U.S. DEPARTMENT OF ENERGY
SMARTMOBILITY
Systems and Modeling for Accelerated Research in Transportation

Typology of Cities for Systems and Modeling for Accelerated Research in Transportation (SMART) Mobility Consortium

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OVERVIEW

Multidimensional typology of adoption/impacts

- GIS-based for reuse and sharing
- Links between social, economic, technological, environmental and governance (SETEG) indicators and energy outcomes

Create a multi-dimensional typology of adoption and impacts of emerging technologies

- To be done across different populations and settlement types

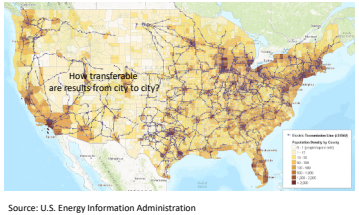
RELEVANCE

Enhance the value of SMART Mobility efforts

- Make relevant outcomes transferable among cities with similar characteristics

SUMMARY

Typology to identify clusters of features and drivers in emergent transportation behavior and energy use across urban areas and socioeconomic groups.



Source: U.S. Energy Information Administration

OUTCOMES AND IMPACT

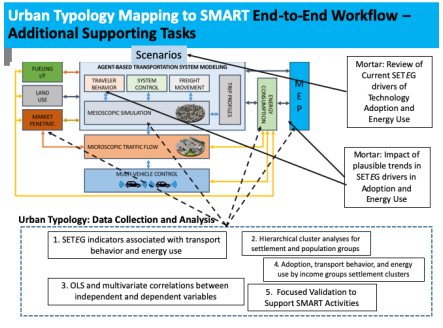
1. **White paper comparing clustering methods and variables with similar geo-typology (NREL)**
2. **Clustering of cities and people by common characteristics for estimating national impact of automated, connected, efficient, and shared transportation scenarios (NREL)**
3. **Accessible data, analytics, and methods for SMART researchers and Cities partners on urban characteristics across many dimensions (NREL)**
4. **Grouping of similar cities and settlements into a small number of clusters (NREL)**
5. **White paper of possible approaches and data to be used to create geotypes for FHWA project (Lawrence Berkeley National Laboratory, LBNL)**

Indicators and Data Sources				
INDICATOR	SETEG	DEP/IND	RESOLUTION	AVAILABILITY
MEP metric	Mobility	DEP	Grid cells	Six cities
Gallons gasoline sold	Energy	DEP	County	Two cities
EV adoption %	Adoption	DEP	Zip code	US
Transit trips/capita	Mobility	DEP	Transit agency	US
Fleet averaged mpg	Energy	DEP	Zip code	US
Gender (female)	S	INDEP	Block group	US
Education (level)	S	INDEP	Block group	US
Race (white)	S	INDEP	Block group	US
Household income	E	INDEP	Block group	US
Employment Access	E	INDEP	Block group	US
House Tenure (own)	E	INDEP	Block group	US
Population Density	T	INDEP	Block group	US
#Vehicles/household	T	INDEP	Block group	US
GHG/MWh electricity	T	INDEP	Block group	US
HTA Index (CNT)	T	INDEP	Block group	US
PM 2.5	E	INDEP	Block group	US
Cancer Hazard	E	INDEP	Block group	US
Respiratory Hazard	E	INDEP	Block group	US
Intersection Density	G	INDEP	Block group	US
Non SOV commuters	G	INDEP	Block group	US

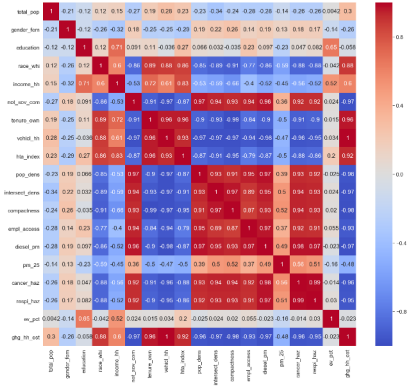
EV = electric vehicle; GHG = greenhouse gases; HTA = housing and transportation affordability index; SOV = single occupancy vehicle; CNT = Center for Neighborhood Technology; DEP = dependent; INDEP = independent

APPROACH

1. Analyze cities' parameters and features—e.g., socioeconomic, technological
2. Coordinate with partners—
   - Cities Leading through Energy Analysis and Planning (Cities-LEAP), Mobility Energy Productivity (MEP),
   - Collaborative effort with Lawrence Berkeley National Laboratory (LBNL) on related Federal Highway Administration (FHWA) geo-typology project
3. Complete systemic review of relevant literature
4. Conduct data analyses of city features:
   - Factor analysis, cluster analysis, and correlations
   - Ordinary Least Squares to examine links between population/settlement type and adoption/impacts
   - Sensitivity analysis of geotypology results to alternative approaches and variables



Correlation Matrix: Exploration of Key Links between Indicators



The reds indicate positive (warm) and the blues indicate negative (cool) correlations respectively. The darker shades are only stronger or weaker correlations, not statistical significance.

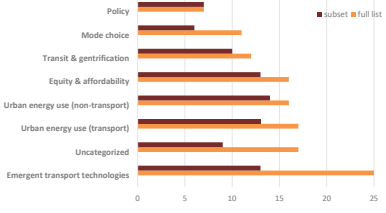
ACCOMPLISHMENTS AND PROGRESS

1. Draft typology report on methods, existing approaches, and datasets
   - (Completed FY 2019 Q2)
2. Create dataset with all indicators
   - (To be completed by FY 2019 Q3)
3. Coordination with partners
   - (Add status update here)
4. Systemic literature review
   - 95% of papers were analyzed
   - Identification of key approaches
   - (To be completed by FY 2019 Q3)
5. Run factor analysis, cluster analysis, and other statistics (underway, to be completed by FY 2019 Q4)

This work will leverage and expand existing analysis, models, and tools towards an effective virtual test bed for advanced transportation systems, vehicle technologies, alternative fuels, and infrastructure. It will support the development of modular tools for smart city planning applications, including (but not limited to) transportation energy infrastructure planning, workplace charging, economic analysis, gap/ opportunity analysis for electric-drive people and goods movement, and other tools for smart city transportation energy planning.

Systematic Review: Multi-Dimensional Determinants (e.g., Urban Form) and Impacts (e.g., on Mobility and Energy) of Emergent Technologies

Systemic Review: Publications by Category



FUTURE WORK

Our efforts have identified potential future research questions, including:

- Can we identify subunits (e.g., block groups) in urban areas that are consistent across different cities, independent of the difference between the cities as a whole?
- Can understanding of what happens within these subunits help inform approaches to challenges in the adoption of efficient transportation technologies?
  - E.g., in accommodating energy sources that are intermittent or at risk from weather extremes and cyber-attacks?
- Can typology tools project technology adoption scenarios across these subunits?

Future work subject to funding.

CHALLENGES AND BARRIERS

- Continued refinement of sources of indicators of energy use and emissions by transport at a finer level of resolution—e.g., census block group level.
- Locating sources of appropriate transportation infrastructure and mobility behavior data layers remains a challenge.

COLLABORATION AND COORDINATION

- **NREL-LBNL collaborations seeking to**
  - Compare applicability to freight transport of clustering methods
- **Typology – MEP collaborations seeking to**
  - Use MEP as dependent variable in Typology regression
- **Typology – Cities LEAP collaborations seeking to**
  - Consider Cities-LEAP assets and visualization tools, Design in the future a buildings and transportation typology
- **Typology – New York collaborations**
  - Apply typology to GIS analysis of adoption of emergent transport technologies and its energy impacts
- **Typology – MIT collaborations seeking to**
  - Compare and contrast MIT and NREL methodologies and Use MIT data archive as an example
- **Typology – School of Mines collaborations to**
  - Refine replicability of statistical methods

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