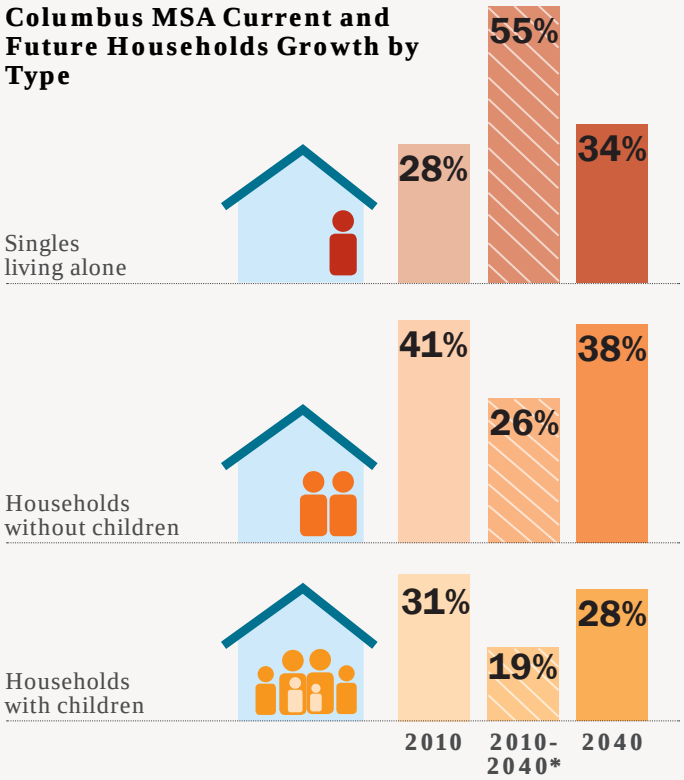
Over the next 40 years, Central Ohio, like most other regions and states across the United States, will be experiencing dramatic changes related to demographics and the shifting preferences of existing and future residents and workers. Nearly 80% of the growth in the last two decades (1990 to 2010) was among 35 to 64 year olds. Over the next decades, this same group will account for only 31% of growth. Aging baby boomers will make up nearly 45% of growth and those under 35 will account for more than 25%. Households with children will account for less than 20% of growth over the next decades, and the region will be more diverse; racial and ethnic minorities are expected to account for a majority of the region's growth by 2050. These significant shifts have implications for the kinds of homes and communities needed and preferred by existing and future residents of Central Ohio.

Columbus MSA Current and Future Household Growth Share by Householder Age



Source: Arthur C. Nelson, COLUMBUS, OHIO Metropolitan Area trends, Preferences, and opportunities: 2010 to 2030 and to 2040 (NRDC)

Columbus MSA Current and Future Households Growth by Type



*Refers to households added from 2010-2040, excluding households that existed prior to 2010.

Source: US Census Bureau, American Community Survey 2012

Scenario Drivers

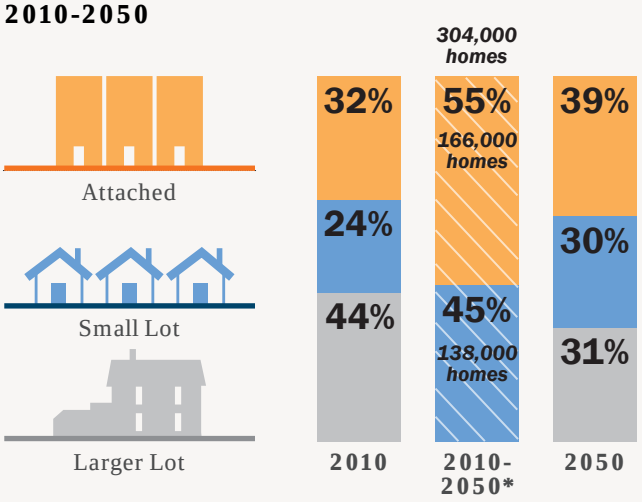
Evolving Housing Needs

What kinds of communities and housing do residents need now & into the future?

Recent studies by the National Association of Realtors (NAR), Urban Land Institute, and other organizations across the country are pointing towards increasing preferences for walkable, complete communities where daily needs are within close proximity to homes and jobs. NAR's 2013 Community Preference Survey points out that "Americans prefer walkable, mixed-use neighborhoods and shorter commutes." More than 60 percent of respondents "favor a neighborhood with a mix of houses and stores and other businesses that are easy to walk to, rather than neighborhoods that require more driving between home, work and recreation."

These trends and changing preferences raise important questions about the vitality and competitiveness of our region and communities over the coming decades. What types of places will attract the skilled labor forces our businesses require? Are today's land use plans and development regulations aligned with the goal of attracting residents and businesses, helping communities to remain competitive and improve their tax bases? Are private developers able to respond to these emerging market trends? A recent study of regional housing demand commissioned by the Urban Land Institute provides a look at the housing demand profile of our changing population. It lays out a shrinking demand for larger-lot single family homes (those on lots greater than 7,200 square feet), and an increasing demand for well-located smaller-lot detached homes, attached/townhome products, and multifamily housing. With more than 330,000 larger-lot homes on the ground now, demand is for an additional 140,000 smaller-lot detached single family homes, and 166,000 attached units. Through 2050, this represents a broader choice in housing products, with just over 60% of homes on single family detached lots in 2050 (compared to 67% in 2010) and just under 40% in townhomes and multifamily products. The insight2050 scenarios are designed in part to test the impacts of meeting this projected demand, compared to maintaining a trend-based housing profile, or building out the housing profile of the local jurisdictions' current plans and policies.

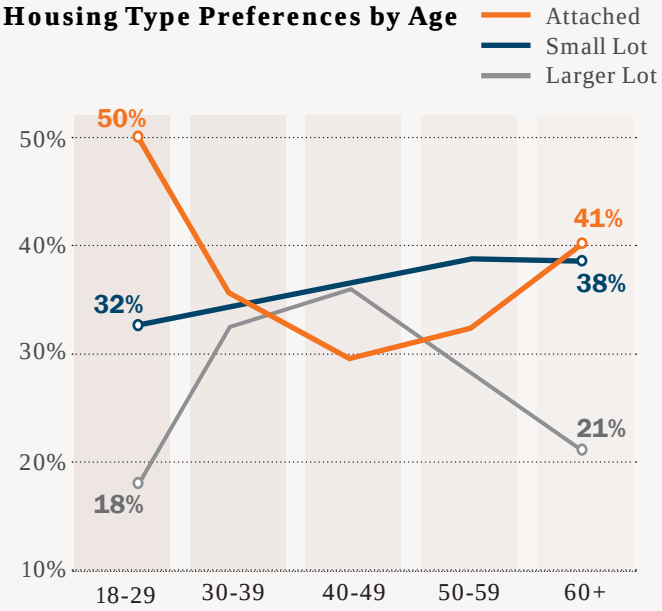
Columbus MSA Housing Needs by Home Type 2010-2050



*Refers to households added from 2010-2050, excluding households that existed prior to 2010.

Source: Arthur C. Nelson, COLUMBUS, OHIO Metropolitan Area trends, Preferences, and opportunities: 2010 to 2030 and to 2040 (NRDC)

Housing Type Preferences by Age



Source: National Association of Realtors (2011)

Local Examples

The City of Newark is preparing for shifting demands and demographics by working to attract millennials to the community. To that end the City is working to make its downtown Courthouse Square a destination by incorporating pedestrian-friendly street designs and necessities within walking distance to mixed-use developments.

The City of Columbus is planning for shifting demographics and demand by accommodating a range of development options in its downtown and urban neighborhoods. A market study for the City's East Franklinton Plan forecasts a potential 2,000-plus market rate housing units; 50,000 square feet of retail; and 100,000 square feet of office, incubator and arts space over the next 10 years. Meanwhile in West Franklinton the City is focusing on stabilizing housing, attracting retail and creating jobs.

Mixed-use projects like The Lane in Upper Arlington, The Heights in Worthington and Bridge Park as a part of the Bridge Street District in Dublin (shown at right) are responding to shifting demographics leading to greater market demand for walkable neighborhoods with access to offices, retail and restaurants.

Building Scenarios

The insight2050 scenarios depict the growth choices facing Central Ohio by combining different land patterns with variations in housing type mix, concentrations of development, and the proportion of growth accommodated either on previously undeveloped land, or through infill and redevelopment on already urbanized "refill" land. They also vary in the proportion of growth accommodated in incorporated or unincorporated areas of the 7-county region.

Using the RapidFire model, land use scenarios are defined by the proportion of growth allocated to Urban, Compact, and Standard 'place types'. The place types represent distinct forms of land use, each of which is associated with a unique set of assumptions describing housing type mix, travel behavior, land consumption, infrastructure costs, and other key factors. The place types are based upon and calibrated to development in the Central Ohio region. The model varies the amount of each place type in four insight2050 growth scenarios:

- Past Trends – extends past development trends (from 1990) forward to 2050
- Planned Future – reflects and extends local plans with moderate infill/redevelopment
- Focused Growth – informed by housing demand forecasts, with significant infill/redevelopment
- Maximum Infill – informed by housing demand forecasts, with maximum infill/redevelopment in existing corridors and city centers

Because the scenarios accommodate new growth with different proportions of the three place types, the scenarios vary in performance in terms of transportation, local government finances, environmental sustainability, and public health. The scenarios illustrate the differing impacts of varying future growth patterns, and are not meant to serve as a prescriptive vision or plan for the region. They do not allocate growth to specific locations, but rather to growth patterns in generalized location types (i.e. infill vs. greenfield locations).

The RapidFire Model

The insight2050 scenarios were produced using the RapidFire scenario modeling tool developed by the planning and design firm Calthorpe Associates. The model is a spreadsheet-based tool used to evaluate scenarios at the national, state, regional, and local scales. It constitutes a single framework into which data and research-based assumptions about the future can be loaded to test the impacts of varying land use patterns across a range of critical metrics.

The RapidFire model emerged out of the near-term need for a comprehensive modeling tool that could inform state, regional, and local agencies and policy makers in evaluating land use, energy, water, transport, and infrastructure investment policies. The model produces results for a range of metrics, including:

- Land consumption
- Travel behavior and vehicle miles traveled (VMT)
- Air pollution and public health impacts
- Fuel use and cost
- Building energy and water use, and cost
- Local fiscal impacts, including capital infrastructure costs, operations and maintenance costs, and local revenues
- Greenhouse Gas (CO_2e) emissions from cars and buildings

The RapidFire model underwent significant customization to prepare it for Central Ohio scenario development and analysis. This included refinement of fiscal impacts assumptions to reflect the unique cost, tax, and revenue structures of Ohio; additional sensitivity to rural housing and development types; and calibration of all analytical models to reflect Ohio land patterns and development intensities and policy assumptions.

A detailed description of the RapidFire model can be found in the RapidFire Technical Summary, available at www.calthorpe.com/scenario_modeling_tools.

Place Types

Building Place Types

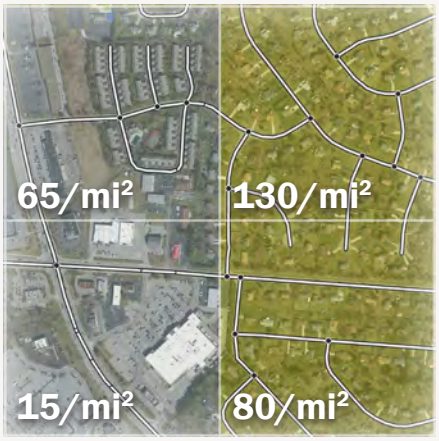
The place types used to build the insight2050 scenarios are based on the characteristics of development in communities across Central Ohio. These Urban, Compact, and Standard place types represent the range of development patterns found in the region, from the most intense and mixed parts of Downtown Columbus, to compact walkable neighborhoods and towns such as Granville and Grandview Heights to standard suburban areas that are common across the 7-county region. Each of the three place types vary in their development intensity, mix of uses, and walkability. Higher levels of each of these characteristics are generally associated with lower automobile use, as well as lower household transportation costs and energy and water bills. The maps below illustrate how these factors come together to impact automobile use in typical Central Ohio communities.

Walkability

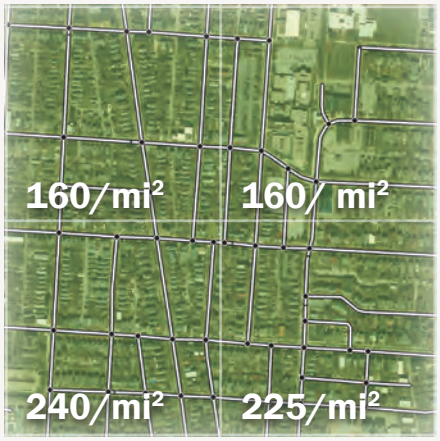
Intersections per square mile

- under 80
- 80 - 150
- over 150

Standard
(Pickerington, Fairfield County)



Compact
(Victorian Village)



Activity Density

Households and jobs per acre

- under 0.5 (not shown)
- 0.5 - 6.0
- over 6.0

Household Driving (VMT)

19,000 miles / year

10,200 miles / year

How Place Types Change

This photo montage illustrates how a typical 'Standard' development environment can transition to a more 'Compact' place over time.

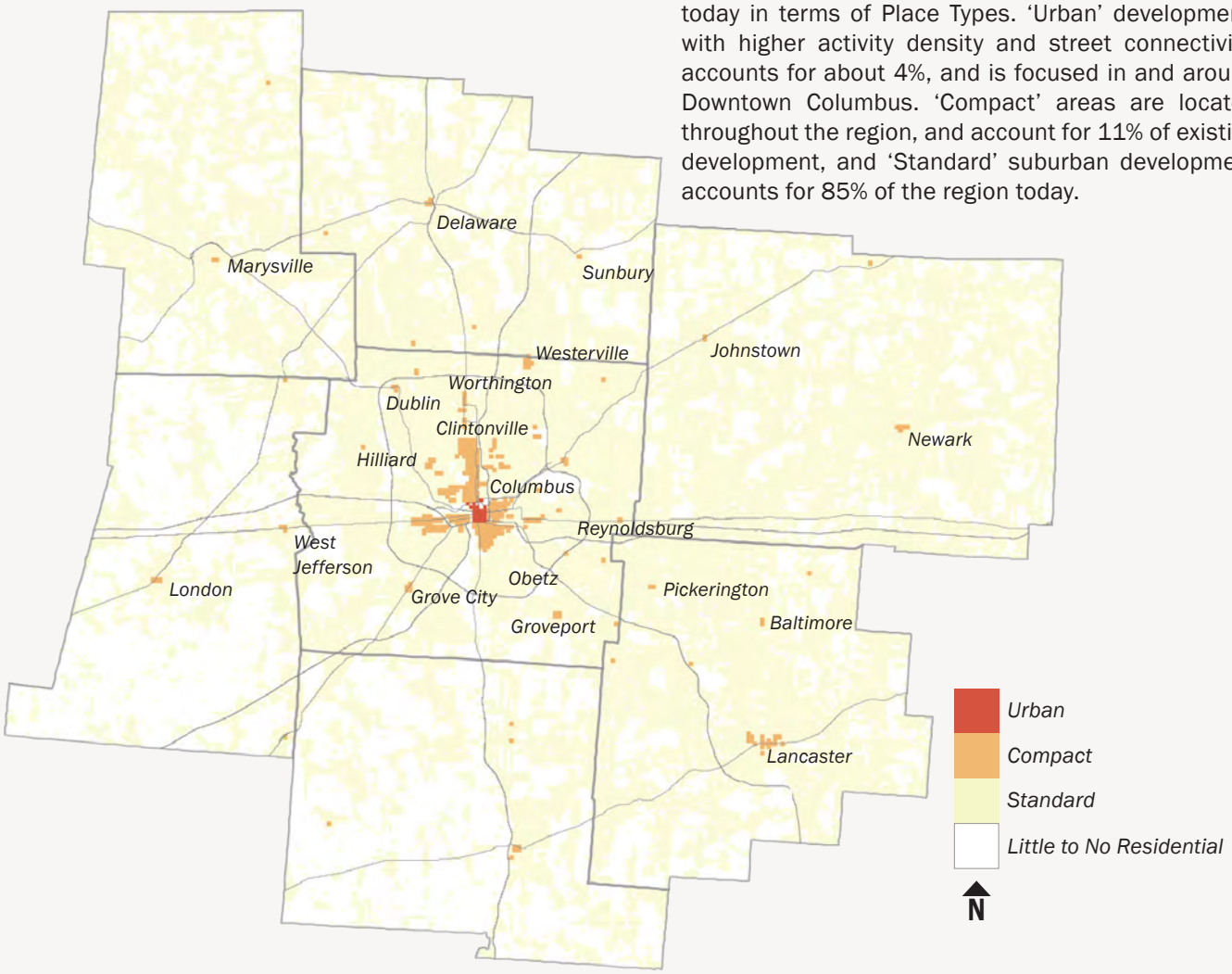
This intersection is typical of many 'Standard' suburban corridors in Central Ohio and the US. There are many opportunities for moderate intensification and improvements to the streetscape.

Sidewalk, crosswalk, landscaping, and other public improvements can set the stage for new residential and commercial development on the corridor.

Moderate scale commercial and residential development can bring vitality and activity to the corridor and place more people and jobs within easy walk, bike, transit, and drive access.

Place Types in Central Ohio Today

This map illustrates how Central Ohio can be described today in terms of Place Types. 'Urban' development, with higher activity density and street connectivity, accounts for about 4%, and is focused in and around Downtown Columbus. 'Compact' areas are located throughout the region, and account for 11% of existing development, and 'Standard' suburban development accounts for 85% of the region today.



Urban

Compact

Standard

Place Types Summary

Urban

Land Use Characteristics

Virtually all new Urban growth would be considered infill or redevelopment, and much of it would occur in the existing urban core in and around Downtown Columbus. The majority of housing in Urban areas is multifamily and attached single family (townhome), with some smaller-lot single family homes.

Transportation Infrastructure

Supported by higher levels of regional and local transit service. Well-connected street networks and the mix and intensity of uses result in a highly walkable environment and relatively low dependence on the automobile for many trips.

Development Mix and Intensity

Housing Mix

Transportation Options

Typical miles driven per household

less than 10,000 per year

Compact

Land Use Characteristics

Less intense than Urban, but yet highly walkable with a rich mix of retail, commercial, residential, and civic uses. There are numerous examples of Compact communities in Central Ohio, from places like Clintonville and Grandview Heights that originally grew around street car lines in the 1920s and 30s, to smaller towns like London, Plain City, Johnstown, or Sunbury. New Compact growth can occur in already urbanized areas, on the urban edge, or in larger-scale redevelopment projects. The Compact place type contains a diverse mix of housing, from multifamily and attached single family (townhome) to small- and medium-lot single family homes

Transportation Infrastructure

Well served by regional and local transit service, but may not benefit from as much service as Urban growth. Streets are well connected and walkable, and destinations such as schools, shopping, and entertainment areas can typically be reached via a walk, bike, transit, or short auto trip.

Development Mix and Intensity

Housing Mix

Transportation Options

Typical miles driven per household

10,000-15,000 per year

Standard

Land Use Characteristics

Represents the majority of suburban auto-oriented development that has occurred in Central Ohio over the past decades. Densities tend to be lower than those of Compact areas, with uses that are generally not highly mixed or organized to facilitate walking, biking, or transit service. The Standard place type can contain a wide variety of housing types, though medium and larger-lot single family homes comprise the majority of this development form.

Transportation Infrastructure

Not typically well served by regional transit service. Local street networks are not as well connected as those in Compact and Urban place types. There are fewer destinations available via walk or bicycle; most trips are made via automobile.

Development Mix and Intensity

Housing Mix

Transportation Options

Typical miles driven per household

above 15,000 per year

Urban Examples

Gay & 4th - Columbus

25 S. High - Columbus

Compact Examples

Granville

Circleville

Hilliard

Standard Examples

Amberleigh Subdivision, Dublin

Grove City (Pinnacle)

Morse Road, Columbus

insight2050 Scenarios Overview

Each of the insight2050 scenarios represents a different way of accommodating projected housing and job growth in Central Ohio to the year 2050. Each includes the same total number of people, homes, and jobs, but varies in where and how they are located across the region. The scenarios also vary in terms of the types of homes that will be built in the coming decades, and the extent to which their mix of housing types meet the demands of Central Ohio's current and future residents.

scenarioA
Past Trends

This scenario extends the land use and transportation investment decisions of the past decades forward to 2050. A majority of growth is accommodated on previously undeveloped land, with most growth (85%) tending towards suburban and rural, auto-oriented development. New development is composed primarily of larger-lot single family homes and suburban office parks and commercial centers.

scenarioB
Planned Future

The housing and job distribution of this scenario reflects the direction of local plans and policies from the cities and townships across the Central Ohio region. There is more Compact growth than in the Past Trends scenario, and more smaller-lot single family and attached homes, though the majority of growth is still auto-oriented and tends to be located at the periphery of cities and towns. About half of new growth is accommodated as infill or redevelopment; the rest occurs on previously undeveloped land.

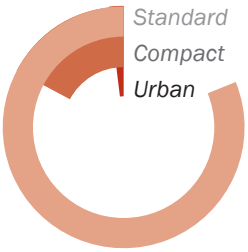
scenarioC
Focused Growth

This scenario seeks to accommodate more growth in infill and redevelopment locations in and around existing cities and towns. Land patterns and housing mix are informed by housing demand forecasts, with significantly more smaller-lot single family, attached single family, and multifamily homes than the Planned Future or Past Trends scenarios. A large majority (84%) of growth takes the form of Compact development in walkable, moderate intensity mixed-use areas. There is also significant Urban development (10% of new growth) in Downtown Columbus. There is very little Standard growth or new larger-lot single family housing development in this scenario, as the majority of demand for this product is met through the existing supply.

scenarioD
Maximum Infill

This scenario strives to maximize growth accommodated through infill on previously developed lands and within existing urban areas. The Urban place type assumes nearly 30% of growth in existing city centers and commercial corridors where significant redevelopment opportunities exist. An additional 70% takes the form of moderate intensity and walkable Compact development. Like the Focused Future scenario, the residential mix is informed by housing demand forecasts, with significantly higher proportions of multifamily, attached single family/townhomes, and smaller-lot single family homes. There is very little new larger-lot single family housing development in this scenario, as the majority of demand for this product is met through the existing supply.

Place Type Proportions	Infill / Redeveloped Land vs. Undeveloped Land	Housing Unit Mix



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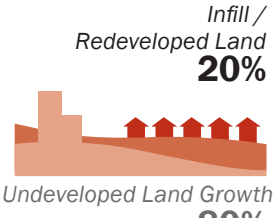

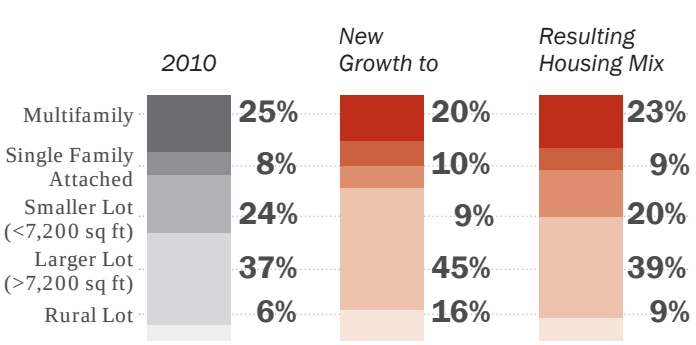

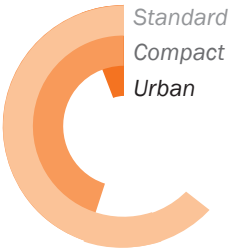

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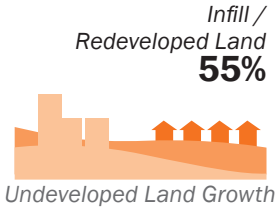

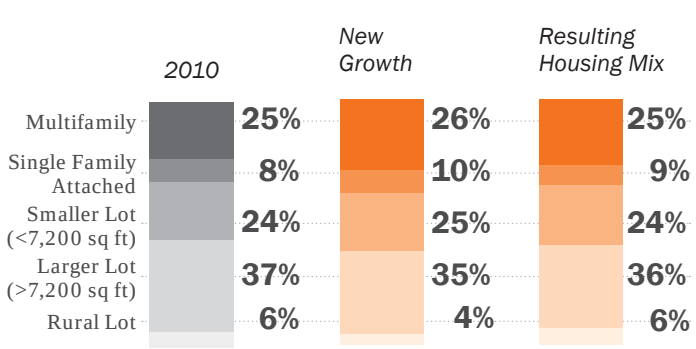

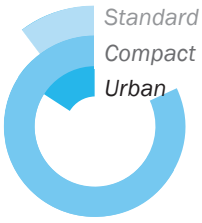

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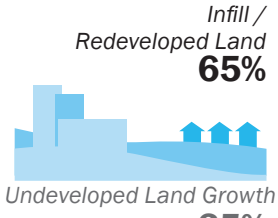

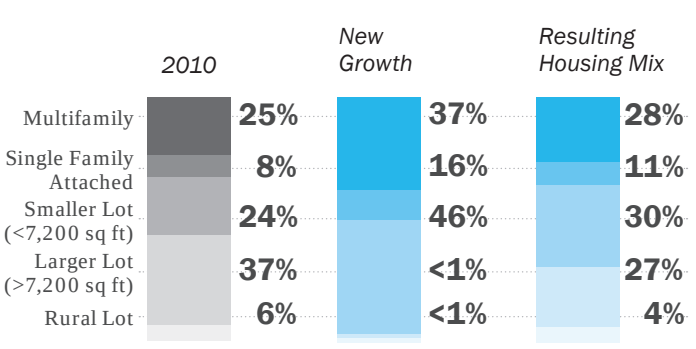

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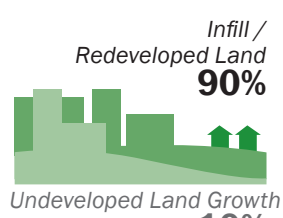
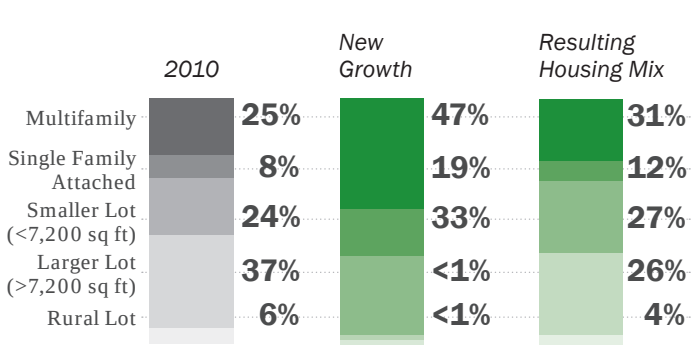
27%





insight2050 Scenario Metrics Summary

The comparative scenario metrics summarized here are described in more detail in the following sections. For clarity, values are rounded. All costs are expressed in 2014 dollars.

Land Consumption

Includes all previously undeveloped land that is urbanized from 2010-2050.

Local Fiscal Impacts

Capital and ongoing operations and maintenance (O&M) costs for new local roads, sewer, water, waste-water infrastructure, and select services (2010-2050).

Transportation

Miles driven in passenger vehicles in Central Ohio in 2050.

scenarioA Past Trends

This scenario extends the land use and transportation investment decisions of the past decades forward to 2050.

495 square miles

O&M 12 | Capital 4.4

$16.4 billion

$408 Million
Average Annual Costs Capital + O&M 2010-2050

15.9 billion miles

8,450 *miles / year (per new resident, 2050)*

scenarioB Planned Future

The housing and job distribution of this scenario reflects the direction of local plans and policies from the cities and townships across the Central Ohio region.

270 square miles

11.3 | 4.5

$15.8 billion

$393 Million
Average Annual Costs Capital + O&M 2010-2050

15.4 billion miles

7,450 *miles / year (per new resident, 2050)*

scenarioC Focused Growth

This scenario seeks to accommodate more growth in infill and redevelopment locations in and around existing cities and towns.

45 square miles

10 | 3.2

$13.2 billion

$329 Million
Average Annual Costs Capital + O&M 2010-2050

12.0 billion miles

4,450 *miles / year (per new resident, 2050)*

scenarioD Maximum Infill

This scenario strives to maximize growth accommodated through infill on previously developed lands and within existing urban areas.

15 square miles

10 | 3

$13.0 billion

$328 Million
Average Annual Costs Capital + O&M 2010-2050

11.1 billion miles

3,850 *miles / year (per new resident, 2050)*

Public Health Costs

Annual costs due to health incidences related to auto emissions, including hospitalization, premature mortality, and lost work days, in 2050.

Scenario A used as baseline for comparison

-$41
Million

-$246
Million

-$315
Million

Building Energy Use

Cumulative energy (electricity and gas) consumed by new and existing residential and commercial buildings from 2010-2050.

4.27
quadrillion Btu
(British thermal units)
$78.2 Billion
Cumulative Costs 2010-2050

4.23
quadrillion Btu
$77.5 Billion
Cumulative Costs 2010-2050

4.15
quadrillion Btu
$76.0 Billion
Cumulative Costs 2010-2050

4.12
quadrillion Btu
$75.5 Billion
Cumulative Costs 2010-2050

Building Water Use

Cumulative water used to serve and maintain new and existing homes from 2010 - 2050.

3.19
trillion gallons

3.12
trillion gallons

3.03
trillion gallons

3.01
trillion gallons

Greenhouse Gas Emissions

Annual CO2e emissions from passenger vehicles, and residential and commercial buildings, in 2050.

Buildings *Transport*

29.06 | 6.71

35.8
MMT / year
(Million Metric Tons)

28.76 | 6.47

35.2
MMT / year

28.20 | 5.05

33.2
MMT / year

28.03 | 4.67

32.7
MMT / year

Household Costs

Annual automobile transportation (fuel, insurance, maintenance) and home energy and water costs, in 2050

$13,100
per new household

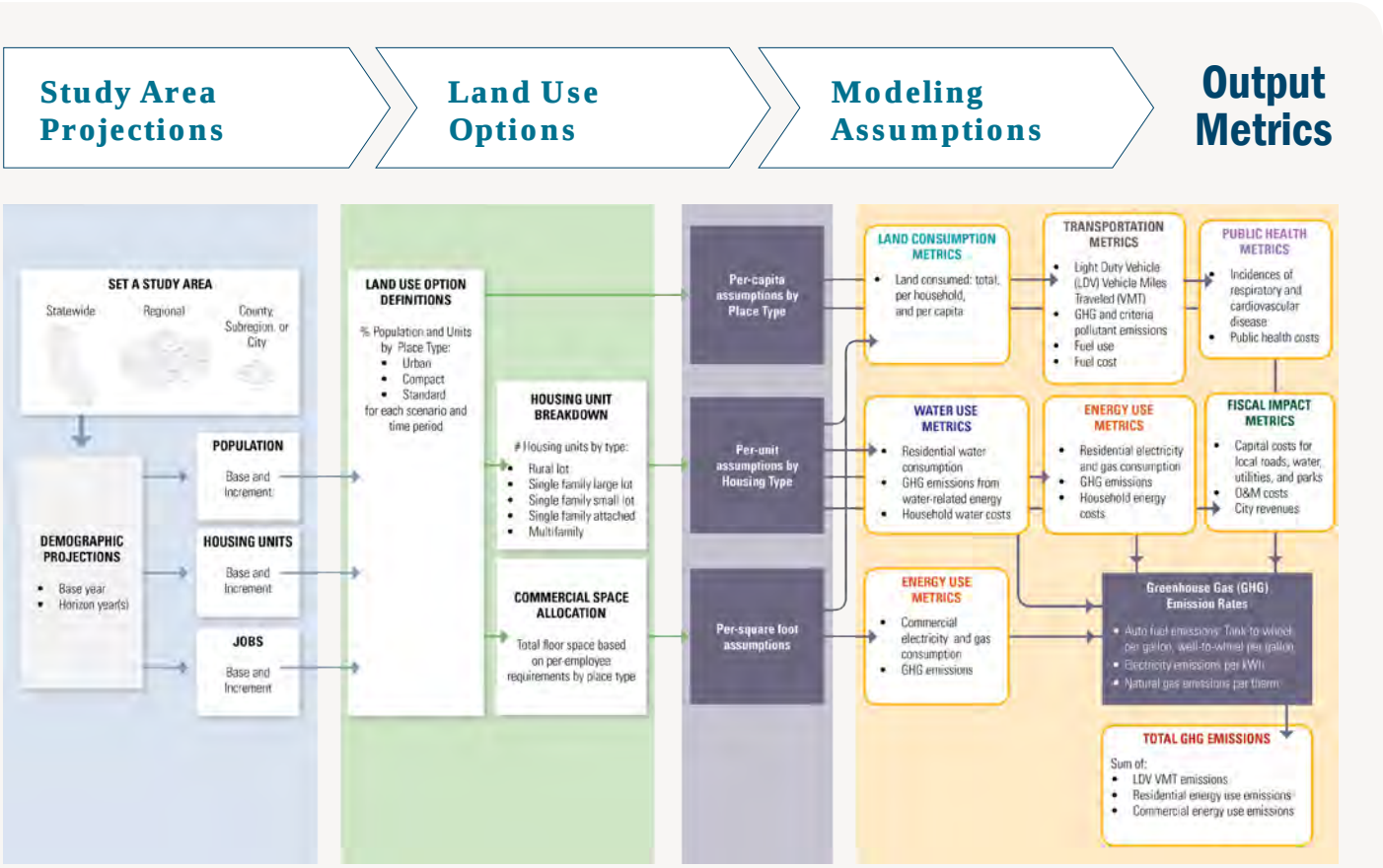
$11,600
per new household

$7,700
per new household

$6,800
per new household

Scenario Metrics

This section explores the impacts of the insight2050 scenarios. It describes the analysis of the scenarios for the complete range of fiscal, environmental, transportation, and other RapidFire output metrics. The RapidFire model underwent significant calibration and customization to prepare it for scenario development and analysis in Central Ohio. The customized model was used to develop and model the full range of metrics for the four insight2050 scenarios described in this report. Region-wide results are presented here; the 7-county region includes Delaware, Fairfield, Franklin, Licking, Madison, Pickaway, and Union counties. Input assumptions for the model and metrics are summarized in the Appendix. Note that "cumulative" results reflect sum totals over many years (e.g., 2010 to 2050), while "annual" results reflect values in a single year.



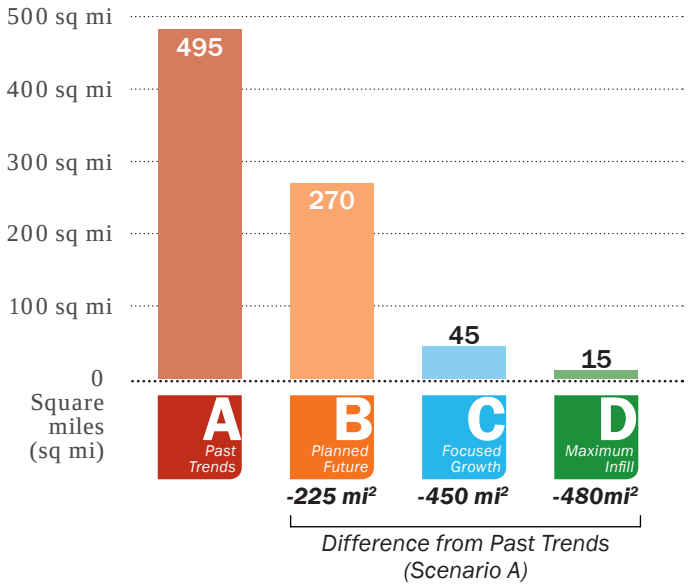
The methodology for calculating scenario metrics is outlined in the RapidFire Technical Summary, available at www.calthorpe.com/scenario_modeling_tools.

Land Consumption

The amount of land needed to accommodate new population growth varies widely among the scenarios. New land consumption includes all land that will be newly urbanized, including residential and employment areas, roadways, open space, agricultural, and public lands. Scenarios that accommodate new growth with greater shares of Urban and Compact development- which include more infill, redevelopment, and focused use of previously undeveloped land - consume less land overall. By contrast, scenarios that place a greater share of new growth in the Standard development pattern consume more land.

The Past Trends scenario, which sees significant additional Standard growth at the outer edges of the region consumes about 500 square miles of previously undeveloped land, or 225 miles more than the Focused Growth scenario (the equivalent land area of the City of Columbus today) The Planned Future scenario consumes 270 square miles; Focused Growth consumes 45 square miles; and Maximum Infill consumes 15 square miles. There were approximately 1,000 square miles of urbanized or developed land in the region as of 2010.

Cumulative New Land Consumption to 2050



Fiscal Impacts

Fiscal Impacts

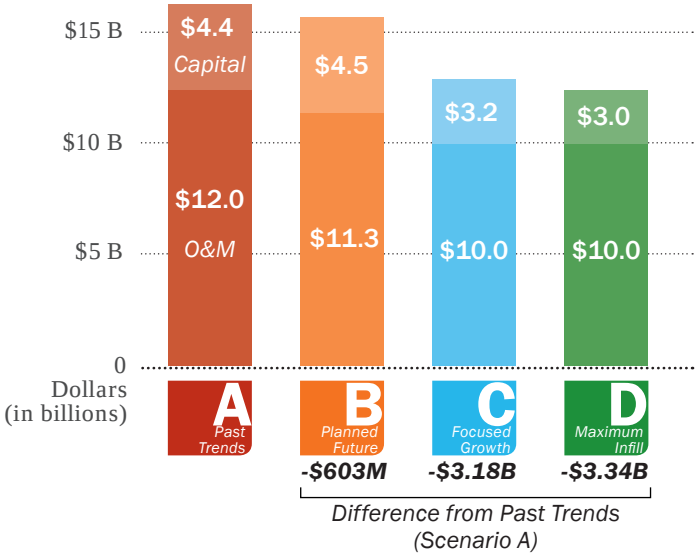
The insight2050 fiscal impact analysis is a regional study designed to provide an understanding of the 'order of magnitude' variations in scenarios as they relate to local government revenues and costs associated with **new** development; the analysis does not include all categories of costs or revenues. The analysis focuses primarily on impacts to the general funds of local jurisdictions (cities and townships), but does include certain county-level costs and revenues in order to provide an equivalent set of service categories for comparison purposes. Therefore, the analysis does include sheriff costs related to townships, but does not consider road maintenance costs for cities or counties because those services are typically provided outside of the general fund. Similarly, the analysis does not include impacts to school districts or other special districts that are funded separately. The fiscal analysis is focused on the costs and revenues associated with new (not existing) residential and commercial development.

Infrastructure and Operations & Maintenance Costs

Increased land consumption can lead to higher costs for local infrastructure and community services, as growth on previously undeveloped land often requires significant capital investments to extend or build new local roads and water and sewer systems, and to provide new public safety services. Growth focused in existing urban areas can take advantage of existing infrastructure and capitalize on the efficiencies of providing service to higher concentrations of jobs and housing. Moreover, accommodating growth within focused urban areas can help to ensure that future infrastructure investments generate a high return on investment.

The cost difference between new compact and more dispersed development can also vary significantly when public sector operations and maintenance (O&M) costs are taken into account. O&M costs include the ongoing expenditures required to operate and maintain the infrastructure serving new residential and commercial growth, as well as the costs to provide other services included in a typical local government (city, village, or township) operating budget.

Cumulative Local Capital Infrastructure Costs and Operations and Maintenance (O&M) Expenditures (2014 dollars)



Average Annual Local Capital Infrastructure & O&M Costs

A	B	C	D
$408M	$393M	$329M	$328M
Difference from Past Trends (Scenario A)	-$15M	-$79M	-$83M

The insight2050 scenarios are compared for their regional impacts on local government O&M costs, including:

- General Government: including administrative and legislative functions
- Fire: including all fire services in incorporated and unincorporated areas
- Community Services: including community and recreation services
- Engineering and Public Works: including only general fund public works functions
- Police and Sheriff: including police and sheriff patrol services in incorporated and unincorporated areas

Fiscal Impacts

Engineering and public works costs are strongly linked to the physical form of infrastructure. More dispersed development, which entails greater lengths of roads and sewer pipes, incur higher O&M costs than more compact development, which capitalizes on the economic efficiencies of shared infrastructure capacity. The same is true for many services such as police and fire, which can cost more to provide when development is more dispersed.

Focusing new growth in and around existing urban areas can reduce costs significantly, as demonstrated by reviewing the capital infrastructure and ongoing O&M costs for each of the insight2050 scenarios. As compared to the Past Trends scenario, following the development pattern of the Planned Future scenario would save $605 million to 2050. The Compact Future scenario saves $3.2 billion, which is a 19% savings compared to Past Trends, and an average annual savings of $79 million. The Maximum Infill scenario saves a total of $3.3 billion compared to Past Trends. The fiscal analysis of the RapidFire scenario model focuses on local and subregional costs borne by cities, townships, and counties for new developments only. It does not include the cost of new regional roadway and transit infrastructure that might be part of the facilities that support a scenario growth pattern.

Note that the cost variations across scenarios do not always vary directly with the proportion of dispersed or Standard development in a scenario. For example, the Planned Future scenario, which is more compact than Past Trends, sees a slight increase in costs for capital infrastructure compared to Past Trends due to the higher proportion of rural and unincorporated residential development in the Past Trends scenario; this is because development in rural areas is served by septic systems and thus does not incur the higher cost of sewer infrastructure (the cost of installing and maintaining private septic systems falls to individuals, and its costs are not included in the scenarios). For more detail on the cost assumptions, refer to the "Central Ohio RapidFire Fiscal Assumptions Development and Methodology" in the Appendix.

Revenues

The insight2050 scenarios are compared for their regional impacts on tax revenue, including:

- Annual income tax and property tax (apportioned to general fund and public safety uses) revenue associated in the model with new commercial development. Commercial development includes all non-residential development.
- Annual property tax revenue apportioned to general fund and public safety uses for new residential development. (Additional property tax revenue levies for schools, libraries, and other services were not included in these scenarios.)
- Annual county sales tax revenue generated from households in new residential development.

Calculating Commercial Income Tax, Property Tax, and Sales Tax Revenue

Income tax is typically the most significant revenue source for cities in Ohio. Since the bulk of income tax is generated in a worker's city of employment, income tax revenue was associated with growth in commercial and other non-residential space for modeling purposes. Income tax revenues received by worker home locations and income tax generated by business profits were also modeled in order to account for their regional distribution in the different scenarios.

Property tax comprises a relatively small share of city revenues, but is the primary source of funding for townships. The portion of property taxes dedicated to city and township general funds and public safety costs were calculated for the scenarios. General fund and public safety revenue streams were calculated because cities typically fund public safety services out of their general funds, whereas townships must levy additional property taxes to fund public safety services. Annual county sales tax revenue, which funds general county services, most notably public safety, is also included in the scenarios revenue comparison. Note that school districts are funded by separate property tax levies and were not included in these scenarios. For more detail on the revenue assumptions, refer to the "Central Ohio RapidFire Fiscal Assumptions Development and Methodology" in the appendix.

Fiscal Impacts

Scenarios Revenue from New Commercial and Residential Development

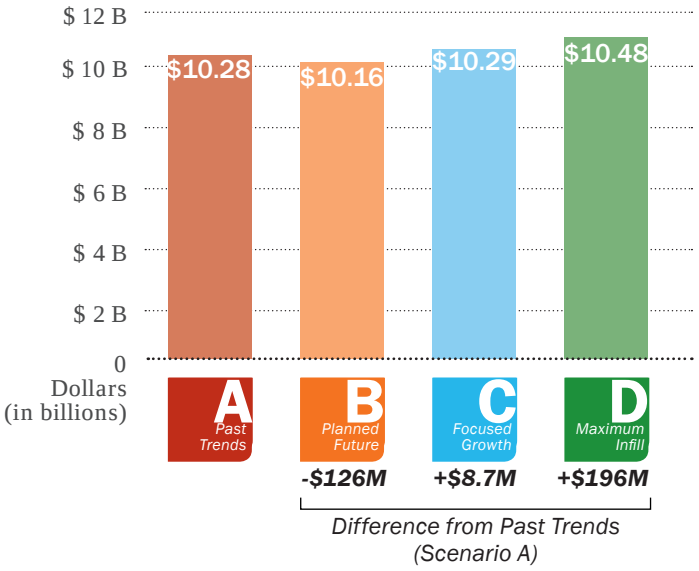
As the majority of income tax is generated in an Ohio worker's city of employment, higher income tax revenue is seen in scenarios with the highest proportions of commercial development in higher value urban locations, followed by compact locations; these places also levy relatively high average income tax rates. Thus the Compact Future and Maximum Infill scenarios see higher commercial tax revenue than the Past Trends and Planned Future scenarios. Focused Growth sees an additional $533 million in revenues through 2050 compared to Past Trends, while Maximum Infill sees a nearly $700 million increase.

Property tax revenue from residential development in Ohio does not favor compact development as strongly as does income tax revenue. In the case of city, township, and county property tax and sales tax revenue related to new residential development, the Compact Future and Maximum Infill scenarios result in tax revenue of $525 million and $500 million less, respectively, than the additional revenue generated in the Past Trends scenario. This is in large part due to the higher proportion of large, higher-value single-family residential development in the Past Trends scenario, and the Past Trends scenario's inclusion of more homes in unincorporated areas with higher property tax rates.

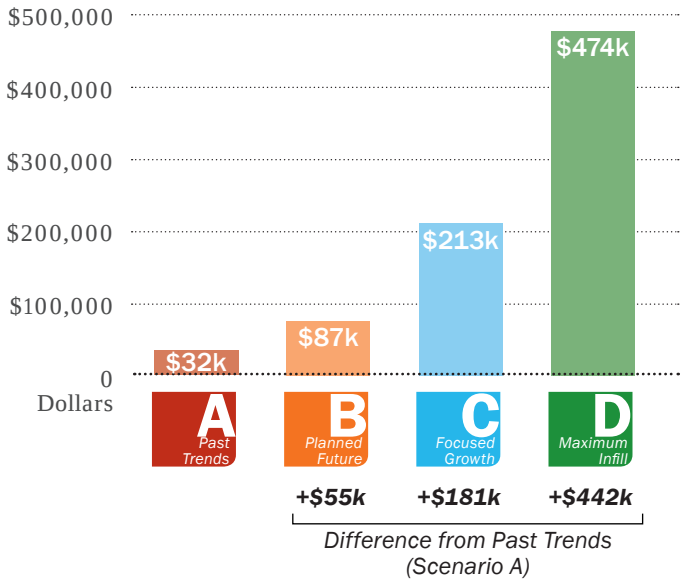
Overall, despite their lower residential revenues, the Compact Future and Maximum Infill scenarios enjoy moderately higher overall revenues when one combines the commercial and residential categories. To 2050, the Maximum Infill scenario sees nearly $200 million more in total revenue, or about $5 million per year. Tax revenue on a per-acre basis illustrates more variation across the insight2050 scenarios. Per-acre residential and commercial revenues add up to $32,000 in Past Trends and $87,000 in the Planned Future scenario. The more compact Focused Growth and Maximum infill scenarios have per acre revenues of $213,000, and $474,000 respectively.

Overall, the insight2050 scenarios illustrate the fiscal efficiency of more compact land patterns in the costs to supply and operate and maintain local infrastructure and community services. While not as significant as the cost advantages, there are also revenue advantages to the more compact scenarios, particularly from a commercial tax revenue perspective and when viewed on a per-acre basis.

Cumulative Residential and Commercial Tax Revenues to 2050 (2014 dollars)



Cumulative Residential and Commercial Tax Revenues per Acre to 2050(2014 dollars)



Transportation

Transportation system impacts – including vehicle miles traveled (VMT), fuel use and cost of driving, and greenhouse gas (GHG) emissions – vary significantly across the scenarios. The land use patterns described in each scenario result in distinct differences in the rates of passenger auto use, measured as VMT, which in turn impacts fuel consumption, fuel cost, and emissions. (Refer to the appendix for specific policy-based assumptions about auto fuel economy and technology, and fuel composition and cost.)

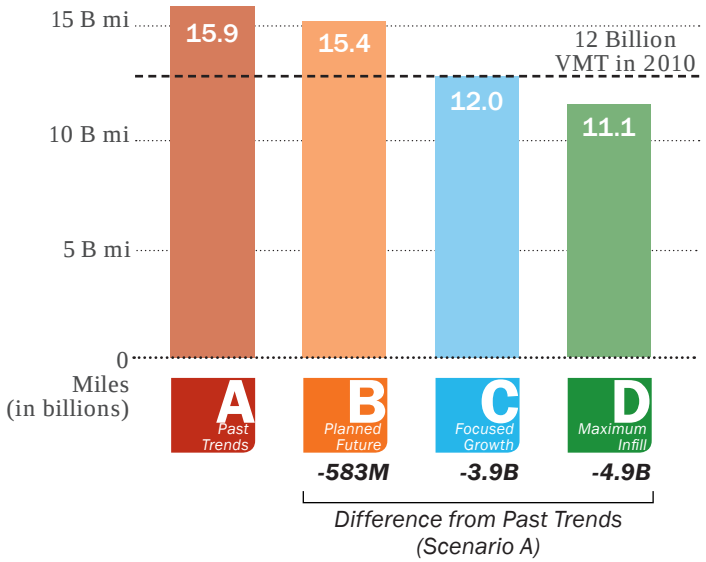
Vehicle Miles Traveled (VMT)

VMT is calculated by applying assumptions about the distances people drive each year to projected population growth. These assumptions, which differ by place type, are calibrated to per-capita driving rates and modeling data from the Central Ohio region. This data, as well as national data sets, illustrate that per-capita VMT of both new and existing population vary based on the form of new growth[1]. For example, when a majority of new growth occurs as Compact or Urban development, over time most people – including those living in existing neighborhoods – will be able to drive less because more jobs, daily destinations, and services will be closer. Likewise, if a majority of new growth occurs as Standard development, many people will be likely to drive more, as workplaces and other destinations will grow farther apart.

The scenarios assume that requisite transportation investments go hand-in-hand with growth patterns, such that scenarios with a greater focus on Compact and Urban place type development would see increased transit, bicycle, pedestrian, streetscape, and livability investments. Conversely, scenarios dominated by Standard development would see larger budget outlays to highway and road expansion and maintenance.

Scenario results for VMT indicate a wide variation in passenger vehicle use related to the form of new growth. The consequence of putting more homes in dispersed patterns is high: The Past Trends scenario, which accommodates 87% of growth in auto-oriented Standard development, produces an average annual VMT of 8,470 per new person per year by 2050. This is 4,000 miles more than the Focused Growth scenario (4,450 miles per capita), and 4,600 more than Maximum Infill (3,850 miles per capita). These figures can be compared to the 2010 region-wide average of about 6,600 miles per person.

Annual Vehicle Miles Traveled (VMT) in 2050



Annual VMT Per Person in 2050

	A	B	C	D
	6,820	6,570	5,130	4,740
Difference from Past Trends (Scenario A)		-250	-1690	-2080

In total, residents of Central Ohio traveled about 12 billion miles per year in their automobiles in 2010. In the Past Trends scenario, this rises to an annual VMT of 15.9 billion miles in 2050; for Planned Future, the total is 15.4 billion. VMT is held at about its 2010 level in the Focused Growth scenario, at 12.0 billion (4 billion miles per year less than Past Trends). Maximum Infill results in an annual total of 11.1 billion miles, nearly 5 billion less than Past Trends. The difference between Past Trends and Focused Growth is equivalent to taking nearly 400,000 cars off Central Ohio's roads each year - the same number of cars on the road every day in Central Ohio during the peak hour of the morning commute.

1 For a description of the RapidFire VMT modeling methodology, refer to the RapidFire Technical Summary, available at www.calthorpe.com/scenario_modeling_tools.

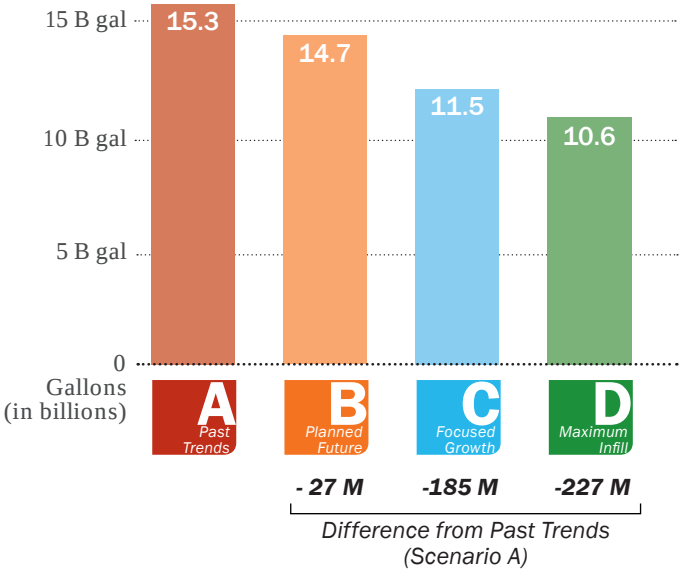
Transportation

Automobile Fuel Use and Cost of Driving

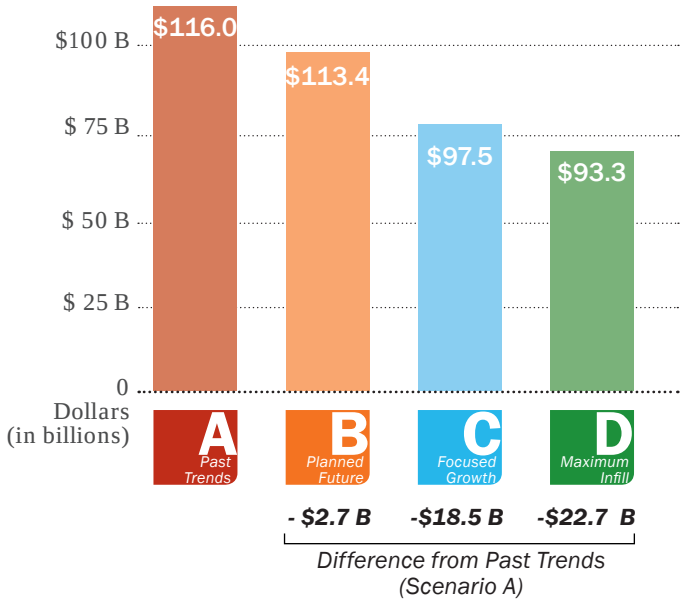
Variations in passenger VMT lead to substantial differences in the amount of gas (or equivalent) used. These differences will vary depending on how efficient cars become. Assuming the same vehicle fuel economy for all scenarios, there would be substantial differences in fuel use due to land use-related VMT variations. By 2050, Past Trends would require 740 million gallons of fuel annually. Planned Future would require 27 million gallons less, Focused Growth would require 185 million gallons less, and Maximum Infill would require 227 million gallons less than the Past Trends scenario.

Reduced VMT and fuel use leads to lower costs for all households. When compared to Past Trends, Planned Future saves the average Central Ohio household $470 per year in driving costs in 2050 (including auto ownership, maintenance, and other driving-related costs); Focused Growth saves $3,200; and Maximum Infill saves $3,900 per year – significant savings that could be applied to housing and other essentials. For the entire region, the driving-related savings total $18.5 billion through 2050 in Focused Growth, and almost $23 billion in the Maximum Infill scenario.

Cumulative Passenger Vehicle Fuel Consumption to 2050 (gallons gasoline equivalent)



Cumulative Fuel Costs to 2050 (2014 dollars)



Annual Passenger Vehicle Fuel Consumption to 2050 (gallons gasoline equivalent)

	A	B	C	D
	740 M	717 M	560 M	518 M
Difference from Past Trends (Scenario A)		-23 M	-180 M	-222 M

Annual Driving Costs per New Household in 2050 (2014 dollars)*

	A	B	C	D
	$10.3 k	$9.0 k	$5.4 k	$4.7 k
Difference from Past Trends (Scenario A)		-$1,300	-$4,900	-$5,600

**includes fuel, insurance, and maintenance associated with auto ownership*

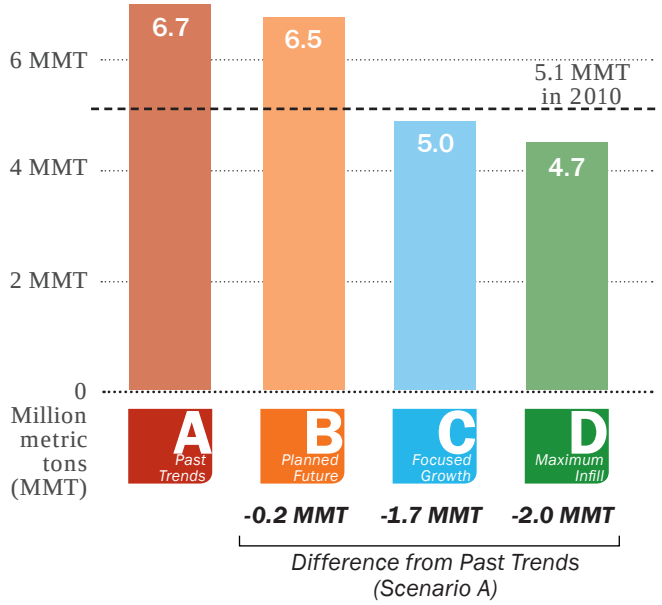
Transportation

Greenhouse Gas (GHG) Emissions from Passenger Vehicles

GHG emissions from passenger vehicles are determined by VMT (related to land use patterns), vehicle fuel economy, and the carbon intensity of automobile fuel. Assuming the same rate of fuel emissions for all scenarios, there would be substantial differences in CO2e emissions (carbon dioxide equivalent, which includes the main forms of greenhouse gases). The land use-related variations in GHG are directly proportional to VMT and fuel use. By 2050, Past Trends would produce 6.7 million metric tons (MMT) of CO2e annually. Planned Future would produce 4% less; Focused Growth would produce 25% less, the equivalent of about 600,000 cars worth of emissions annually; and Maximum Infill would produce 30% less, the equivalent annual GHG emissions of about 730,000 passenger cars. When combined with the effects of more stringent vehicle and fuels policies, which would reduce the amount of fuel used and GHG emissions for every mile traveled, automobile-related emissions could be reduced even further.

Note that the transportation GHG emissions reported here are limited to tailpipe (tank-to-wheel) emissions. A more complete picture of emissions emerges in an analysis of full lifecycle (well-to-wheel) emissions, which take into account the emissions associated with generating fuel from various sources. The RapidFire model estimates both fuel combustion and full fuel lifecycle emissions.

Annual Transportation GHG Emissions in 2050 (MMT CO2e)



Annual Transportation GHG Emissions per Capita (lbs CO2e)

	A	B	C	D
	6,350	6,100	4,750	4,400
Difference from Past Trends (Scenario A)		-250	-1,600	-1,950

Public Health

Air Pollutant Emissions from Passenger Vehicles

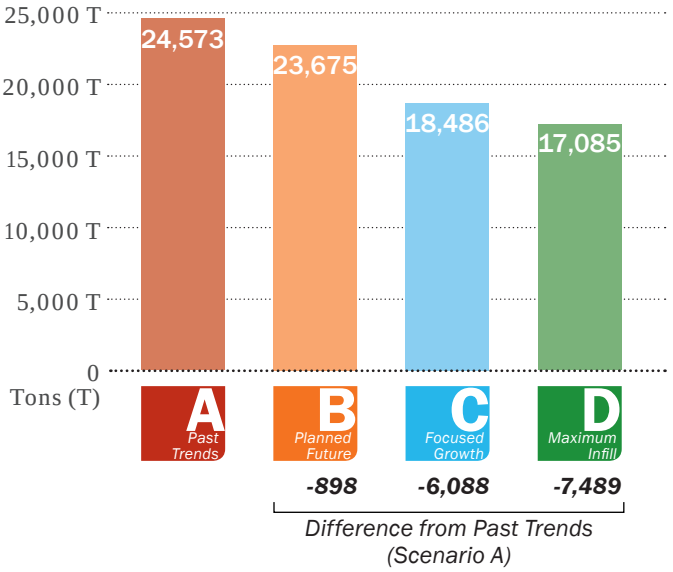
Differences in VMT lead to different levels of air pollutants (including nitrogen oxides, volatile organic compounds, and particulate matter) among the insight2050 scenarios. With higher VMT, the Past Trends scenario sees 2050 passenger-vehicle pollutant emissions that are 4% higher than emissions in Planned Future, 25% higher than Focused Growth, and 30% higher than Maximum Infill. These results translate to significant public health impacts, as described in the following sections.

Health Incidences and Costs

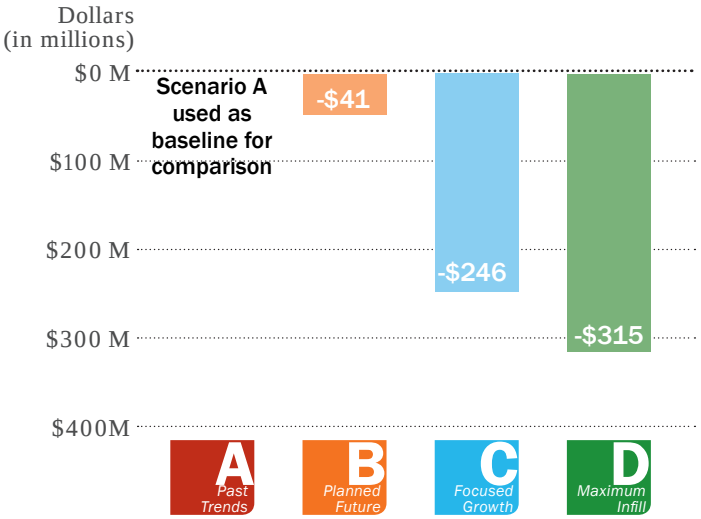
Auto-related air pollution results in a spectrum of health incidences, including cases of chronic bronchitis; acute myocardial infarction; respiratory and cardiovascular hospitalizations; respiratory-related ER visits; acute bronchitis; work loss days; premature mortality; asthma exacerbation; and acute, lower, and upper respiratory symptoms. Health incidences and their related costs are reduced along with miles driven and consequential reduction in passenger vehicle emissions. Using research-based rates and valuations , the RapidFire model estimates savings (rather than absolute totals) in health incidences and costs to 2050[1].

Relative to the Past Trends scenario, all scenarios show significant reductions in health incidences and costs. In 2050, Planned Future results in a $41 million annual savings to treat respiratory health incidences related to passenger vehicle pollution. In Focused Growth, the savings rise to nearly $250 million per year, and go up to $315 million per year in the Maximum Infill scenario.

Annual Automobile Pollutant Emissions in 2050



Annual Health Costs in 2050



1 The public health incidence and cost assumptions were initially developed by TIAX, LLC for the American Lung Association. Assumptions are based on national data from the EPA, Office of Air Quality Planning & Standards, Air Benefit and Cost Group (August 2010). While valuations (costs) were extrapolated for 2035, they are applied to 2050 pollutant emissions as an approximate estimate of costs in that year.

Residential and Commercial Building Energy

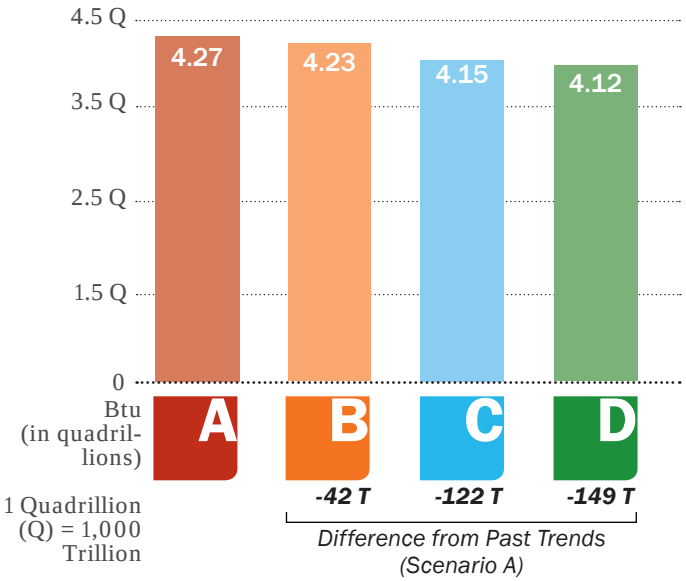
The insight2050 scenarios vary in their building energy use profiles due to their different mixes of housing types and commercial building types. Scenarios that contain more Compact and Urban development accommodate a higher proportion of growth in more energy-efficient building types such as apartments, attached single-family homes, and smaller single family homes, as well as more compact commercial building types. By contrast, a large proportion of Standard place type development leads to a higher proportion of larger single family homes, which are typically less energy-efficient.

Energy Consumption, Cost, and Emissions

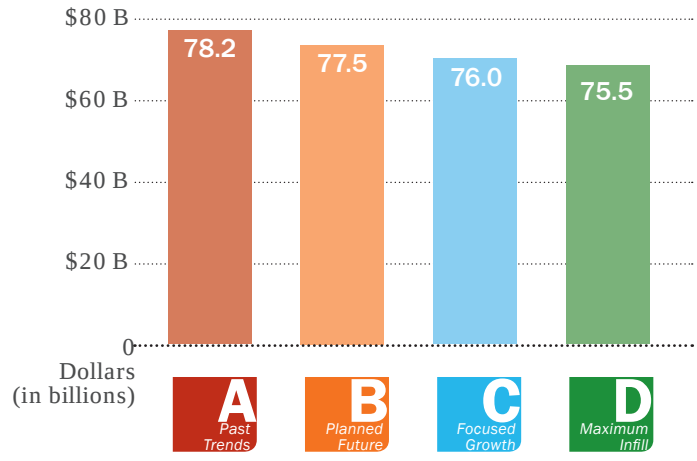
Variations in land use patterns lead to substantial differences in the amount of energy used. These differences depend in part on policies regulating how efficient buildings become. Assuming the same efficiency standards for all scenarios, there would be marked differences in energy use due to land use-related and building program variations.

The combined energy and cost savings in residential and commercial energy through 2050 are significant: compared to Past Trends, Focused Growth saves enough energy to power more than 25,000 homes for a year. With the Maximum Infill scenario, that savings rises to the equivalent of 32,000 homes. Energy costs for households and businesses add up as well: to 2050, total residential and commercial energy costs (including existing and new growth) in Planned Future would be $800 million less than Past Trends. In Focused Growth, the costs would be $2.3 billion less; in the Maximum Infill scenario, the costs would be $2.8 billion less.

Cumulative Residential and Commercial Building Energy Use to 2050 (British Thermal Units, Btu)



Cumulative Residential & Commercial Energy Costs to 2050 (2014 dollars)



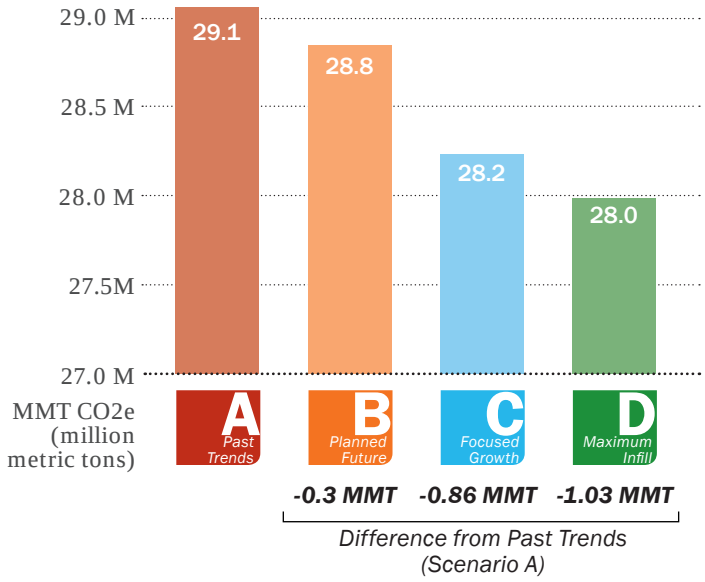
Annual Residential & Commercial Energy Costs in 2050 (2014 dollars)

A	B	C	D
$3.82 B	$3.78 B	$3.70 B	$3.68 B
Difference from Past Trends (Scenario A)	-$38.8 M	-$112 M	-$134 M

Residential and Commercial Building Energy

Conserving energy also reduces greenhouse gas (GHG) emissions. More compact land uses reduce building emissions in proportion to energy use – 1%, 3%, and 4% each year, for the Planned Future, Focused Growth, and Maximum Infill scenarios respectively, as compared to Past Trends. The annual reduction in the Focused Growth scenario equals the equivalent of the yearly emissions of over 200,000 cars on Central Ohio roads. When combined with the effects of more stringent clean energy policies, which would reduce the amount of GHG emissions for every kilowatt-hour of electricity used, building energy emissions could be reduced even further.

Annual Residential and Commercial Building Energy GHG Emissions in 2050 (MMT CO2e)



Comparing Energy Sources

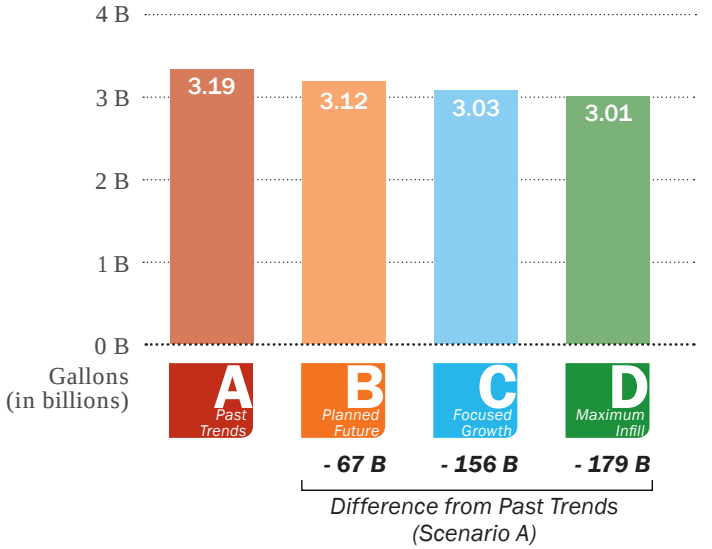
The insight2050 scenarios tally greenhouse gas (GHG) emissions from passenger vehicle transportation as well as residential and commercial buildings. These two sectors generally combine for 35-50% of total GHG emissions in a metropolitan area. In Central Ohio, where the electricity mix includes a relatively high proportion (~70%) of coal, building electricity use takes on a much higher proportion of overall emissions, at nearly 50% of the total. The insight2050 scenarios illustrate the role that land use pattern differences can play in reducing building and transportation energy use and related GHG emissions. Additional policies to reduce the carbon intensity of the power generation portfolio (i.e. more renewable or lower-carbon electricity generation, cleaner power plant technology) can also play a role in reducing emissions.

Residential Water Use

Variations in land use patterns and their related building profiles lead to substantial differences in residential water use and cost. Residential water use is a function of both indoor and outdoor water needs, with outdoor use (landscape irrigation) accounting for the majority of the difference among housing types. Because homes with larger yards require more water for landscape irrigation, lot size is generally correlated with a household's overall water consumption. Thus, scenarios with a greater proportion of the Standard place type, which includes more larger-lot single-family homes, require more water than scenarios with a greater proportion of Compact or Urban development, which include more attached and multifamily homes, and smaller-lot single-family homes.

Assuming the same modest improvements for all scenarios, there are the potential savings attributable to land use patterns and building program alone. Compared to Past Trends, which uses 91 billion gallons of water per year in 2050, Planned Future uses 88 billion gallons, or 3%, less; Focused Growth uses 84 billion gallons, or 8%, less; and Maximum Infill uses 83 billion gallons, or 9%, less. Cumulatively, the water savings are substantial: by 2050, Focused Growth uses 156 billion gallons less water – enough to supply over 46,000 homes for a year; that difference rises to 53,000 homes in the Maximum Infill scenario. When combined with the effects of more stringent building and landscape policies, which would reduce the amount of indoor and outdoor water used, water use could be reduced even further.

Cumulative Residential Water Use to 2050 (gallons)



Annual Residential Water Use per Household in 2050 (gallons)

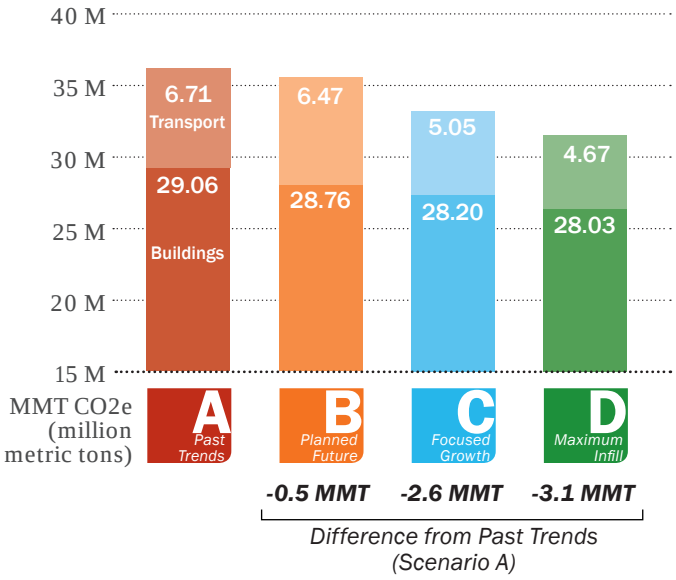
	A	B	C	D
	84,100	81,150	77,700	76,750
Difference from Past Trends (Scenario A)		-2,950	-6,400	-7,350

Greenhouse Gas Emissions Summary

Combined transportation and building sector impacts provide the most complete picture of the greenhouse gas emissions of the varying futures presented by the insight2050 scenarios. Passenger vehicle transportation, along with residential and commercial building energy use, currently account for over half of total carbon emissions in Central Ohio. Land use and transportation planning in the region, in conjunction with state and federal policies in regulating energy emissions and efficiency, will play a role in reducing greenhouse gas (GHG) emissions.

Total GHG emissions – including those from passenger vehicles, and emissions associated with residential and commercial building energy consumption – vary across the scenarios due to their differences in land use patterns. In 2050, Past Trends, with the highest proportion of growth occurring as Standard suburban development, would produce about 36 million metric tons (MMT) of annual GHG emissions from buildings and transportation, the highest among the scenarios. Emissions decrease as land use patterns become more compact: in comparison to Past Trends, Planned Future results in 2% lower annual emissions; Focused Growth results in 7% lower emissions, and Maximum Infill results in 9% lower emissions. For Focused Growth, the reduction is equal to the annual GHG emissions of 600,000 cars on Central Ohio roads; for Maximum Infill the reduction is the equivalent of the yearly emissions from 730,000 cars.

Annual Transportation and Building Energy GHG Emissions in 2050 (MMT CO2e)



Annual Transportation and Building Energy GHG Emissions per Capita (lbs CO2e)

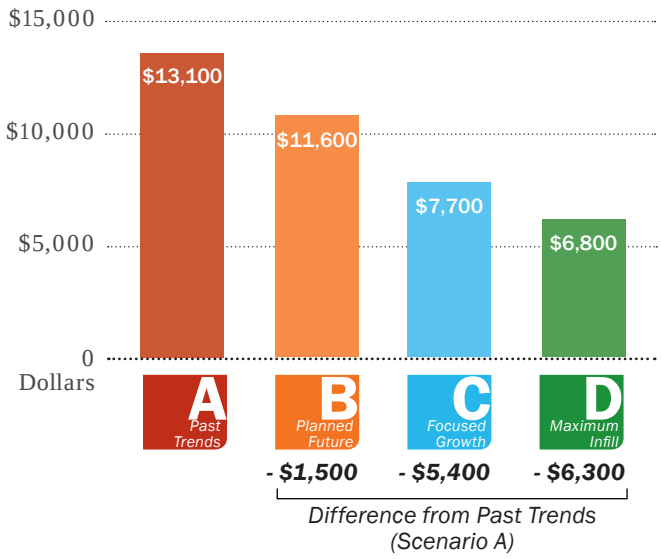
	A	B	C	D
	33,700	33,200	31,350	30,850
Difference from Past Trends (Scenario A)		-500	-2350	-2850

Household Costs Summary

The total cost burden for the insight2050 scenarios varies along with their land patterns and resource consumption. Infrastructure costs to serve new development and its associated travel demand, as well as household transportation, energy, and water costs, are higher in scenarios with greater land consumption, higher VMT, and building programs that rely more on larger-lot single family construction.

Breaking costs down to the household level exposes the impact of land use and policy choices on Central Ohio households: by 2050, the Past Trends scenario would cost the average new household about $13,000 in expenditures associated with driving and residential energy and water use per year. By comparison, Planned Future would cost about $1,500 less; Focused Growth would cost about $5,400 less; and the Maximum Infill scenario would cost nearly $6,300 less per year. Over time, the differences in annual expenditures would amount to a significant sum for each household – money that could instead be applied to a home mortgage or other living expenses. Collectively to 2050, household spending amounts to $94 billion in the Past Trends scenario. By comparison, Planned Future would cost $10.5 billion less; Focused Growth would cost $39 billion less; and Maximum Infill would cost $46 billion less.

Annual Household Costs per New Household in 2050 (2014 dollars)



Appendix A: RapidFire Inputs and Outputs Catalog

RapidFire Model Output Metrics and Input Assumptions

Summary of Output Metrics

Land Consumption

- *Land Consumed (square miles)*

Fiscal Impacts

- *Capital Costs for local infrastructure to serve new development ($)*
- *Operations and Maintenance Costs to provide ongoing services for new development ($)*
- *Revenues associated with new residential and commercial development ($)*

Transportation System Impacts and Emissions

- *Vehicle Miles Traveled (VMT) (miles)*
- *Fuel Consumed (gal)*
- *Fuel Cost ($)*
- *Transportation Electricity Consumed* (kWh)*
- *Transportation Electricity Cost* ($)*
- *Transportation Electricity CO_2e Emissions* (MMT)*
- *ICE Fuel Combustion CO_2e Emissions (MMT)*
- *ICE Full Fuel Lifecycle CO_2e Emissions* (MMT)*
- *Criteria Pollutant Emissions (tons)*

Public Health Impacts Related to Transportation Emissions

- *Respiratory and Cardiovascular Health Incidences (#)*
- *Health Costs associated with Health Incidences ($)*

Building Energy, Cost, and Emissions

- *Residential Energy Consumed (Btu)*
- *Commercial Energy Consumed (Btu)*
- *Total Energy Consumed (Btu)*
- *Residential Building CO_2e Emissions (MMT)*
- *Commercial Building CO_2e Emissions (MMT)*
- *Residential Energy Cost ($)*
- *Building Water Use, Cost, and Emissions*
- *Water Consumed (AF)*
- *Water Cost ($)*

Summary of Input Assumptions

Demographics

- *Baseline population and population growth*
- *Baseline households and household growth*
- *Baseline housing units and housing unit growth*
- *Baseline non-farm jobs and job growth*

Scenarios

- *Place type proportions for each scenario and time period*
- *Housing unit composition for each place type*

Fiscal Impacts

- *Per-unit capital cost assumptions to provide local roads, sewer, and water facilities for new development, by building type and place type*
- *Per-unit operations and maintenance cost assumptions to provide ongoing services to new development, by building type and place type*

Land Consumption

- *Percent greenfield vs. infill/greyfield/brownfield growth for each place type and scenario*
- *Residential and employment densities by building type, place type, and scenario*

Summary of Input Assumptions [continued]

Vehicle Miles Traveled (VMT)

- *Baseline Per Capita Light Duty Vehicle (LDV) VMT*
- *VMT adjustment factors by place type and scenario for growth increment population*
- *VMT escalation and deceleration rates for the baseline environment population*
- *Elasticity of VMT with respect to driving costs per mile**

Vehicle Fuel Economy and Cost

- *Baseline fuel economy for total fleet, internal combustion engine vehicles alone*, and alternative/electric vehicles alone**
- *Fuel economy in horizon years for total fleet, internal combustion engine vehicles alone*, and alternative/electric vehicles alone**
- *Elasticity of fuel economy with respect to fuel cost**

Transportation Emissions

- *Baseline fuel emissions, combustion (tank-to-wheel) for total fleet, internal combustion engine vehicles alone*, and alternative/electric vehicles alone**
- *Baseline fuel emissions, full lifecycle (well-to-wheel)* for total fleet, internal combustion engine vehicles alone, and alternative/electric vehicles alone*
- *Percent gasoline vs. diesel in liquid fuel mix**
- *Composition of gasoline and diesel fuel mix**
- *Criteria pollutant emissions per mile traveled*

Public Health Impacts Related to Transportation Emissions

- *Health incidences per ton of pollutant*
- *Health costs per ton of pollutant*

Building Energy Emissions

- *Electricity generation emissions (lbs/kWh)*
- *Natural gas combustion emissions (lbs/therm)*
- *Electricity generation emissions in horizon years (lbs/kWh)*
- *Natural gas combustion emissions in horizon years (lbs/therm)*

Residential Building Energy Use & Price

- *Baseline average annual energy use per unit for base/existing population*
- *Annual energy use by building type*
- *New efficiency factor for new units of the growth increment*
- *Upgrade efficiency factor for base/existing housing stock*
- *Baseline residential electricity and natural gas prices*
- *Residential electricity and natural gas prices in horizon years*
- *Residential gas price in horizon years*

Commercial Building Energy Use & Price

- *Non-farm job proportion by floorspace-type category*
- *Floorspace per employee by category for each place type*
- *Baseline average annual energy use per square foot for base/existing commercial space*
- *Annual baseline energy use for new commercial space*
- *New efficiency factor for new floorspace of the growth increment*
- *Upgrade efficiency factor for base/existing commercial space*
- *Baseline commercial electricity and natural gas prices*
- *Commercial electricity and natural gas prices in horizon years*

Residential Building Water Use

- *Baseline per capita indoor water demand by building type*
- *Baseline per-unit outdoor water demand by building type*
- *New residential water efficiency (% reduction from baseline)*
- *Upgrade efficiency factor for base/existing housing stock*
- *Baseline water price ($/acre foot)*
- *Water price in horizon years ($/acre foot)*

Residential Water-Related Energy Use and Emissions

- *Average water energy proxy (electricity required per million gallons water used)**

** RapidFire input or output not applied or analyzed as part of this process.*

Appendix B: Central Ohio RapidFire Technical Assumptions

Transportation	
Fuel economy	*On-road passenger vehicle average: 20.7 mpg estimated based on MORPC regional vehicle mix and EIA average performance for light-duty vehicles (short/long wheelbase, including cars and light trucks) for 2012.*
Fuel price	*$5 per gallon (2014 dollars)*
Auto operating cost	*$0.63 per mile (2014 dollars), including ownership and maintenance. AAA Your Driving Costs 2013 data, including depreciation, insurance, finance charges, maintenance, and tires.*
Transportation fuel emissions	*19.9 lbs carbon dioxide equivalent (CO_2e) per gallon, statewide average*
Buildings	
Baseline energy use of buildings	*Energy Information Administration (EIA) Residential Energy Consumption Survey 2009 average annual energy use per housing unit by type for East North Central Region.* • *Rural lot single family: 11,980 kWh; 970 therms* • *Larger lot single family: 11,980 kWh; 970 therms* • *Smaller lot single family: 11,980 kWh; 970 therms* • *Townhome: 8,035 kWh; 750 therms* • *Multifamily: 6,550 kWh; 650 therms.* *Commercial energy use: baseline averages by sector estimated based on EIA Commercial Buildings Energy Consumption Survey data, 2003 (published 2006) and job sector/floorspace distribution among categories.* • *Retail: 21.9 kWh/sf; 0.86 therms* • *Office: 18.2 kWh/sf; 0.43 therms* • *Warehouse: 10.9 kWh/sf; 0.30 therms* • *Civic/Institutional: 20.3 kWh/sf; 0.68 therms*
Electricity price	*$0.12 per kWh, EIA state average.*
Natural gas price	*$0.85 per therm, EIA state average.*
Baseline residential water use	*Annual baseline estimate from Ohio EPA Water + Wastewater survey: 0.26 AF. Use for new units estimated on per-capita indoor estimates and estimated outdoor irrigation needs.* • *Rural lot single family: 0.32 AF* • *Larger lot single family: 0.27 AF* • *Smaller lot single family: 0.19 AF* • *Townhome: 0.18 AF* • *Multifamily: 0.15 AF*
Water price	*$2,960 per AF. From Ohio EPA Water + Wastewater cost survey. Regional composite rates cover drinker water and wastewater.*
Energy Emissions	
Electricity emissions	*Average rate for carbon dioxide equivalent (CO_2e) from EIA 2012 Summary Statistics for Ohio: 2.09 lbs/kWh.*
Natural gas emissions	*Static rate based on carbon content: 11.7 lbs/therm.*

Appendix C: insight2050 Committees

Steering Committee

Mark Barbash	Finance Fund
Trudy Bartley	PACT Neighborhood
Chris Bauserman	Delaware County Engineer's Office
Marilyn Brown	Franklin County Commissioner
Shawna Davis	Ohio Health
Tom Goodney	Educational Service Center of Central Ohio
Bill Greenlee	ROI Realty
Bill Habig	Raccoon Valley Partners, LLC
Tracy Hatmaker	Prairie Township
Charles Hillman	Columbus Metropolitan Housing Authority
Jim Hilz	Building Industry Association of Central Ohio
Doug Kridler	Columbus Foundation
Mitch Lynd	Lynd Fruit Farms
Glenn Marzluf	Del-Co Water Company, Inc.
Holly Mattei	Fairfield County Regional Planning Commission
Linda Mauger	OSU, Office of Geriatrics and Gerontology
Keith Myers	OSU, Office of Administration & Planning
Mike Pannell	Franklin County Emergency Management and Homeland Security
Torrance Richardson	Columbus Regional Airport Authority
Jim Schimmer	Franklin County Economic Development
Ike Stage	City of Grove City
Laura Swanson	Columbus Appartment Association
Krystina Schaefer	Public Utilities Commission of Ohio
Guy Worley	Columbus Downtown Development Corporation
Jerry Newton	Licking County Planning Commission
Nathan Wymer	Nationwide Insurance
David Efland	City of Delaware

Executive Committee

Terry Foegler	City of Dublin
Kenny McDonald	Columbus 2020
William Murdock	Mid-Ohio Regional Planning Commission
Vince Papsidero	City of Columbus
Eric Phillips	Union County-Marysville, Economic Development Partnership
Yaromir Steiner, Chair	Steiner + Associates
Curtis Stitt	Central Ohio Transit Authority