

## CommunityViz Indicators

CommunityViz software is an ArcGIS® extension for planning and analysis.<sup>1</sup> At its core is a powerful, flexible modeling framework that allows users to create tools for all kinds of GIS (geographic information system) modeling applications quickly and efficiently.

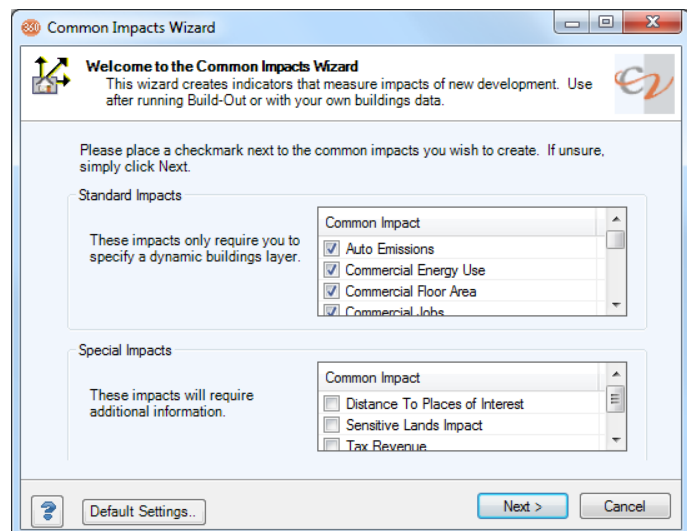
Planners use the term “indicators” to denote quantitative measurements of the characteristics and outcomes associated with a proposed future plan or scenario. Indicators can measure almost anything, but the classic categories include economics, environment, and “society,” which broadly refers to demographics and services infrastructure.

Indicator “models” are the formulas or algorithms used to calculate indicator values. For example, a simple model for calculating population is to multiply the number of dwelling units by the average number of persons per dwelling unit. At the other end of the spectrum, travel demand models combine very detailed information about transportation networks and land use distributions with sophisticated algorithms to estimate vehicle trips, CO<sub>2</sub> emissions, average trip length, and other transportation indicators.

CommunityViz supports indicator modeling across a broad range from simple and easy to sophisticated and complex. The following paragraphs provide a brief tour, starting with the simplest and progressing to the most sophisticated.

### *Common Impacts Wizard*

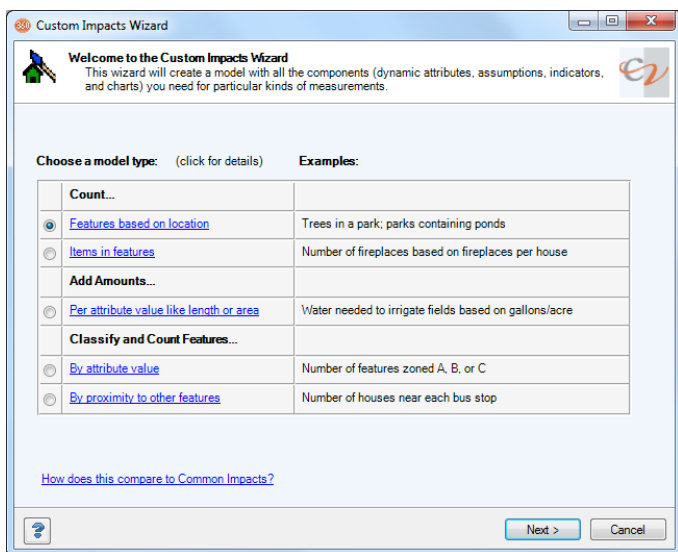
The *Scenario 360™* Common Impacts Wizard provides a good starting point for indicator modeling. It uses relatively simple multipliers and coefficients to calculate a spectrum of indicators associated with the impacts of development. Calculations happen automatically after the user runs a straightforward setup wizard. The only data required is a layer containing current or proposed dwelling unit counts and/or commercial floor area. U.S. national averages are built into the tool and used as defaults, but users are encouraged to adjust these settings to match local conditions or to test “what-if” changes in their assumptions. Experimenting with changes is easy using the famous CommunityViz variable assumption “slider bar” controls provided, and more advanced users can reset even the default values to match local needs.



<sup>1</sup> CommunityViz is a registered trademark of Placeways LLC. ArcGIS is a registered trademark of Esri.

Here are the indicators the Common Impacts Wizard can provide:

- Auto emissions (CO, CO<sub>2</sub>, NO<sub>x</sub>, Hydrocarbons)
- Commercial energy use
- Commercial floor area
- Commercial jobs
- Commercial jobs-to-housing ratio
- Commercial tax revenue
- Distance to places of interest
- Residential water use
- Labor force
- Population
- Residential dwelling units
- Residential energy use
- Residential tax revenue
- School children
- Sensitive lands impacts
- Vehicle trips per day



### Custom Impacts Wizard

The *Custom Impacts Wizard* provides the next step up in flexibility and sophistication. It provides an easy-to-use, step-by-step tool for setting up custom indicator models. For example, it would take only a few clicks to set up planning-level indicators for the cost and energy savings of rooftop photovoltaic panels based on a certain adoption rate by households. You specify the type of analysis you want—counts, sums, classifications—and the parameters you want to use. The wizard takes it from there, setting up the formulas, attributes, indicators, assumptions and charts you can use to see how your impact is affected by potential decisions you might make.

The impact models supported by the Custom Impacts Wizards cover some of the most commonly used simple structures. For example, you can:

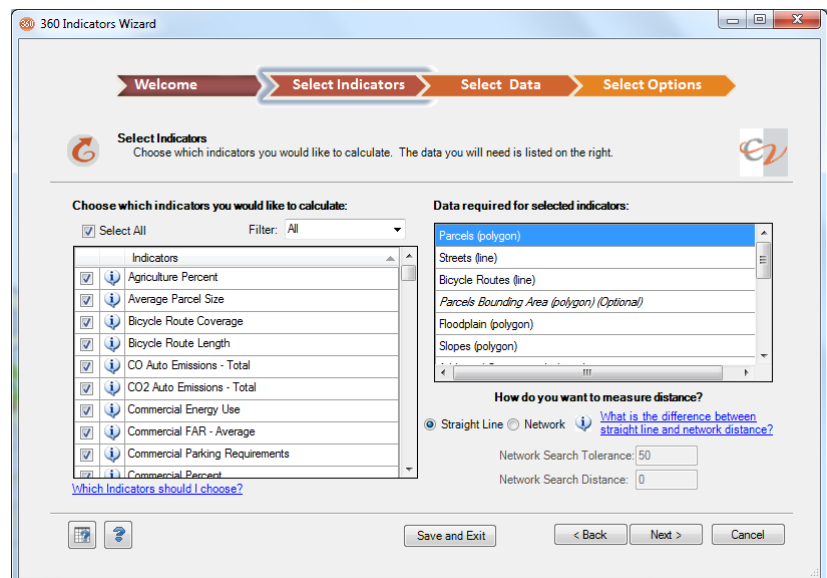
- Count features based on their location, such as counting all the trees in a park or counting all the septic tanks near a river
- Count items in features, such as counting all the chimneys in a group of houses
- Add amounts per feature attribute, such as amount of water needed to irrigate a polygon layer representing farm fields
- Classify and count features based on one of their existing attribute values, such as calculating how many roads are local, collector, and arterial, respectively
- Classify and count features based on their proximity to other features, such as counting how many septic tanks are near each of four rivers

### *360 Indicators Wizard*

The *360 Indicators Wizard* provides a well-rounded, “360-degree” planner’s assessment of community planning scenarios. Starting from standard planning layers you provide, the wizard automatically creates indicators and supporting analysis components in topics of demographics, employment, environment, housing, land use, recreation, and transportation. Up to 101 indicators are available from this single wizard if all the input layers are available.

Anywhere from 1 to 19 input layers are needed for the 360 Indicators Wizard, depending on the indicators you want to create. The primary requirement is a land use layer such as parcels, and optional layers include common planning data such as roads and transportation networks, amenities, schools, and constraints to development.

In addition to indicators and indicator formulas themselves, 360 Indicators produces numerous **charts**, **variable assumptions** with appropriate **default values**, and other components. As usual with CommunityViz, all formulas and components generated by the wizard are completely transparent, and you can view or edit them using standard Scenario 360 formula tools.



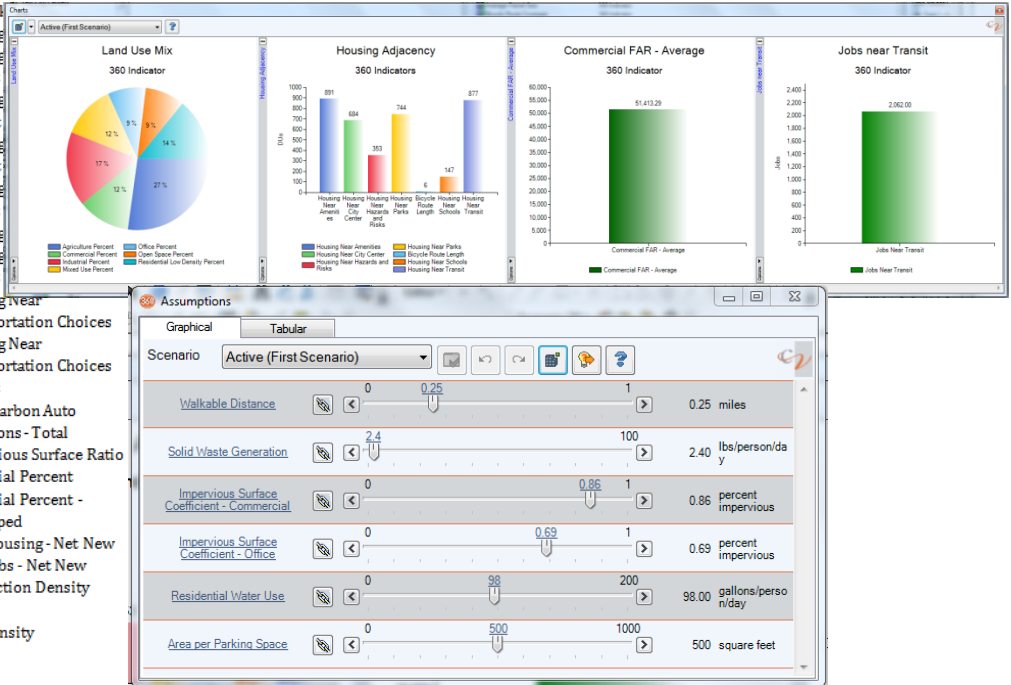
The accompanying charts and table provide representative outputs of the 360 Indicators wizard.

Agriculture Percent  
Average Parcel Size  
Bicycle Route Coverage  
Bicycle Route Length  
CO2 Auto Emissions - Total  
CO2 Auto Emissions - Total  
Commercial Energy Use  
Commercial FAR - Average  
Commercial Parking Requirements  
Commercial Percent - Developed  
Constrained Land Percent  
Developed Land Area  
Distance to Amenities  
Distance to City Center  
Distance to Hazards and Risks  
Distance to Parks  
Distance to Transit  
Distance to Transit - Jobs  
Dwelling Units  
Floodplain Area  
Floodplain Percent  
Government Percent  
Government Percent - Developed  
Housing Near Amenities  
Housing Near Amenities Percent

Housing Near City Center  
Housing Near City Center Percent  
Housing Near Hazards and Risks  
Housing Near Hazards and Risks Percent  
Housing Near Transportation Choices  
Housing Near Transportation Choices Percent  
Hydrocarbon Auto Emissions - Total  
Impervious Surface Ratio  
Industrial Percent  
Industrial Percent - Developed  
Infill Housing - Net New  
Infill Jobs - Net New  
Intersection Density  
Jobs  
Jobs Density

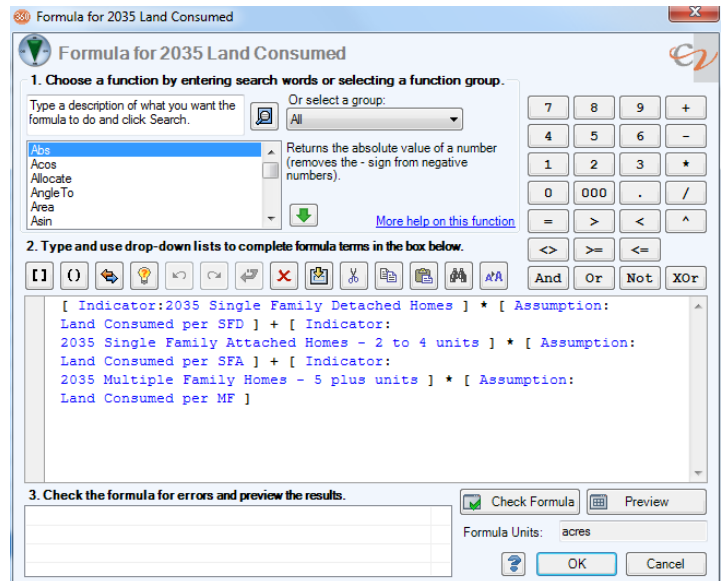
Jobs Near Amenities  
Jobs Near Amenities Percent  
Jobs Near City Center  
Jobs Near City Center Percent

Residential Area per 1000  
Residential Density  
Residential Energy Use  
Residential High Density Percent  
Residential Low Density



### Creating Your Own Custom Formulas

CommunityViz provides a rich set of tools for creating your own indicator models, quickly and efficiently. No programming or additional software is required. The experience is something like creating an Excel spreadsheet, except that you have access to a large library of spatial functions (e.g., distances, overlaps, and spatial lookups) in addition to Excel-like numeric functions. Formulas can be connected together to create a complete analysis model. Once the formulas are created, they are saved with your analysis, and you can edit or change them normally. They are “always on,” so that changes to underlying data, assumptions, or scenarios automatically trigger indicator updates.



More information about the CommunityViz modeling framework appears in a later section. Among its many benefits:

- Adapts to available data. Unlike models that require particular data in particular formats, CommunityViz can usually work with whatever data you have.
- Allows use of best-available models. You can use the newest, most contextually appropriate indicators and analysis for your work.
- Infinitely innovative. You can model any planning issue you like, without waiting for a new version of the software with your particular issue built in.

As an illustration of the flexibility custom formulas provide, Placeways has been building experience in models that tie subjective community values, like “family friendliness,” to characteristics of the built environment (such as access to schools). This is a new field with little published research, so not surprisingly there are no pre-made tools or models for conducting this kind of analysis. Nevertheless, by using custom formulas Placeways has built scenario planning models with over 100 indicators focused on value-based attributes of a community.

### *External Models*

In addition to providing its own internal modeling capabilities, CommunityViz is designed to trade information, inputs, and outputs with other modeling tools if appropriate. For example, you can use it in conjunction with a sophisticated pro forma or cost-of-development model implemented in Excel. In that case you use CommunityViz for creating maps and scenarios, send summarized data to the external model for numerically-intensive financial calculations, and then read the results back into CommunityViz for display and further analysis. The external model can be implemented in almost any platform that uses inputs from databases, geodatabases (GIS maps), or tables. Here are a few proven examples:

- Cost-of-services models
- Travel demand models
- Biodiversity impact models
- Water quality and run-off models
- Building energy models

Although specialized wizards are not required for connections to external models, CommunityViz does provide a few for particular needs. The *External Table Links* wizards sets up dynamic connections to Excel tables, and the twin tools *Hazus Risk Assessment Wizard* and *Hazus Risk Assessment Exporter* provide a two-way connection to the US Federal Emergency Management Agency’s Hazus-MH model for analyzing risks from natural hazards. In some cases the number of Hazus-driven indicators can exceed several hundred.

### *Popular Summary Indicators*

In practice, CommunityViz users often need a standard set of summary indicators describing basic characteristics of the built environment. These indicators are useful both on their own and as inputs to coefficient-based impact models. If relevant data is available, summary indicators are extremely easy to create and display in CommunityViz, often with the press of a single button. Thus while these indicators are not built into CommunityViz, they are very easy to access. Here are some common examples:

- Demographics
  - Population
  - Population density
  - Employment
  - Employment density
  - Composite residential/non-residential population
  - School-aged children
  
- Transportation
  - Vehicle miles traveled (VMT)
  - VMT per capita
  - Vehicle trips per day
  - Sidewalk ratio
  - Bicycle trail density
  - Intersection density
  - Walkability
  - Households served by transit
  - Average distance to transit (residential)
  - Average distance to transit (non-residential)
  - Accessibility index
  - Residential density: road network balance
  - Transit service coverage area
  - Transit population coverage
  
- Land Use and Housing
  - Residential density
  - Single-family units
  - Multifamily units
  - Non-residential density
  - Retail square feet
  - Office square feet
  - Other non-residential square feet
  - Average lot size
  - Open space
  - Use mix (residential vs. non-residential)
  - Residential vacancy percentage
  - Open space by type (spot parks, regional parks, trails, preserves)

- Environment and Climate Change
  - Residential building energy use
  - Non-residential building energy use
  - Residential building CO<sub>2</sub>-equivalent emissions
  - Non-residential building CO<sub>2</sub>-equivalent emissions
  - Vehicle-based CO<sub>2</sub>-equivalent emissions
  - Impervious surface
  - Water use
  - Wastewater generation
  - Buildings in 100-year floodplain
  - Buildings in 500-year floodplain
  - Buildings in environmentally sensitive areas
  - Open space percent
  
- Economy
  - Jobs-housing balance
  - Jobs
  - Retail/service floor space
  - Total commercial floor space
  - Cost of new residential infrastructure
  - Cost of new transit facilities

### *CommunityViz Modeling Framework*

“Modeling” is the process of creating mathematical representations of real-world systems for the purpose of studying their behavior and improving their design. Regional planners, for example, often use CommunityViz to model future development and estimate its economic, environmental, and social outcomes under alternative planning scenarios.

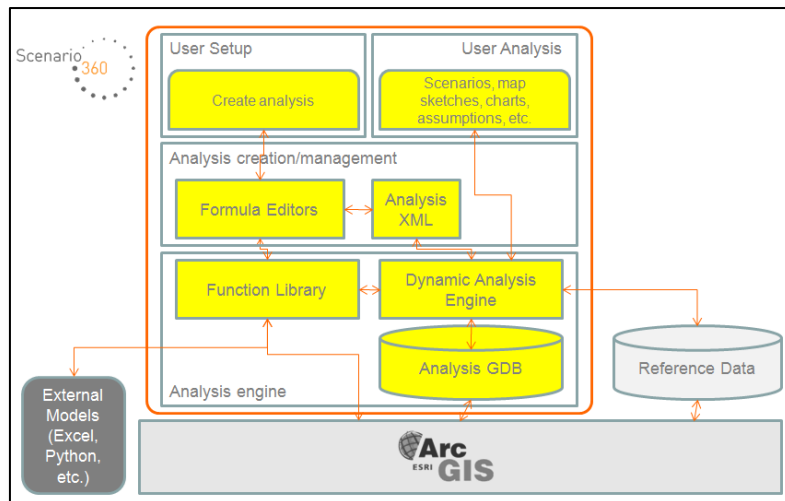
While CommunityViz has a number of built-in models for common land use planning and resource management applications, its greatest power lies in its ability to support custom models. Rather than programming complete models into its internal software code, CommunityViz, through the CommunityViz component called *Scenario 360*, provides an open modeling framework and building blocks—called functions—that let users create the exact models they need when they need them.

The “open modeling framework” means that users create their own analysis tools. The model formulas and assumptions are completely transparent: anyone can look at them, edit them, or add to them, just as they would with an Excel spreadsheet. To make these changes there are no charges and no data maintenance fees, and consultation from Placeways or other certified CommunityViz consultants is completely optional.

Yet the models can be very sophisticated, and *Scenario 360* provides over 80 building block functions to work with. Function categories include numeric, spatial, statistical, database lookup, network, trigonometric, text manipulation, user input, and custom script types. There are also many functions to facilitate moving data across geographic scales (small study polygons vs. large study polygons), such as

*OverlapWeightedAverage* and *GetFromClosest*. Two types of processing that Scenario 360 does not provide internal capabilities for are geoprocessing, for which ArcGIS and ArcGIS Model Builder provide ample capability, and looping or iterative computations and simulations, for which external scripts are required.

The figure below illustrates the CommunityViz *Scenario 360* modeling environment. Starting at the top left, the User Setup components provide the human interface into *Scenario 360* model creation capabilities. Users create projects or models, called analyses, with these parts of the software. Set up



up includes creating variable input assumptions, various data set up functions, result measurements called indicators, and other components. At the heart of the set up lie “dynamic attributes,” which are GIS layer attributes whose values are dynamically controlled and updated by *Scenario 360*.

Moving downward in the diagram, you see the functions for creating dynamic attribute formulas and indicator formulas. Modelers

create *Scenario 360* formulas, which look something like Excel formulas and use an easy-to-learn notation. These can be written directly with the Formula Editor, or in a more automated fashion by using a variety of wizards and tools included in the software. Sets of formulas can be saved and reused on other datasets by means of Analysis Templates for the Analysis XML, which stores the settings that have been created.

Moving downward in the diagram again, the *Scenario 360* analysis engine is the proprietary nerve center of the modeling framework. It uses ArcObjects, C#, the ArcGIS platform, and other software to execute formulas and manage the cascade of model updates that occurs each time a change occurs to input data, variable assumptions, scenarios, or map data. Those changes are driven by the intuitive, planner-friendly, “User Analysis” controls shown in the upper right of the diagram.

For all its internal modeling power, CommunityViz architecture also embraces the notion of integration with external models of all kinds. It provides the ability to call custom scripts, import and export tables, exchange database and geodatabase files, exchange analysis structures via XML, share CommunityViz analysis templates, and read external tables (including Excel spreadsheets) dynamically. In addition, because CommunityViz is an ArcGIS extension, it takes advantage of the broad spectrum of interoperability capabilities provided by that platform. This means that users can

- Trade inputs and outputs with other software tools
- Connect to existing spreadsheet-based impact models
- Use data from one, several, or hundreds of external databases
- Call custom scripts
- Make use of almost any data type supported by ArcGIS
- And more



The end result of the *Scenario 360* modeling architecture is a powerful, flexible environment for creating modeling tools. It gives CommunityViz users the ability to build new tools for novel problems as they arise. And it also lets them build reliable, reusable models that implement a proven technique and can be used again and again. CommunityViz has been extensively proven in the field during 10 years of projects by thousands of users all over the world. At first, the custom modeling focus of CommunityViz may seem daunting to people who are accustomed to using pre-programmed models. Its huge advantage is an analysis framework that is always made to meet the needs of the project, not the other way around.

### *Conclusion*

CommunityViz provides a broad spectrum of indicator modeling tools to match every level of sophistication and need. As this paper described, *Scenario 360* includes the Common Impacts Wizard with built-in fast and simple models, the Custom Impacts Wizard for easy creation of additional indicators, and a powerful, flexible open modeling framework for creating the tools you need, when and how you need them. These, combined with the rich set of built-in analysis and interaction features of CommunityViz, provide an ideal framework all kinds of indicator modeling.

Much more information on CommunityViz is available online at [placeways.com/communityviz](http://placeways.com/communityviz), or call Placeways toll-free (in the U.S. and Canada) at 1.866.953.1400 to ask for help, ideas, and suggestions.