CALIFORNIA HYDROGEN INFRASTRUCTURE TOOL (CHIT) 2017 RELEASE WEBINAR: UPDATES AND NEW CAPABILITIES

November 14, 2017

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Discussion Outline

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Purpose: To review updates made during 2015-2017 to the methodologies and data inputs provided with CHIT, the geographical information system tool developed by CARB to assist in analysis of needs for new hydrogen fueling infrastructure.

- Recap of CHIT fundamentals
- Simulated traffic intensity data
- Implementation of auto manufacturer survey and DMV registration data
- Alternative coverage gap formulation
- Coverage gap re-tuning tool
- Single station impact and re-evaluation tool
- Local capacity need calculation
- Evaluation grid geometry and coordinate system
- Demographic data updates and comparison to CVRP data
- Updated online map viewer
- Future implementation of CHIT

Discussion Outline

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- This discussion will answer questions like:
 - What new features and data inputs are available with CHIT 2017 Release? How were they developed?
 - What defaults settings have been adjusted in CHIT 2017 Release compared to 2015 Release?
 - What data inputs have been updated with CHIT 2017 Release?
 - What new operations are available with CHIT 2017 Release?
 - What is the current plan for ongoing CHIT development and use?

REVIEW OF CHIT 2015 RELEASE

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CHIT/CHAT Tools and AB 8

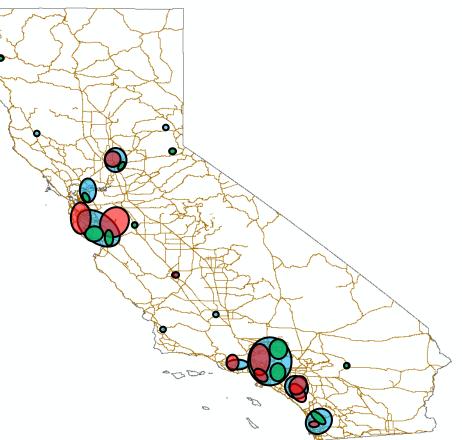


Station Coverage Assessment Market Indicator Assessment Localized Targets for Further Funding

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Big Picture Goal

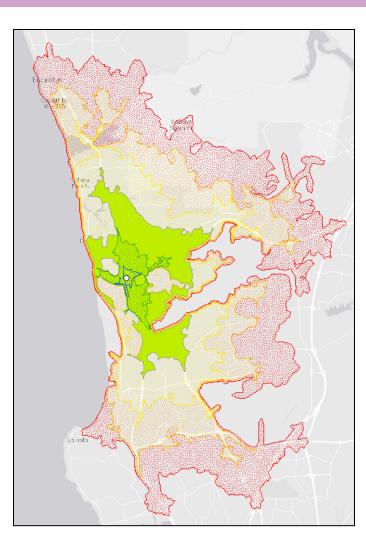
- Plan infrastructure placement appropriately for upcoming FCEV releases
- 1) Identify Market
- 2) Evaluate current infrastructure Existing and potential station coverage
- 3) Prioritize uncovered market from year-to-year



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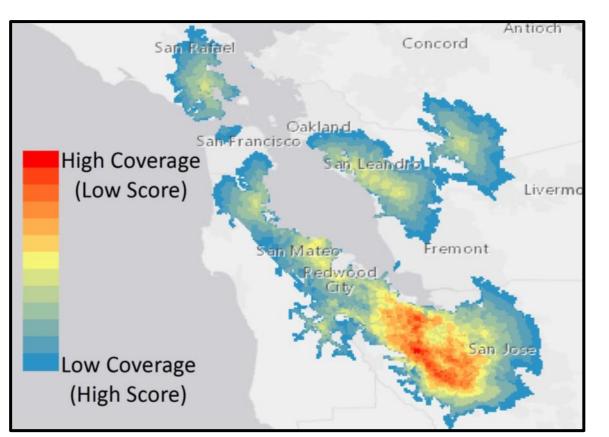
Central Theme: Coverage

- Conceptual representation of convenient access to fueling stations
- Often discussed in terms of drive time, e.g. coverage is provided to all neighborhoods within a 15-minute drive of a station
- Coverage can be conceptualized as binary (yes/no) or as degrees of coverage
- Well-planned coverage increases consumer confidence and adoption of vehicles



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Goals for Analyzing Existing Coverage

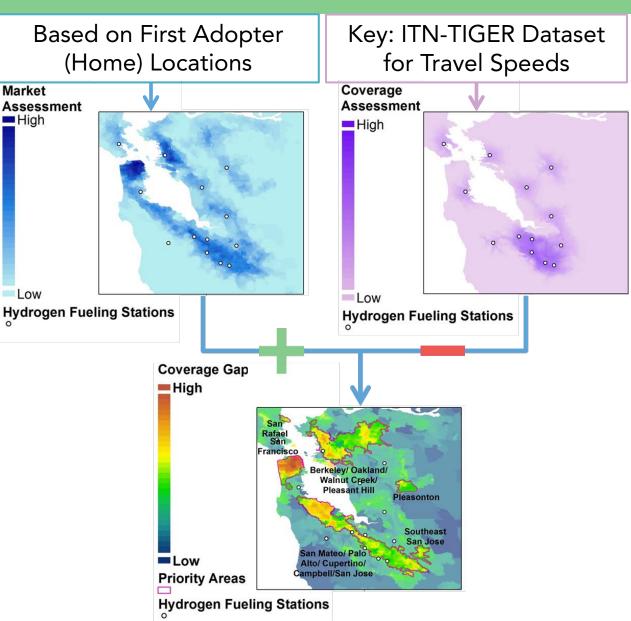


*Areas without coverage have no color and score highest

- Provides an estimate of coverage that is more informative than a binary yes/no, allowing for estimation of degrees of coverage
- Estimates combined coverage provided by multiple stations that may be reachable within various drive times

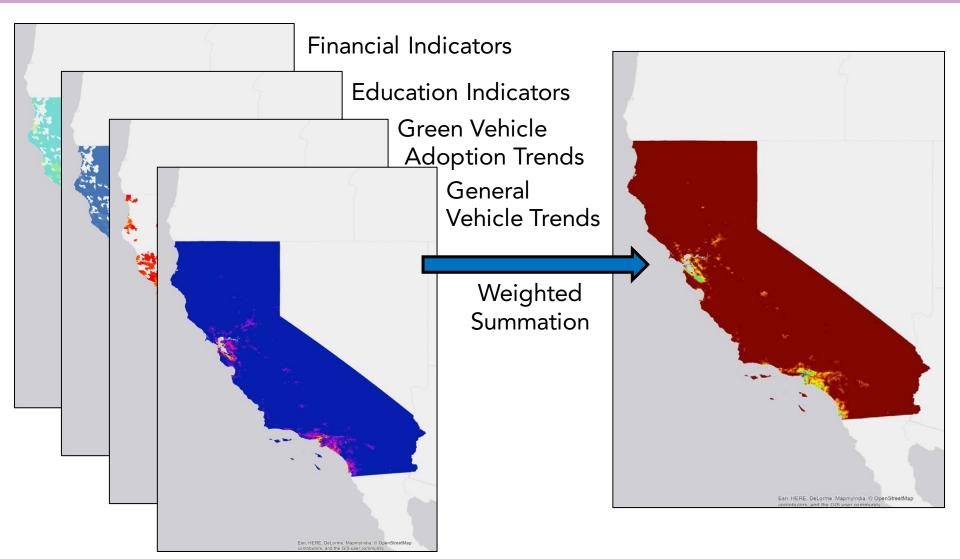
 CHIT is a <u>planning</u> tool intended to provide general direction indicating areas of needed infrastructure

 CHIT evaluates <u>relative</u> need for hydrogen infrastructure based on a gap analysis between a projected market and current infrastructure



Review

Analyzing the Early Adopter Market



Review

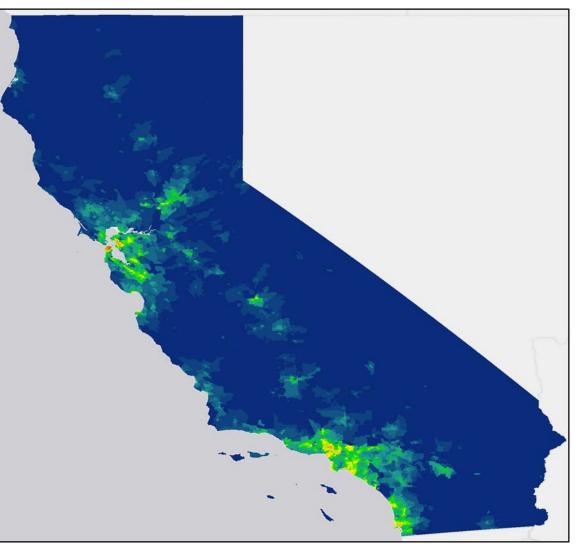
Coverage Gap Map Formulation

Heat = Coverage * Market

Coverage= 0.5 * Existing + 0.5 * Potential

Market= 0.5 * Financial + 0.3 * P/HEV + 0.2 * Edu

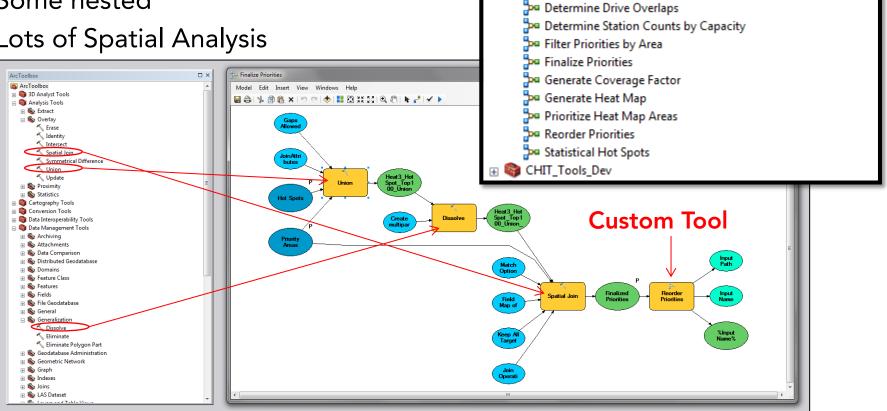
Financial= 0.34 * Income + 0.33 * MSRP + 0.33 * Luxury



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CHIT 2015 Toolbox

- CHIT is (mostly) a set of custom tools built in ArcGIS ModelBuilder
- Some iterative
- Some nested
- Lots of Spatial Analysis



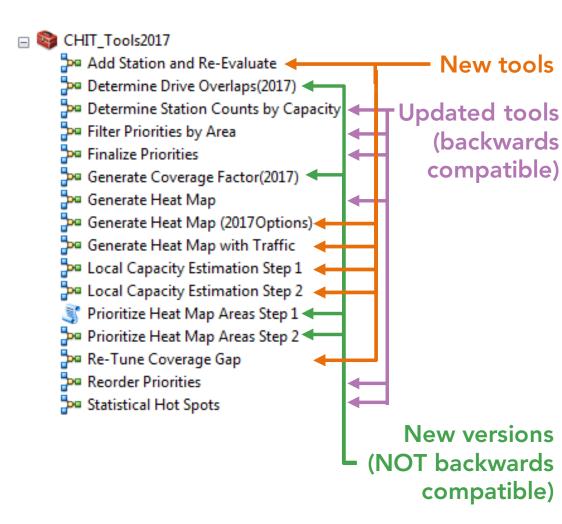
CHIT_Tools

CHIT is envisioned as a tool that could be used year-after-year for public planning and reporting purposes, while providing a consistent assessment method across the entire state. Related fundamental principles guide development of CHIT:

- Principle #1: CHIT is a relative assessment
- Principle #2: CHIT is a statewide assessment
- Principle #3: CHIT assesses only the first adopter market
- Principle #4: The FCEV market can be estimated by the relative distribution of multiple demographic indicators
- Principle #5: Accurate assessment of coverage depends on detailed roadway data
- Principle #6: Coverage matches the market when it provides convenient fueling access near FCEV drivers' homes
- Principle #7: CHIT must be a tool that can be shared with the public

CHIT 2017 TOOLBOX OVERVIEW

- Prior unreleased tools
- New tools developed for GFO-15-605 support
- New tools developed based on stakeholder feedback
- New tools developed for 2017 Annual Evaluation
- Process improvements



Generate Heat Map (2017Options)	1.	
Click error and warning icons for more information	××	Generate Heat Map (2017Options)
CA HexCells		conclute flour map (2011 optione)
C:\CHIT\CHIT2017.gdb\CA_HexCells		Generates a statewide heat map of localized
		desirability/need for new hydrogen refueling station
Traffic Volume Map		(s). The output feature class will have geometry
C:\CHIT\CHIT2017.gdb\Traffic_Intensity2017		matching the selected input grid file.
Traffic Volume Weight	0.2	Key features new to CHIT 2017 Release:
Access Factor Map		
C:\CHIT\CHIT2017.gdb\Access_Factor2017		 ARB's implementation uses a hexagonal grid,
Access Weight		replacing the previous square grid
	0.1	The option to include traffic intensity data as a
Coverage Factor Map		market input
C:\CHIT\CHIT2017.gdb\DriveRatings_2017		
No Coverage Value		 The option to include auto manufacturer
	2	survey responses as a market input
Financial Weight		
	0.5	 The option to include registered FCEV data as a market input
Income Factor Map		a market input
C:\CHIT\CHIT2017.gdb\Income_Factor2017		The input maps may be of any arbitrary polygon
Income Weight		geometry. However, they each have a requirement for
	0.34	a specific field name denoting the local score of that
Luxury Vehide Factor Map		factor. The user is highly advised to review the input file requirements listed in this tools help while
C:\CHIT\CHIT2017.gdb\Luxury_Veh2017		implementing the tool.
Luxury Vehicle Weight		
	0.33	The final heat map score will be stored in the output
MSRP Factor Map		feature class in a field called HeatScole_CxM.
C:\CHIT\CHIT2017.gdb\MSRP_Veh2017	- 🖻	Algebraically, the heat map is represented by the
MSRP Weight	0.33	following set of equations:
Education Factor Map	0.55	
C:\CHIT\CHIT2017.gdb\Education_Factor2017		HeatScore= CoverageScore * (x*Market Score +
		y*Drive Volume Score)
Education Weight	0.2	CoverageScore= a*Existing Coverage + b*Potential
Green Vehide Market Map		Access
C:\CHIT\CHIT2017.qdb\HEV PHEV2017		
Green Vehide Weight		MarketScore= ((1 - w)*(c*Financial + d*PHEV and
Green venice weight	0.3	HEV + e*Education) + w*Registrations) *Auto Manufacurer Response
Auto Manufacturer Splits		Manuacurer Response
C:\CHIT\CHIT2017.gdb\County_Survey		Financial= f*Income + g*Luxury Vehicles + h*Vehicle
FCEV Registrations		MSRP
C:\CHIT\CHIT2017.gdb\ZIP_FCEV_Regs		On White the state of the state
Registered FCEV Weight		Coefficients a through h, and w through y are weighting factors, as described in the explanations
	0.1	for each parameter. The following rules should be
Heat Map		followed for weighting factors:
C:\CHIT\CHIT2017.gdb\Coverage_Gap2017		
E hah da OFM Carana Waldeling		x + y=1 (in CHIT 2017 this is enforced automatically)
Include OEM Survey Weighting		a + b=1 (in CHIT 2017 this is enforced automatically)
	-	a . o . (or in 2017 this is enlorced automatically)
OK Cancel Enviro	nments << Hide Help	Tool Help

Updated base input data

- • ×

New functionality options in some tools (See Users Guide v2 for guidance on invoking new features)

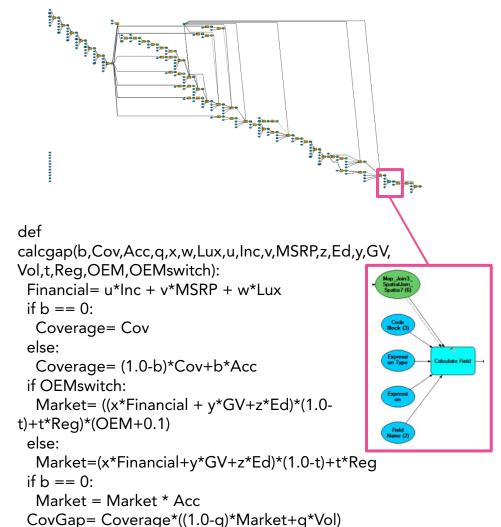
New input data options available in some tools

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CHIT 2015 Release

(%Coverage Weight%* [Rel_Score_DT] +%Access Weight%* [Rel_Score_AC])*(%Financial Weight%*(%Luxury Vehicle Weight%* [Rel_Score_LV] +%Income Weight%* [Rel_Score_Inc]+%MSRP Weight%* [Rel_Score_MSRP])+%Education Weight%* [Rel_Score_Ed]+%Green Vehicle Weight%* [Rel_Score_GV])

CHIT 2017 Release



return CovGap

CHIT 2015 Release

🖃 🧊 CHIT_Final.gdb		
🗉 🖶 TestNet_2		
ITN_TIGER_Junctions		
ITN_TIGER_Roads		
TestNet_2_ND		
TestNet_2_ND_Junctions		
BlockGrp15Min		
CA_BlockPopulations		
CA_Gridded		
Education_Tract_2013ACS_5Yr_Project		
IDW_Stat_Acc_Poly		
Income_Tract_2013ACS_5Yr_Project		
LocalConsumption_DrivePolys	•	Consolidate 2
LocalConsumption_Facilities		
Luxury_Veh_ZIPs		gdb's to 1
PMPK_Proj_Junctions		gub s to T
TIGER_ITN_PMPkSp_Proj		
Update_Stations_022715		
Vehicle_Sales_Bracket_Project		
ZIP_HEV_BEV_PHEV_Project	-	Add new data
🖃 🧊 CHIT_Scratch.gdb		la a wa
AB82017_CoverExtent		layers
😳 Blockgroup_Facilities		5
Blockgroup_Facilities_012717		
😳 Blockgroup_Facilities_Backup		
CA_Polygon	•	Simplified
CA_Polygon_Proj2		•
CA_Polygon_Proj3		Naming
CensusUrbAreas		i taining
Connector_Coverage		
County_DemandProp		
CountyBalance_2016Report		
CountyDemand_2016Report		
Coverage_Gap_2017_Web		
CSULA_Only15		
DMV_2016_ByZIP		
Drive_Ratings		
Drive_Ratings_Connector		
Drive_Ratings012717		
Drive_Times		

Drive Times012717

CHIT 2017 Release

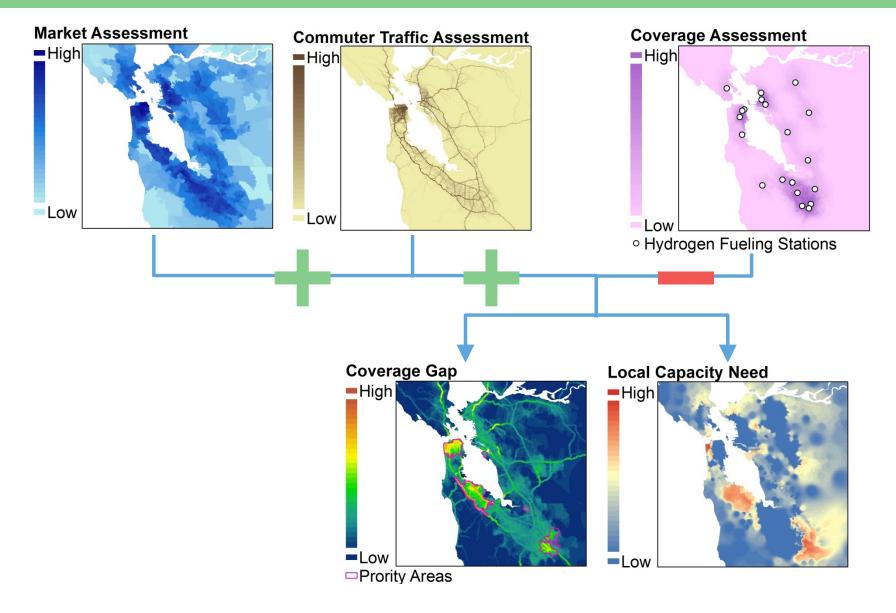
E CHIT2017.gdb TISER_2017 ITN TIGER 2017 ND **ITN_TIGER_2017_ND_Junctions ITN_TIGER_Junctions** ITN_TIGER_Roads Access Factor2017 AddedStation_DrivePolys BlockGroup_15Min BlockGroups_CHIT2017 CA BlockPopulations CA_HexCells CA_HexCells_Cap CA_Poly_Project Consumption SeedPoints Consumption_SeedPoints_Temp County_Survey Coverage_Gap2017 DriveRatings_2017 DriveRatings_PostAddition DriveTimes 2017 Education_Factor2017 Final_Priority HEV_PHEV2017 Hot_Spots Income_Factor2017 Local CapacityNeeds IIII LocalNeedsIDW Luxury_Veh2017 Market_FinalPriorities 🖾 Market Map Market_PriorityAreas MarketHot_Spots MSRP Veh2017 Priority_Areas PriorityArea_Stations Stations_CHIT2017 Test_Join_Temp2017 Test Join2017 Tracts_CHIT2017 Traffic_Intensity_Weighted Traffic_Intensity2017 ZCTA 2017 ZIP_FCEV_Regs

SIMULATED TRAFFIC INTENSITY

Traffic Intensity Changes CHIT Fundamentals

- Principle #6 (2015): Coverage matches the market when it provides convenient fueling access near FCEV drivers' homes
- Principle #6 (2017): Coverage matches the market when it provides convenient fueling access near FCEV drivers' homes and/or within proximity to commonly-traveled routes
- Principle #4 (2015): Identification of the FCEV market can be estimated by consideration of the relative distribution of multiple demographic indicators
- Principle #4 (2017): Identification of the FCEV owner market can be estimated by consideration of the relative distribution of multiple demographic indicators; the total fueling market potential can be estimated by consideration of both the owner market and commonly-traveled routes

CHIT 2017 Release Structure Revised



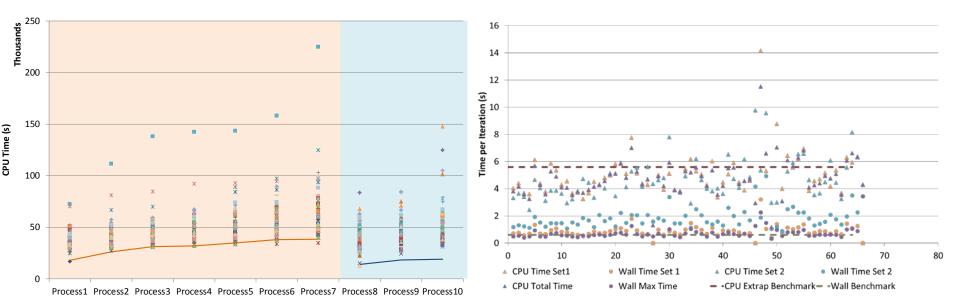
Simulation Concept

- Given a sufficiently-detailed street geometry and travel speed data (provided by ITN-TIGER)...
- Availability of Origin-Destination data for commutes may enable route simulation...
- However, simulated data requires elevated scrutiny compared to observational data
- Major lead: Stakeholder suggestion at October 2015 webinar to look into LODES (LEHD Origin-Destination Employment Statistics) data set

Method

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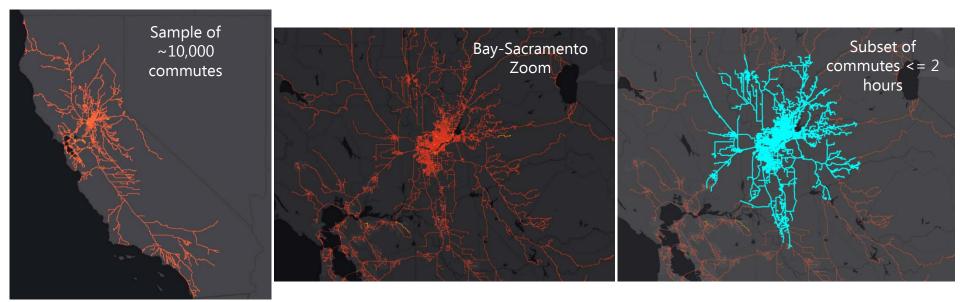
- Step 1: Simulate all entries in the LODES data file
 - Geocode census block centroids and extract x/y to be able to load origins and destinations in Network Analyst
 - Use Network Analyst to simulate PM commute routes of all entries
 - Inherently assumes travel time optimization
 - Large processing effort: ~7.6 million records for ~8.36 million commutes
 - Executed via stand-alone arcpy across 10 processors on 2 computers
 - Batch processed 10,000 routes on each processor at a time: ~6 months



Method

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- Step 2: Combine data from resulting ~760 files
 - Down-select within each file to routes with 2 hours or less drive time
 - Spatially join with analysis grid
 - Keep running total of number of commutes through each cell
 - Smaller computing effort: python script executed in ArcMap
 - Batch processed over ~3 weeks

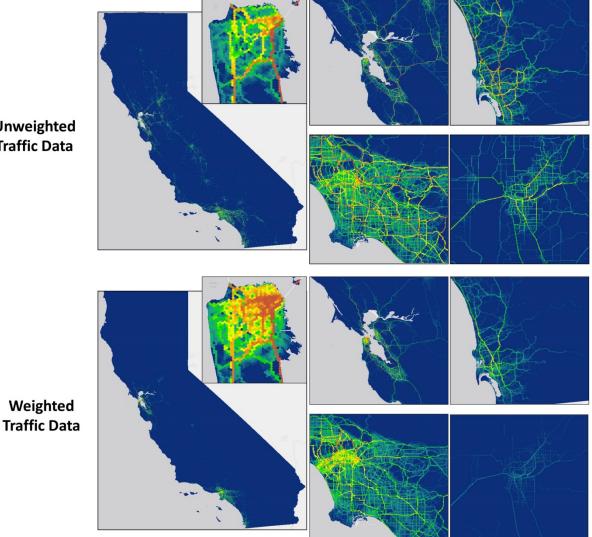


Method

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- Step 2, adjusted: Combine data and weight each drive according to homebased market potenti
 - Concept was suggeste at March webinar and received positive stakeholder feedback
 - Allows traffic data to more selectively reflec FCEV first adopters' lik driving patterns
 - Due to time constraint uses 2015 market assessment
 - Both data sets availab in CHIT 2017 for user implementation

Unweighted **Traffic Data**



Recap of Simulated Data Set

- What the simulated traffic data **DOES** provide:
 - Detailed routing information, based on speed data at fine resolution
 - The <u>optimized</u> travel route for the simulated commuters, given the input speed data
 - A reasonably-sized sample of the full labor force
 - US Bureau of Labor Statistics estimates ~17.6 million in California's employed work force in late 2014
 - An estimate of what the relative commuter traffic intensity <u>might be</u> in different locations throughout the state
 - A unified estimate that is similarly developed for all locations in the state
 - An estimate of traffic volume that is self-consistent with traffic speeds already implemented in CHIT

Recap of Simulated Data Set

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- What the simulated traffic data **DOES NOT** provide:
 - Observed, actual routes of commuters
 - The full commuter travel pattern
 - Travel patterns of non-commuter vehicles
 - Occupational, Medium-Duty, Heavy-Duty, and other vehicles not included
 - The traffic patterns of these vehicles can affect Light-Duty commuter traffic
 - The intricacies and interactions are not accounted for
 - An assessment of commuter travel via public transportation or other modes
 - Any indication of the travel routes specifically utilized by first adopters
 - Exact door-to-door routes

Using Traffic Data

	Traffic Volume Weight
A_HexCells C:\CHIT\CHIT2017.gdb\CA_HexCells	
raffic Volume Map	The weighting to attribute to the drving volume
C:\CHIT\CHIT2017.gdb\Traffic_Intensity2017	(equivalently traffic intensity) factor. For proper results, this should be a value between 0 and 1
raffic Volume Weight	results, this should be a value between 0 and 1. Correspondingly, the weighting factor for the overall
and found weight	0.2 market score will be automatically taken as 1 minus
ccess Factor Map	this value.
C:\CHIT\CHIT2017.gdb\Access_Factor2017	
ccess Weight	
	0.1
overage Factor Map	
C:\CHIT\CHIT2017.gdb\DriveRatings_2017	
o Coverage Value	2
nancial Weight	
······································	0.5
come Factor Map	
C:\CHIT\CHIT2017.gdb\Income_Factor2017	
ncome Weight	
	0.34
JXUry Vehide Factor Map C:\CHIT\CHIT2017.gdb\Luxury_Veh2017	
uxury Vehide Weight	
oxory venice weight	0.33
SRP Factor Map	
C:\CHIT\CHIT2017.gdb\MSRP_Veh2017	
SRP Weight	
	0.33
ducation Factor Map	
C:\CHIT\CHIT2017.gdb\Education_Factor2017	
ducation Weight	0.2
reen Vehide Market Map	
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reen Vehide Weight	
	0.3
eat Map	
C:\CHIT\CHIT2017.gdb\Coverage_Gap2017	

CHIT_Tools2017 Add Station and Re-Evaluate Determine Drive Overlaps(2017) Determine Station Counts by Capacity Filter Priorities by Area Finalize Priorities Generate Coverage Factor(2017) 🞾 Generate Heat Map 蹄 Generate Heat Map (2017Options) Generate Heat Map with Traffic Local Capacity Estimation Step 1 Local Capacity Estimation Step 2 💐 Prioritize Heat Map Areas Step 1 Prioritize Heat Map Areas Step 2 눡 Re-Tune Coverage Gap Reorder Priorities Statistical Hot Spots

Traffic data implementation available in fully revised Heat Map tool (2017 Options). Also available as only additional data option (Heat Map with Traffic) to avoid additional processing time for all options in fully revised tool.

Revised CHIT Coverage Gap Equation

• CHIT 2015:

Heat = Coverage * Market • CHIT 2017 w/ Traffic:

Heat= Coverage * (0.8 * Market + 0.2 * Traffic Volume)

Coverage= 0.5 * Existing + 0.5 * Potential

Market= 0.5 * Financial + 0.3 * P/HEV + 0.2 * Education

Financial= 0.34 * Income + 0.33 * MSRP + 0.33 * Luxury Coverage= 0.9 * Existing + 0.1 * Potential

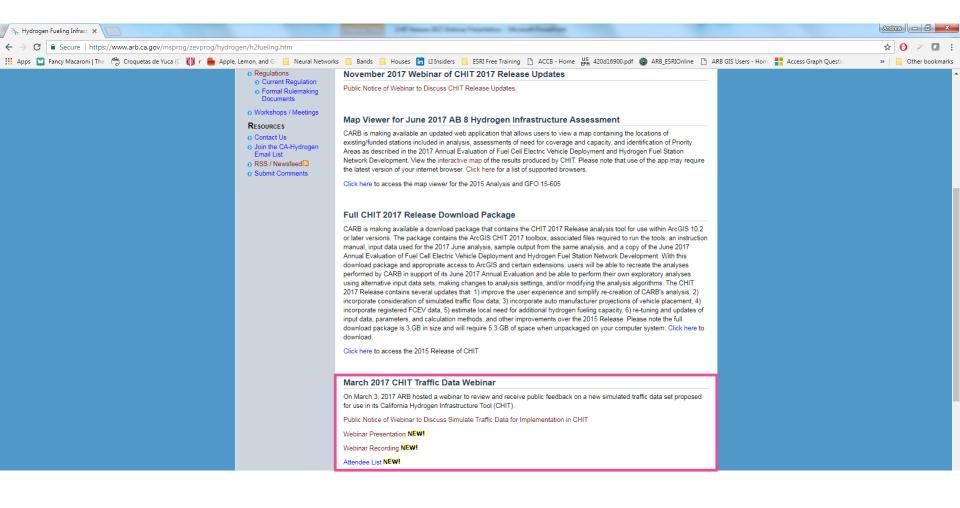
Market= 0.5 * Financial + 0.3 * P/HEV + 0.2 * Education

Financial= 0.34 * Income + 0.33 * MSRP + 0.33 * Luxury

CHIT Traffic Webinar

• For more information, see:

https://www.arb.ca.gov/msprog/zevprog/hydrogen/h2fueling.htm

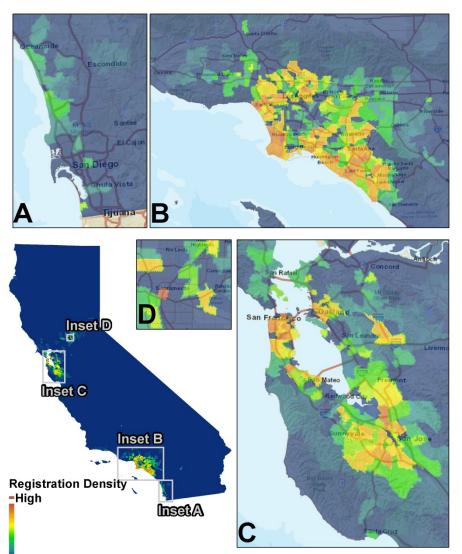


AUTO MANUFACTURER SURVEY AND DMV DATA

Concepts and Motivations

- DMV Registration Data
 - Historically, CHIT and other tools have been intended to analyze forecasted needs for hydrogen fueling
 - No empirical data previously available for existing gaps (other than caseby-case and anecdotal data)
 - As California's network continues to develop, assessment of gaps will need to move away from forecasts and estimates of market potential to empirically-proven market development
- Auto Manufacturer Data
 - CHIT relies on open, public data sets for forecasting and estimating FCEV market potential
 - Input data elements are limited and likely provide only a portion of the full picture
 - Auto manufacturer survey data is a second, independent assessment and may more closely represent direct FCEV intender market

DMV Registration Data Input

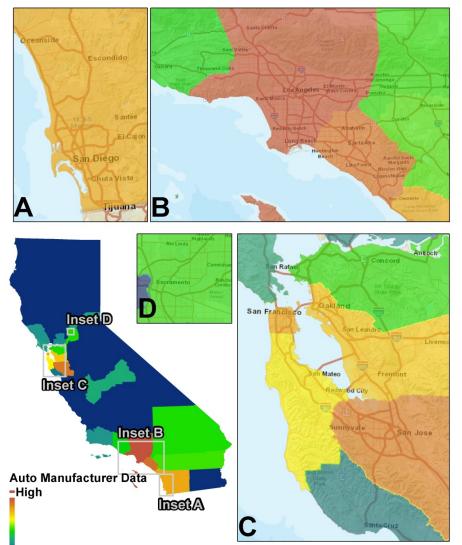


 Based on April 2017 registration data reported in the 2017 Annual Evaluation

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- Similar to other market indicators, use spatial densities of vehicle deployments on a ZIPcode basis (count/sq mi)
- Total of 1,609 FCEVs throughout the state
- Applied to market evaluation portion of coverage gap as an additive factor with other indicators

Auto Manufacturer Data Input



 Based on April 2017 auto manufacturer survey data, administered under the AB 8 program and reported in the 2017 Annual Evaluation

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- Spatial resolution is limited by the format of the survey (county-level)
- Due to low spatial resolution, data are not considered on an area density basis
- Applied as overall scaling factor to market evaluation

Using FCEV Deployment Data

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Generate Heat Map (2017Options)			
C:\CHIT\CHIT2017.gdb\DriveRatings_2017		Auto Manufacturer Splits	
No Coverage Value		A feature class representing direct auto manufacture	
man shunda	2	indications of preference for market locations. In the	
Financial Weight	0.5	context of AB 8, this is developed directly from the	
Income Factor Map		aggregate responses of the auto manufacturers to the Air Resources Board's annual survey of projected	
C:\CHIT\CHIT2017.gdb\Income_Factor2017		future ZEV deployment. Data are collected on a	
Income Weight		county basis in this survey. Must have a field named	
	0.34	SurveyProp of type double.	
Luxury Vehicle Factor Map			
C:\CHIT\CHIT2017.gdb\Luxury_Veh2017			
Luxury Vehicle Weight			
	0.33		
MSRP Factor Map C:\CHIT\CHIT2017.gdb\MSRP_Veh2017			
MSRP Weight	0.33		
Education Factor Map			
C:\CHIT\CHIT2017.gdb\Education_Factor2017			
Education Weight			
	0.2		
Green Vehicle Market Map			
C:\CHIT\CHIT2017.gdb\HEV_PHEV2017			
Green Vehicle Weight			
	0.3		
Auto Manufacturer Splits ::\CHIT\CHIT2017.gdb\County_Survey			
FCEV Registrations C:\CHIT\CHIT2017.qdb\ZIP FCEV Regs	🔁 📗		
Registered FCEV Weight			
Registered PCEV weight	0.1		
Heat Map			
C:\CHIT\CHIT2017.gdb\Coverage_Gap2017			
Include DEM Survey Weighting			
	T		

💱 CHIT_Tools2017
Add Station and Re-Evaluate
🔤 Determine Drive Overlaps(2017)
Determine Station Counts by Capacity
🔤 Filter Priorities by Area
🔤 Finalize Priorities
🔤 Generate Coverage Factor(2017)
🔤 Generate Heat Map
🔤 Generate Heat Map (2017Options)
🔤 Generate Heat Map with Traffic
🔤 Local Capacity Estimation Step 1
Local Capacity Estimation Step 2
💐 Prioritize Heat Map Areas Step 1
🔤 Prioritize Heat Map Areas Step 2
🔤 Re-Tune Coverage Gap
🔤 Reorder Priorities
🔤 Statistical Hot Spots

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DMV and auto manufacturer implementation available in fully revised Heat Map tool (2017 Options).

Auto manufacturer data implemented as a switch (see next slide).

Revised CHIT Coverage Gap Equation

• CHIT 2015:

Coverage Gap = Coverage * Market

Coverage= 0.5 * Existing + 0.5 * Potential

Market= 0.5 * Financial + 0.3 * P/HEV + 0.2 * Education

Financial= 0.34 * Income + 0.33 * MSRP + 0.33 * Luxury

```
    CHIT 2017 w/ all Optional Data:
Coverage Gap= Coverage *
(0.8 * Market +
0.2 * Traffic Volume)
```

Coverage= 0.9 * Existing + 0.1 * Potential

Market= 0.9 * (0.5 * Financial + 0.3 * P/HEV + 0.2 * Education) + 0.1 * DMV Regs

or (if Auto Data Switch Set):

Market= (0.9 * (0.5 * Financial + 0.3 * P/HEV + 0.2 * Education) + 0.1 * DMV Regs) * Auto Data

Financial= 0.34 * Income + 0.33 * MSRP + 0.33 * Luxury

COVERAGE GAP RE-TUNING

Motivation

- CHIT 2017 Release expands the possible options for input data considered, all associated with individual weighting factors
- CHIT users may be interested in sensitivity analyses to assess the appropriate weighting factor for each input data set
- Full coverage gap calculation hours long because of aligning and joining of several data inputs
- However, for a re-calculation, do not need to perform spatial aligning if base data sets remain the same
- New tool takes advantage of this to complete a coverage gap reassessment in a short period

Using Re-Tuning Tool

눧 Re-Tune Coverage Gap

Base Coverage Gap		Re-Tune Coverage
C:\CHIT\CHIT2017.gdb\Coverage_Gap2017		De trans the land serve
Traffic Volume Weight		Re-tunes the input para map of localized desirat
	0.5	refueling station(s). The
Access Weight		data spatial alignment c
	0.2	the Generate Heat Map
No Coverage Value		can only be used with a
	1	generated with 2017 Op Heat Map tool.
Financial Weight		rieat Map tool.
	0.5	This tool is provided for
Income Weight		coverage gap with new i
	0.34	tool requires a base cov
Luxury Vehicle Weight		previously been calculat
	0.33	values for all input data.
MSRP Weight	0.00	to investigate different w (and not investigate alte
	0.33	can be used to guickly
Education Weight	0.2	under the assumption o
	0.2	values.
Green Vehicle Weight	0.3	
	0.5	If the base coverage ga
Registered FCEV Weight	0.1	at the same time this to
	0.1	neccessary to reclassif HeatScore CxM after the
Include OEM Survey Weighting		properly visualize the ne
		As a reminder, the cove
		the following set of equa
		HeatScore= CoverageS v*Drive Volume Score)
		y Drive Volume Score)
		Financial= f*Income + c
		MSRP
		If b (Access Weight) is
		than 0:
		CoverageScore= a*Exis
	T	ObviciageOcole= a Exis

e Gap

mater weighting for a heat ility/need for new hydrogen tool takes advantage of the ompleted by a previous run of (2017 Options) tool. This tool base coverage gap map ions version of the Generate

- - -

quick re-calculation of nput factor weightings. The erage gap map that has ed with a set of weighting For users who simply want eightings on input factors rnative data sets), this tool e-calculate the coverage gap a revised set of weighting

map is displayed in arcmap ol is run, it may be the visualization of ne tool completes in order to w results.

rage gap is represented by tions:

core * (x*Market Score +

*Luxury Vehicles + h*Vehicle

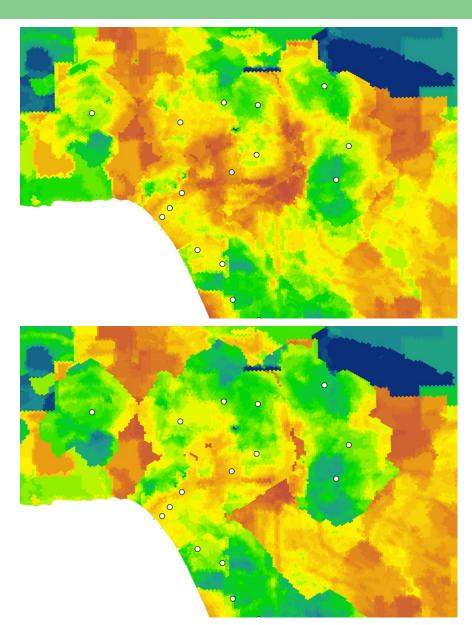
set to any value other

ting Coverage + b*Potential

🐚 CHIT Tools2017 Add Station and Re-Evaluate Determine Drive Overlaps(2017) Determine Station Counts by Capacity Filter Priorities by Area Finalize Priorities Generate Coverage Factor(2017) 🞾 Generate Heat Map Generate Heat Map (2017Options) Generate Heat Map with Traffic Local Capacity Estimation Step 1 Local Capacity Estimation Step 2 Prioritize Heat Map Areas Step 1 Prioritize Heat Map Areas Step 2 🞾 Re-Tune Coverage Gap Reorder Priorities Statistical Hot Spots

NOTES:

- Base Coverage Map must be developed only with the Generate Heat Map (2017 Options) tool (or the Re-Tuning tool beginning with such a map)
- The No Coverage Value parameter is defined *relative* to the value used to calculate the Base Coverage Map
- This tool modifies the Base Coverage Map file. It does not generate a new feature class; users should backup the Base Coverage Map if it is desirable to keep the base map



Example of Retuning

- Example shows Coverage Gap as calculated in 2017 Annual Evaluation in West LA region in top figure
- Bottom figure shows effect of quadrupling the priority placed on areas with no coverage provided at all (by setting the No Coverage Value in the Re-Tuning Tool to 4)
- White dots indicate locations of funded stations

Example of Retuning

Re-Tune Coverage Gap	×
Completed	
<< Detail	ils
Close this dialog when completed successfully	
0.2 0.3 0.1 false Start Time: Tue Oct 17 16:05:11 2017 Executing (Calculate Field): CalculateField C:\CHIT\CHIT_Scratch.gdb\Coverage_Gap2017Backup HeatScore_CxM calcgap(0.1, !Rel_Score_DT!, !Rel_Score_AC!, 0.2, 0.5, 0.33, !Rel_Score_DV!, 0.34, !Rel_Score_Inc!, 0.33, ! Rel_Score_MSRP!, 0.2, !Rel_Score_Ed!, 0.3, !Rel_Score_GV!, !Rel_Score_DV!, 0.1, !Rel_Score_Reg!, ! Rel_Score_OEM!, "false", 4) PTHON "def calcgap (b,Cov,Acc,q,x,w,Lux,u,Inc,v,MSRP,z,Ed,y,GV,Vol,t,Reg,OEM,OEMswitch,NCV):\n Financial= u*Inc + v*MSRP + w*Lux \n if NCV!=1:\n if Cov==1:\n Cov=Cov/n else:\n Cov=Cov/NCV\n if b == 0:\n Coverage= Cov\n else:\n Coverage= (1.0-b)*Cov+b*Acc\n if OEMswitch:\n Market= ((x*Financial + y*GV+z*Ed)*(1.0-t)+t*Reg)* (OEM+0.1)\n else:\n Market=(x*Financial+y*GV+z*Ed)*(1.0-t)+t*Reg\n if b == 0:\n Market = Market * Acc\n CovGap= Coverage*((1.0-q)*Market=q*Vol) \n return CovGap" Start Time: Tue Oct 17 16:D5:11 2017 Succeeded at Tue Oct 17 16:D5:11 2017 Succeeded at Tue Oct 17 16:11:36 2017 (Elapsed Time: 6 minutes 25 seconds) Executing (Summary Statistics (11)): Statistics C:\CHIT\CHIT_Scratch.gdb\Coverage_Gap2017Backup C:\Users \amartine\Documents\ArcGIS\Default.gdb\Coverage_Gap2017_Statistics "HeatScore_CxM MAX" # Start Time: Tue Oct 17 16:11:36 2017 Succeeded at Tue Oct 17 16:12:24 2017 (Elapsed Time: 47.65 seconds) Executing (Get Field Value (11)): GetFieldValue C:\Users\amartine\Documents\ArcGIS\Default.gdb\Coverage_Gap2017 Statistics MAX_HeatScore_CXM String 0 Start Time: Tue Oct 17 16:12:24 2017	
Succeeded at Tue Oct 17 16:12:24 2017 (Elapsed Time: 0.06 seconds) Executing (Calculate Field (12)): CalculateField C:\CHIT\CHIT_Scratch.gdb\Coverage_Gap2017Backup HeatScore_CxM !HeatScore CxM!/0.162864255729808 PYTHON #	
Start Time: Tue Oct 17 16:12:24 2017 Succeeded at Tue Oct 17 16:16:31 2017 (Flansed Time: 4 minutes 7 seconds)	
Succeeded at Tue Oct 17 16:16:32 2017 (Elapsed Time: 11 minutes 20 seconds)	

SINGLE STATION RE-EVALUATION

Motivation

- First developed as a tool to quickly implement iterative evaluation process of GFO-15-605
 - GFO-15-605 first solicitation where the "network effect" of each proposed award explicitly evaluated
 - After a station award selected, CHIT data (coverage gap and capacity need) adjusted to account for impact of that station
 - All stations' Coverage, Capacity, and Market Viability scores reconsidered on the basis of this updated analysis
 - Repeated for every award in NOPA-15-605 (each iteration referred to in NOPA as a "CHIT Round")
- Full coverage gap calculation hours long because of aligning and joining of several data inputs
- However, for a re-calculation, do not need to perform spatial aligning if calculation inputs known
- New tool takes advantage of this to complete a coverage gap re-assessment in roughly 20 minutes

Using Coverage Re-Evaluation

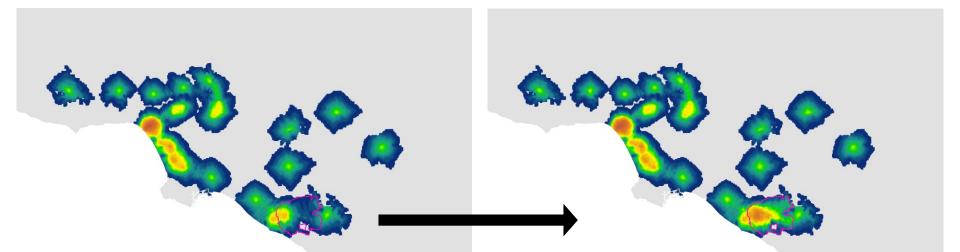
Add Station and Re-Evaluate This tool has been generated as part of the GFO-15- Go evaluation process to speed up iterative calculation of the network effect of proposed station awards. The intent is to be able to quickly calculate rew Drive Polygons C:\CHIT\CHIT2017.gdb\DriveRatings_2017 Im Score Add Station and Re-Evaluate This tool has been generated as part of the GFO-15- Go evaluation process to speed up iterative calculation of the network effect of proposed station awards. The intent is to be able to quickly calculate rew Location Values (HeatScore_CXM in the output feature class) for the entire state, accounting for the addition of a single station into the state's funding network. This entails re-calculating the Coverage provided by the funded (and 1 proposed) stations. To do so requires unpacking the previously-calculated coverage for the base network, identifying cells affected by the new station's addition, re-calculating the entire state's coverage values, and re-calculating the entire state's coverage values, and re-calculating the entire state's coverage values, and re-calculating the final Location Value. In order to use this tool, users must first generate the 1, 3, 6, 9, 12, and 15-	 Add Station and Re-Evaluate Determine Drive Overlaps(2017) Determine Station Counts by Capacity Filter Priorities by Area Finalize Priorities Generate Coverage Factor(2017) Generate Heat Map
Base Heat Map [C:\CHIT\CHIT2017.gdb\Coverage_Gap2017 Base Drive Ratings C:\CHIT\CHIT2017.gdb\DriveRatings_2017 New Drive Polygons [C:\CHIT\CHIT2017.gdb\AddedStation_DrivePolys 1 Min Score 6 Min Score 6 Min Score 9 Min Score	 Determine Drive Overlaps(2017) Determine Station Counts by Capacity Filter Priorities by Area Finalize Priorities Generate Coverage Factor(2017)
Image: Drive Ratings 605 evaluation process to speed up iterative calculation process to speed up iterative calculation of the network effect of proposed station. New Drive Polygons Image: Drive Polygons [C:\CHIT\CHIT2017.gdb\AddedStation_DrivePolys Image: DrivePolygon 1Min Score 6 3Min Score 6 6Min Score 6 6Min Score 5 6Min Score 5 9Min Score 4 9Min Score 4 9Min Score 4	 Determine Station Counts by Capacity Filter Priorities by Area Finalize Priorities Generate Coverage Factor(2017)
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New Drive Polygons new Location Values (HeatScore_CxVI in the output feature class) for the entire state, accounting for the addition of a single staiton into the state's funding network. This entails re-calculating the Coverage provided by the funded (and 1 proposed) stations. To do so requires unpacking the previously-calculated coverage for the base network, identifying cells affected by the new station's addition, re-calculating raw coverage scores for those cells, re-normalizing the final Location Value. In order to use this tool,	 Filter Priorities by Area Finalize Priorities Generate Coverage Factor(2017)
Inter Orygons Image: Second Secon	Finalize Priorities Generate Coverage Factor(2017)
1 Min Score network. This entails re-calculating the Coverage rovided by the funded (and 1 proposed) stations. To do so requires unpacking the previously-calculated coverage for the base network, identifying cells affected by the new station's addition, re-calculating raw coverage scores for those cells, re-normalizing the entire state's coverage values, and re-calculating the other state's coverage values, and re-calculating the fund Location Value. In order to use this tool,	Finalize Priorities Generate Coverage Factor(2017)
6 provided by the funded (and 1 proposed) stations. To do so requires unpacking the previously-calculated coverage for the base network, identifying cells affected by the new station's addition, re-calculating raw coverage scores for those cells, re-normalizing the final Location Value. In order to use this tool, the final Location Value. In order	🔤 Generate Coverage Factor(2017)
3 Min Score do so requires unpacking the previously-calculated coverage for the base network, identifying cells affected by the new station's addition, re-calculating raw coverage scores for those cells, re-normalizing the final Location Value. In order to use this tool,	🔤 Generate Coverage Factor(2017)
Min Score affected by the new station's addition, re-calculating raw coverage scores for those cells, re-normalizing the entire state's coverage values, and re-calculating the final Location Value. In order to use this tool,	-
Min Score 4 PAIn Score 4 This Score 4	-
e Min Score the entire state is coverage values, and re-calculating the final Location Value. In order to use this tool,	P Generate Heat Map
2 Min Score minute drive time polygons for the additional station through the use of the Network Analyst Service Area	🔤 Generate Heat Map (2017Options)
15 Min Score functionality. For a guide to this process, see the	🗫 Generate Heat Map with Traffic
1 CHIT Users Guide.	Pre Generate Heat Map with Traffic
No Coverage Value NOTES:	Local Capacity Estimation Step 1
2	2 Local Capacity Estimation Step 1
Access Weight 0.1 1. In case of processing error, it is suggested	Local Capacity Estimation Step 2
Dutput Heat Map files utilized in this tool.	
C:\CHIT\CHIT2017.gdb\Heat_PostAddition	💐 Prioritize Heat Map Areas Step 1
Output DriveRating Location 2. For proper execution, it is important to use the same variable values in this tool as were	
used in the generation of the base heat map	蹄 Prioritize Heat Map Areas Step 2
Output DriveRating Filename It is recommended that the user maintain	
DriveRatings_PostAddition appropriate documentation of variable values in any CHIT evaluations.	🔤 Re-Tune Coverage Gap
3. This tool ONLY addresses re-evaluation of	🔤 Reorder Priorities
OK Cancel Environments << Hide Help Tool Help	🔤 Statistical Hot Spots

NOTES:

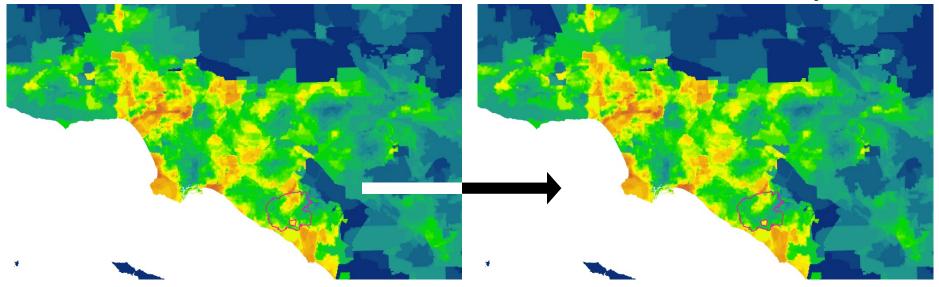
- Must first complete a Service Area calculation for the new station placement
- Able to recalculate Coverage Gap map generated with any version of Generate Heat Map
- Does not make any adjustment to market side of evaluation
- Does not re-calculate capacity need
- Faster than full Generate Heat Map process for a single station
- Can be used iteratively for multiple stations though after ~15 stations, this tool is slower

Coverage Re-Evaluation Example

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Final GFO 15-605 CHIT Round: Evaluation after Addition of 5333 University Dr (Irvine)



ALTERNATIVE COVERAGE GAP FORMULA

Motivation

- Through the exercise of the iterative evaluation in GFO-15-605, CARB noted that coverage gap was more heavily controlled by population density (captured in the "Potential" Coverage data factor) than initially desired
- CARB performed sensitivity analysis and determined that the weight attributed to this factor (previously 0.5 in CHIT 2015 Release) needed to be exceedingly small in order for population density not to be the most important factor in coverage gap evaluations
- CARB proposed that another solution was to re-cast the "Potential" Coverage factor as a scaling factor on market evaluation rather than as an additive factor in the coverage evaluation

```
Alternative CHIT Coverage Gap Equation

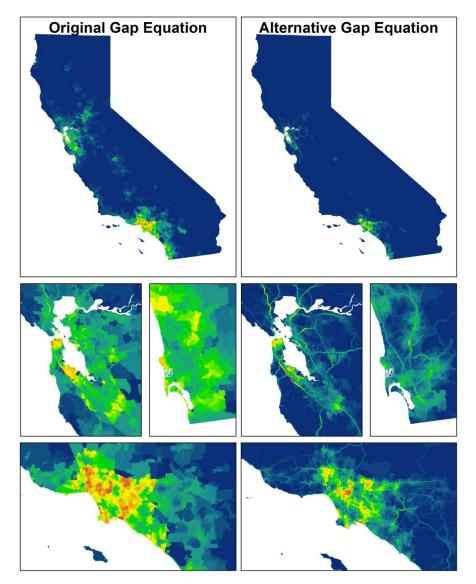
    CHIT 2017 w/ all Optional Data:

    CHIT 2017 Alternative:

Coverage Gap= Coverage *
                                       Coverage Gap= Coverage *
       (0.8 * Market +
                                              (0.8 * Market +
       0.2 * Traffic Volume)
                                              0.2 * Traffic Volume)
Coverage= 0.9 * Existing +
                                      Coverage= Existing
           0.1 * Potential
                                       Market= (0.9 * (0.5 * Financial +
Market= (0.9 * (0.5 * Financial +
          0.3 * P/HEV + 0.2 *
                                                0.3 * P/HEV + 0.2 *
                                                 Education) + 0.1 *
          Education) + 0.1 *
                                                 DMV Regs) *
          DMV Regs) * Auto Data
                                                 Auto Data * Potential
Financial = 0.34 \times \text{Income} + 0.33 \times \text{Income}
                                       Financial = 0.34 * Income + 0.33*
          MSRP + 0.33 * Luxury
```

MSRP + 0.33 * Luxury

Using Alternative Coverage Gap Formulation



 Can be implemented in Coverage Gap calculation tools (including Re-Tune Coverage Gap) by setting the weight for the Potential Coverage (called "Access Factor" in the tools) to 0

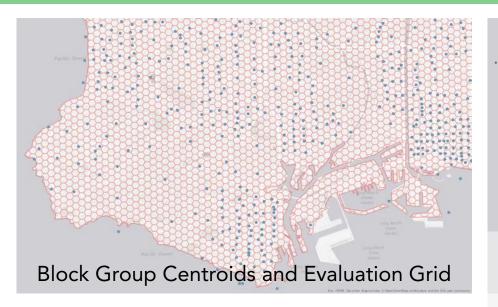
- With all other factor weights left unchanged, CARB found that results were too spatially limited
- 2017 Annual Evaluation does not use this formulation but will continue to be investigated at CARB and provided in tool for stakeholder investigation

LOCAL CAPACITY NEED

Motivation

- First created to aide decision-making process for GFO 15-605
- Estimates localized capacity need based on auto manufacturer survey data and extent of coverage provided by funded stations
- Capacity need is a localized, continuous value across the state
 - The total of all cells is much larger than the total need for the assumed number of vehicles
 - Interpolation step adds spatial variation according to distance from stations, even outside range of a station's coverage

Capacity Need Estimation Process



In Each Cell, Identify Market Evaluation and Collect Number of Households

Number of Vehicles Assigned According to Normalized Evaluation of Weighted Sum of Market (60%) and Households (40%)

Market Evaluation

15-Minute Drive Times Calculated Around All Centroids

Select Grid Cells within all 15-Minute Polygons as Market to Spread Vehicles Across



Sum of Capacities of Stations in Extent Collected and Assigned to Point

Rancho Palos Verdes: 180 kg/day

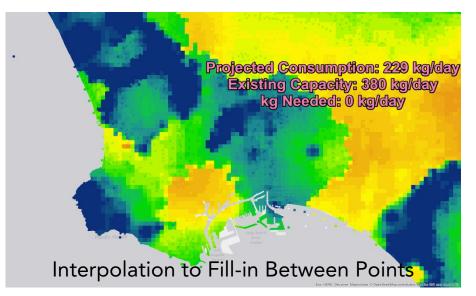
Huntington Beach: 310 kg/day

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Nearby Station Coverage

Capacity Need Estimation Process





 Interpolation relies on built-in ArcGIS methods

- Process has been divided into two steps to allow tuning of interpolation
- Interested users can explore impacts of re-tuning the interpolation after Step 1
 - Requires access to Geostatistical Analyst Extension
 - Users without this access can either accept defaults or iteratively use trial-and-error in Step 2
 - Step 2 interpolation has been built assuming only Inverse Distance Weighting (IDW) interpolation method

Using Local Capacity Estimation

- • • ×

Pa Local Capacity Estimation Step 1	
Consumption Area Gridded	Local Capacity Estimation Step 1
C:\CHIT\CHIT2017.gdb\CA_HexCells_Cap	
Block Populations	This tool is meant to be used as part of a 4-step
C:\CHIT\CHIT2017.gdb\CA_BlockPopulations	process with separate data exploration and a complementary CHIT tool. The process
FCEV Market Estimate	suggested is:
C:\CHIT\CHIT2017.gdb\Market_Map	
Existing and Funded Hydrogen Stations	1. Create a copy of
C:\CHIT\CHIT2017.gdb\Stations_CHIT2017	Consumption_SeedPoints to be implemented as a working copy in this
Consumption Seed Points	process.
C:\CHIT\CHIT2017.gdb\Consumption_SeedPoints	
Consumption Polygons	2. Run Local Capacity Estimation Step 1.
C:\CHIT\CHIT2017.gdb\BlockGroup_15Min	
FCEV Population	Use ArcGIS' Geostatistical Wizard option to explore the spatial distribution of the
37400	kgNeed field and determine an
*	appropriate power for use in IDW interpolation. (For users with access to
OK Cancel Environments	Tool Help

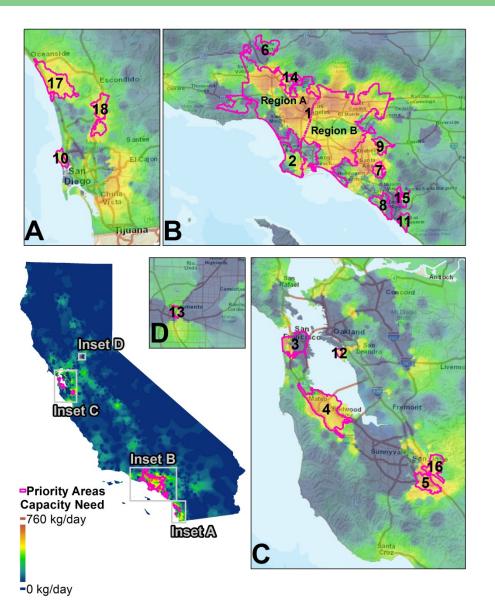
Dea Local Capacity Estimation Step 2	
Click error and warning icons for more information	Local Capacity Estimation Step 2
Updated Consumption Seed Points C:\CHIT\CHIT2017.gdb\Consumption_SeedPoints	This tool is meant to be used as part of a 4-step process with separate data exploration and a
State Polygon C:\CHIT\CHIT2017.gdb\CA_Poly_Project	complementary CHIT tool. The process suggested is:
FCEV Population 37400	1. Create a copy of
IDW Power 4.90815160298557	Consumption_SeedPoints to be implemented as a working copy in this process.
Capacity Needs Output	P
C:\CHIT\CHIT2017.gdb\Local_CapacityNeeds	2. Run Local Capacity Estimation Step 1.
-	3. Use ArcGIS' Geostatistical Wizard option to explore the spatial distribution of the kgNeed field and determine an appropriate power for use in IDW interpolation.
OK Cancel Environments << Hide Help	Tool Help

🐚 CHIT Tools2017 Add Station and Re-Evaluate Determine Drive Overlaps(2017) Determine Station Counts by Capacity Filter Priorities by Area Finalize Priorities Generate Coverage Factor(2017) 눡 Generate Heat Map Generate Heat Map (2017Options) Generate Heat Map with Traffic Local Capacity Estimation Step 1 Local Capacity Estimation Step 2 Prioritize Heat Map Areas Step 1 Prioritize Heat Map Areas Step 2 눧 Re-Tune Coverage Gap Reorder Priorities Statistical Hot Spots

Using Local Capacity Estimation

- Local Capacity Estimation Step 1 overwrites the Consumption_SeedPoints feature class with new calculated data
- CARB recommends maintaining a clean copy of Consumption_SeedPoints_Temp as a convenient backup of the initialized feature class so it can be used to re-initialize after previous evaluations
- Local Capacity Estimation Step 2 requires the modified Consumption_SeedPoints output of Step 1
- 15-minute drive time polygons and consumption seed points provided in CHIT2017 have synched data fields for matching
 - Necessary for processing steps to associate "captured" demand with each consumption seed point
 - CHIT Users' Guide v2 provides guidance for users to create their own files in case they wish to use their own set of consumption seed points
- See CHIT Users' Guide v2 for important notes on processing settings for stable execution

Localized Capacity Need in CHIT 2017



 Provides direct calculation of capacity metric as separate from coverage metric referenced in AB 8 and other efforts

- Coverage and capacity similar and related, but can be very different locally
- Spotty appearance (especially in low-need areas) by-product of interpolation method

A Note on Priority Area Capacity Needs

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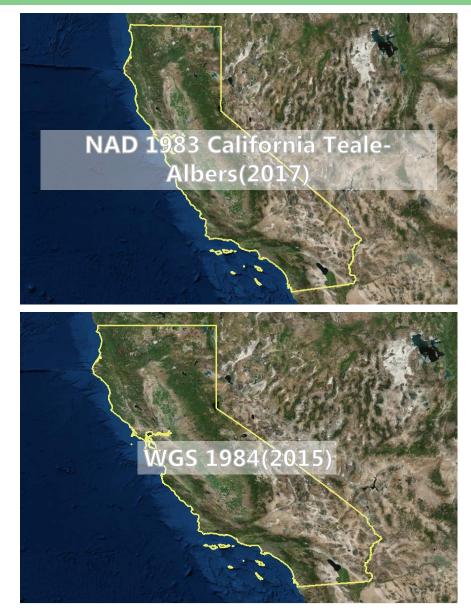
			🖃 🖏 CHIT_Tools2017
Pre Determine Station Counts by Capacity			Add Station and Re-Evaluate
Click error and warning icons for more information	× ^	Determine Station Counts by Capacity	Determine Drive Overlaps(2017)
Priority Areas C:\CHIT\CHIT2017.gdb\Final_Priority Full Market Priority Areas C:\CHIT\CHIT2017.gdb\Warket_FinalPriorities Market Heat Map C:\CHIT\CHIT2017.gdb\Warket_Map Existing Station Locations C:\CHIT\CHIT2017.gdb\Stations_CHIT2017 Drive Time Polygons C:\CHIT\CHIT2017.gdb\CA_BlockPopulations Maximum Drive Inclusion Heat Weight Projected Vehicle Count Average Daily Hydrogen Consumption Station Size Station Size Station Counts Projection C:\CHIT\CHIT2017.gdb\PriorityArea_Stations	 ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓	Utilized finalized Heat Map Priorities, drive time analysis, user-supplied vehicle volume estimate, population, and tunable parameter inputs to provide an estimate of the number of hydrogen fueling stations needed in each area to support the estimated vehicle population. MAJOR NOTE: ArcGIS appears to have stability issues with the number of spatial joins completed this process. If you are having trouble with getting ArcGIS to complete this model without crashing, y may need to restart your computer. You may also attempt running the model in ArcCatalog, if attemp in ArcMap continue to fail.	 Determine Station Counts by Capacity Filter Priorities by Area Finalize Priorities Generate Coverage Factor(2017) Generate Heat Map Generate Heat Map (2017Options) Generate Heat Map with Traffic Local Capacity Estimation Step 1 Local Capacity Estimation Step 1 Local Capacity Estimation Step 1 Prioritize Heat Map Areas Step 1 Prioritize Heat Map Areas Step 2 Re-Tune Coverage Gap
	K Cancel Environments << Hide Help	Tool Help	Reorder Priorities Statistical Hot Spots

NOTES:

- CHIT 2015 Release included a tool for determining the number of stations (based on user-provided station capacity and FCEV deployment assumptions) needed in Priority Areas
- The tool's main purpose is to determine number of stations needed in each Priority Area
- The tool's math DOES preserve total capacity need for a given FCEV deployment volume
- An updated version of this tool is still available in CHIT 2017 Release
- The Priority Area needs and Local Capacity tools have similar characteristics but are fundamentally different in intended use and interpretation

EVALUATION GRID UPDATE

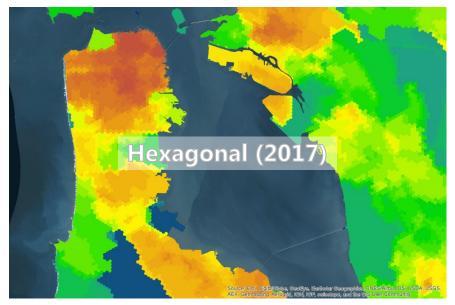
Standardized Coordinate System

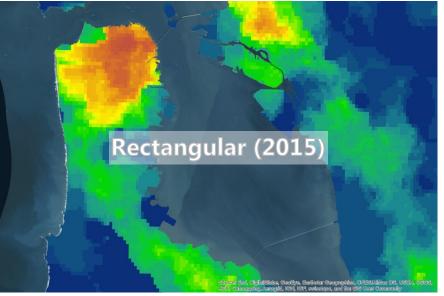


- Part of CARB-wide effort to standardize GIS data products
- Agreed-upon agency-wide coordinate system is Projected State-Based NAD 1983 California Teale-Albers (CARB has implemented the 2011 update for CHIT 2017 Release)

- Effect should be transparent to majority of users
- ArcGIS has extensive routines and methods to automatically manage combining data sets with varying coordinate systems
- CHIT 2017 Release default data all provided in this coordinate system, but can still be used with data in other coordinate systems

Hexagonal Analysis Grid





• New analysis grid implemented in CHIT 2017 Release

- Analysis grid is basis of geometries used to aggregate spatial distribution of underlying data inputs
- Modern GIS pursuits and tools have recognized several benefits of a hexagonal grid compared to a rectangular grid (see CHIT Users Guide v2 for discussion)
- Hexagonal grids' largest disadvantage to a CHIT user is increased number of vertices, which translates to increased calculation load in GIS systems

DEMOGRAPHIC DATA UPDATES AND CVRP

CHIT Demographic Principles

- Principle #3: CHIT assesses only the first adopter market
- Principle #4: Identification of the FCEV owner market can be estimated by consideration of the relative distribution of multiple demographic indicators; the total fueling market potential can be estimated by consideration of both the owner market and commonly-traveled routes
- Demographic-based indicators used in CHIT:
 - Household income
 - Rates of graduate degree attainment
 - Past green vehicle adoption rates (PHEV/HEV)
 - Past luxury vehicle brand adoption rates
- Income, Education from US Census Bureau's American Community Survey. Updated to latest available for CHIT 2017.
- Vehicle adoption data from DMV historical records. Luxury vehicles updated to trends for last 5 years. Green vehicle data (PHEV rates in first adopter period) now completely specified in CHIT 2017.

Motivation

- Fundamental principles and selection of data inputs for market evaluation based on assumptions, expectations, and prior research of indicators for likelihood of FCEV adoption
 - Many of these indicators are more general for "green" or "new" technology adoption overall
 - California, among other jurisdictions worldwide, is one of the first places where factors indicating likelihood of adoption can be empirically evaluated
- The Clean Vehicle Rebate Project (CVRP) includes optional surveys for FCEV purchases to provide feedback to CARB
 - A purchase decision survey is currently the only active survey
 - Follow-on surveys are in development and will be offered for ongoing input from FCEV adopters

Purchase Motivations

Reducing Vehicle styling, finish and comfort Purchase Decision Vehicle performance Factors environmental Convenience/speed of vehicle refueling Increased energy independence impacts #1 Other Saving money on fuel costs purchase A desire for the newest technology Saving money overall motivator Carpool or High Occupancy Vehicle (HOV) lane access Reducing environmental impacts 0 10 20 30 Percent FCEV chosen Vehicle Other Alt Fuel Technologies with Diesel Considered Gasoline significant CNG amount of FCEV technology BEV PHEV cross-HEV shopping 0 10 20 30 Percent

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Vehicle Type

Demographics

•CHIT uses demographic indicators of income and education attainment

•Survey responses seem in line with educational factor use

 Income considered by CHIT may be higher than responses











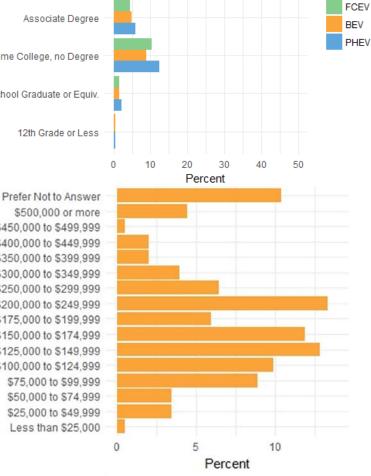
Prefer not to Answer

Postgraduate Degree

Bachelor's Degree

Distribution of FCEV Adopters \$450,000 to \$499,999 Household Income

\$500,000 or more \$400,000 to \$449,999 \$350,000 to \$399,999 \$300,000 to \$349,999 \$250,000 to \$299,999 \$200,000 to \$249,999 \$175,000 to \$199,999 \$150,000 to \$174,999 \$125,000 to \$149,999 \$100,000 to \$124,999 \$75,000 to \$99,999 \$50,000 to \$74,999 \$25,000 to \$49,999 Less than \$25,000

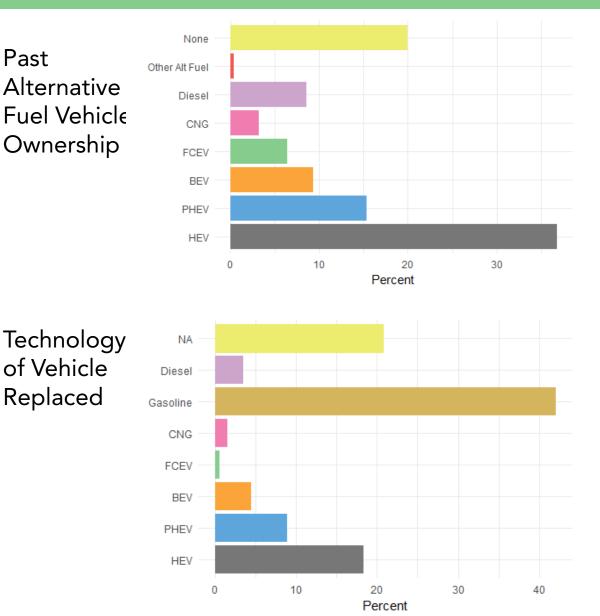


Past Vehicle Purchase Indicators

 Past green vehicle adoption used in CHIT as indicator for FCEV adoption

•Implemented as HEV/PHEV (not BEV)

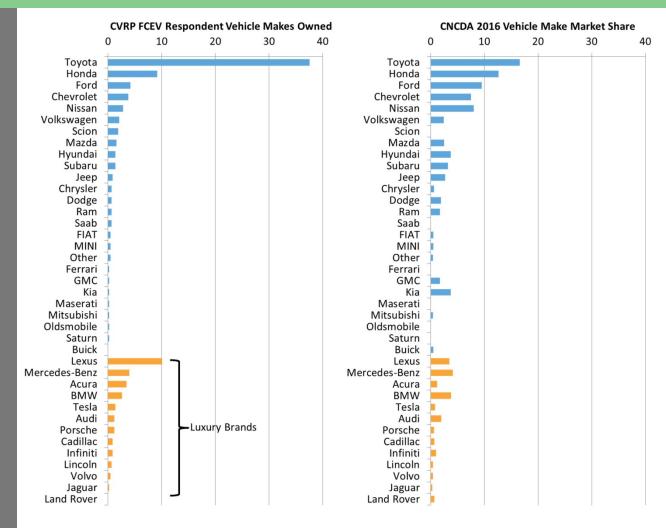
 Survey data appear to support method



Past Vehicle Purchase Indicators

•Luxury vehicle branding previously cited as potential indicator for FCEV adoption

•May be slightly more affinity in FCEV adopters, but maker loyalty and differences in deployment plans may also play a role



Other vehicle makes owned by adopters vs. new car market

CHIT Coverage Principle

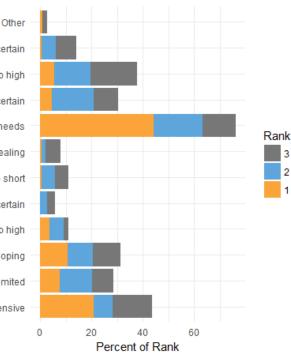
Principle #6: Coverage matches the market when it provides convenient fueling access near FCEV drivers' homes and/or within proximity to commonly-traveled routes

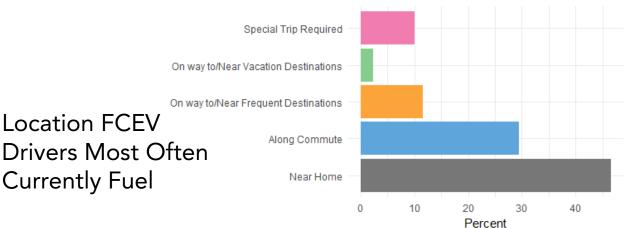
Importance of Station Locations

•Stations are early adopters' primary concern

•Price (vehicle and fuel) were second largest concern

•Drivers most often fueling near home Environmental impact of producing hydrogen fuel is uncertain Cost of hydrogen fuel is too high Reliability of hydrogen fueling stations working properly is uncertain Too few hydrogen stations to accommodate my travel needs Variety of vehicle models and body styles is too limited/unappealing Vehicle safety record is too short Vehicle repair costs are too high or uncertain FFCEV Fuel cell durability is uncertain and replacement cost is too high Adopter Ownership Concerns





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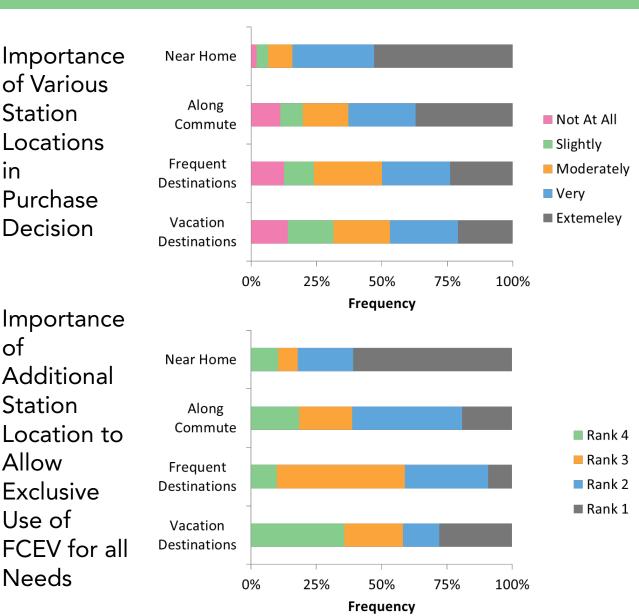
Importance of Station Locations

•Locations of stations affect the purchase decision based on their location relative to the FCEV adopter

in

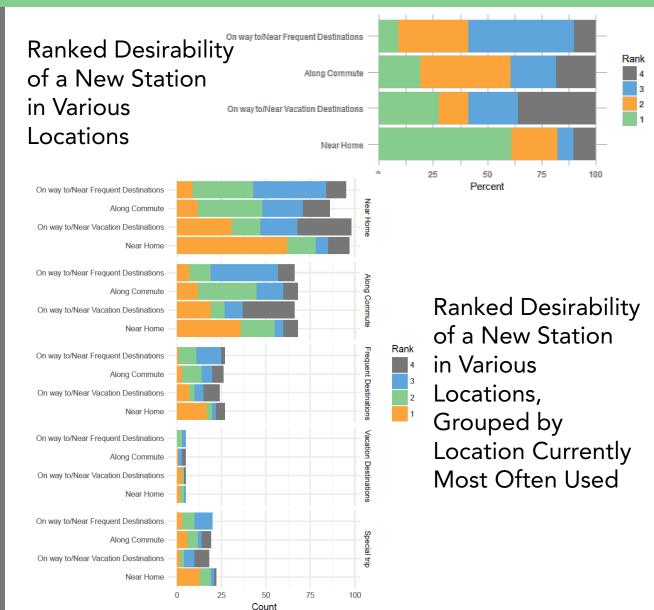
of

•Additional nearhome location most needed



Desired Station Locations

•Additional stations near home are the most desired location overall and (mostly) regardless of the station location drivers currently use most often

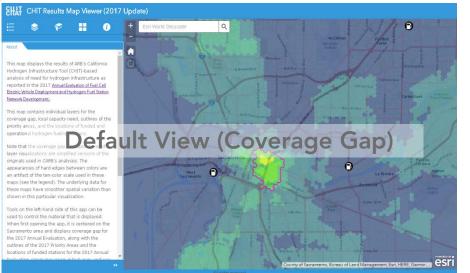


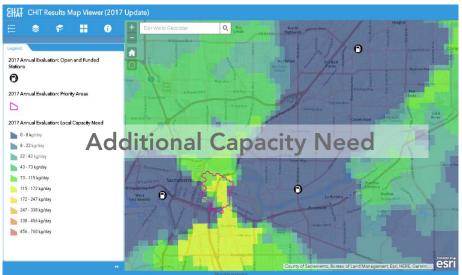
ONLINE VIEWER

Updated Online Viewer for CHIT 2017 Release

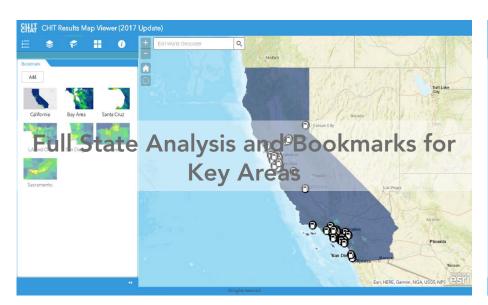
- Intended to allow interested parties without access to desktop ArcGIS (since it is not free software) to have access to the results of the CHIT analysis utilized in the 2017 Annual Evaluation
- Link provided on CARB's Hydrogen Fueling Infrastructure Assessments page: <u>https://www.arb.ca.gov/msprog/zevprog/hydrogen/h2fueling.</u> <u>htm</u>
- Previously provided similar map viewer for CHIT 2015 Release results used in 2015 and 2016 Annual Evaluations and updated analysis used for GFO-15-605

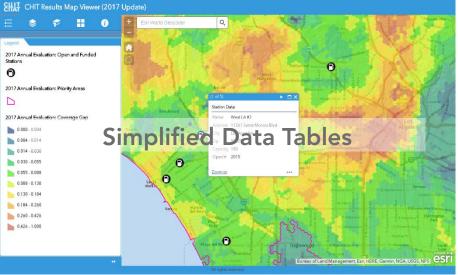
Updated Online Viewer for CHIT 2017 Release





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FUTURE IMPLEMENTATION

Ongoing Development Concepts

- Scenario analysis tool of station placement
 - Exploration of "what if" scenarios for numbers/locations of stations assuming various station technology development and vehicle rollout schedules
 - CARB is NOT developing this as a capability to determine specific optimized locations for station placement
 - Any analysis likely to be presented for discussion and aggregated regionally
- Addition of a redundancy factor to increase CHIT coverage gap evaluation tendency to cluster stations
- Implementation of station availability data (such as through SOSS) to scale coverage provided by stations
 - Proprietary station operational data concerns need to be recognized
- Addition of station throughput data (such as through NREL data reporting) as an additional observational demand input
 - Proprietary station operational data concerns need to be recognized

ACCESS TO CHIT DATA AND TOOLS

CHIT Desktop Tool available at (2017 and 2015 Releases both posted): https://www.arb.ca.gov/msprog/zevprog/hydrogen/h2fueling.htm

CHIT 2017 Release Online Map Viewer: <u>http://californiaarb.maps.arcgis.com/apps/webappviewer/index.html?i</u> <u>d=99be905d3127405e81851fd60b19cda2</u>

CHIT 2015 Release and GFO-15-605 Online Map Viewer still Available: <u>http://californiaarb.maps.arcgis.com/apps/webappviewer/index.html?id=f2bc784715984f3cb2905dbc4a0391b6</u>

OPEN DISCUSSION

For questions or comments, contact: Andrew Martinez (916) 322-8449 andrew.martinez@arb.ca.gov





Coverage, Capacity, and Market Viability under GFO-15-605

Jane Berner

Hydrogen Unit Fuels and Transportation Division California Energy Commission

November 14, 2017



Objectives

- Review the GFO-15-605 evaluation criteria
- Focus on the "Coverage, Capacity, and Market Viability" evaluation criterion
 - California Hydrogen Infrastructure Tool (CHIT) components
 - Non-CHIT components
- Review each component
 - What types of information could have been provided?
 - Comments and questions



Upcoming Energy Commission Staff Workshops on Hydrogen Station Network Future Approaches

- November 30: Hydrogen Refueling Infrastructure Alternative Funding Mechanisms
- December 4: Hydrogen Refueling Station Technical Requirements
- December 14: Evaluation Criteria for Hydrogen Refueling Station Applications, Critical Milestones, and Data Collection



Docket Information

- <u>http://www.energy.ca.gov/altfuels/2017-HYD-</u>
 <u>02/</u>
- On this site
 - Relevant workshops, notices, and documents
 - Submit e-comments
 - Contact information
 - Subscribe to Alternative Fuels List Serve



GFO-15-605 Evaluation Criteria

Evaluation Criteria	Possible Points
Qualifications of the Applicant/Project Team	60
Coverage, Capacity, and Market Viability	100
Safety Planning	40
Project Readiness	40
Station Operation and Maintenance	40
Project Budget	25
Financial Plan	15
Hydrogen Refueling Station Performance	60
Economic and Social Benefits	20
Innovation	20
Renewable Hydrogen Content	30
Renewable Hydrogen from Direct Sources	30
Sustainability and Environmental Impacts	20
Total Points	500

GFO-15-605 Scoring Scale Summary

From GFO-15-605, Table 8

% of Possible Points	Interpretation
0%	Not Responsive
10 – 30%	Minimally Responsive
40 - 60%	Inadequate
70%	Adequate
80%	Good
90%	Excellent
100%	Exceptional



GFO-15-605 Scoring Scale

% of Possible Points	Interpretation	Explanation of Percentage Points
0%	Not Responsive	Response does not include or fails to address the requirements being scored. The omission(s), flaw(s), or defect(s) are significant and unacceptable.
10-30%	Minimally Responsive	Response minimally addresses the requirements being scored. The omission(s), flaw(s), or defect(s) are significant and unacceptable.
40-60%	Inadequate	Response addresses the requirements being scored, but there are one or more omissions, flaws, or defects or the requirements are addressed in such a limited way that it results in a low degree of confidence in the proposed solution.
70%	Adequate	Response adequately addresses the requirements being scored. Any omission(s), flaw(s), or defect(s) are inconsequential and acceptable.
SPE OF CALIFORES	From GFO-15-	605, Table 8 Continued on next slide



GFO-15-605 Scoring Scale, Continued

% of Possible Points	Interpretation	Explanation of Percentage Points
80%	Good	Response fully addresses the requirements being scored with a good degree of confidence in the Applicant's response or proposed solution. No identified omission(s), flaw(s), or defect(s). Any identified weaknesses are minimal, inconsequential, and acceptable.
90%	Excellent	Response fully addresses the requirements being scored with a high degree of confidence in the Applicant's response or proposed solution. Applicant offers one or more enhancing features, methods or approaches exceeding basic expectations.
100%	Exceptional	All requirements are addressed with the highest degree of confidence in the Applicant's response or proposed solution. The response exceeds the requirements in providing multiple enhancing features, a creative approach, or an exceptional solution.
From GFO-15-605, Table 8		605, Table 8
ENERGY COMMISSION	CALIFOI	RNIA ENERGY COMMISSION 86

From GFO-15-605, Section IX (F)(4)(g)

"Applicants should address each Evaluation Criterion in this solicitation (including all sub-bullets under each criterion) providing sufficient, unambiguous detail so that the Energy Commission Evaluation Team will be able to evaluate the application.

Applicants are highly encouraged to use the exact titles from the Evaluation Criteria as the heading for each response.

If an Evaluation Criterion does not apply to the proposed project, Applicants should briefly describe why the criterion does not apply."



Coverage, Capacity, and Market Viability Evaluation Criterion

- CHIT coverage
- CHIT capacity
- Projected vehicle demand
- Redundancy and back-up
- Fleets
- Peak fueling
- Average number of fills
- Proximity to facilities
- Complements existing and planned stations



Coverage, Capacity, and Market Viability (Main Station Competition)

From GFO-15-605, Table 9

"Applications will be evaluated on the degree to which:

- The proposed station location results in a high CHIT Station Coverage Value.
- The proposed station capacity results in a high CHIT Station Capacity Value.
- The proposed station provides refueling service that meets the hydrogen refueling needs for the projected vehicle demand (light duty vehicle traffic count and patterns).
- The proposed station provides redundancy and backup in a location needing fueling capacity."





Coverage, Capacity, and Market Viability (Main Station Competition)

Continued from previous slide

"Applications will be evaluated on the degree to which:

- The proposed station provides refueling service for local fleets, as practicable.
- The proposed station provides refueling service that is available during peak fueling periods for light duty vehicles passing the station (daily, weekly, or during other time periods) and the peak fueling periods for the location do not conflict with timeframes allowed by local ordinances.
- The proposed station meets the needs of a higher average number of fills over a 1- and 12-hour period."



Continued on next slide

Coverage, Capacity, and Market Viability (Main Station Competition)

Continued from previous slide

"Applications will be evaluated on the degree to which:

- The proposed station provides refueling service for vehicles tested and deployed at automotive parts assembly, testing, distribution, and demonstration facilities.
- The proposed station's refueling service complements the coverage and capacity of the network of existing and planned hydrogen refueling stations in Table 1 and any other new stations proposed for funding by the Applicant under this solicitation."



First and Second Bullet Points

"The proposed station location results in a high CHIT Station Coverage Value."

"The proposed station capacity results in a high CHIT Station Capacity Value."

- Applicants provided these two values in their applications
- CARB confirmed the values with the Energy Commission Evaluation Team
- The Evaluation Team considered the CHIT values qualitatively and independently
- CARB recalculated CHIT values after each station was selected



Classification of Data

- For transparency and completeness, CHIT results have been provided to the public and GFO applicants with relatively high precision
 - Online Map: Range from 0-1, with precision to 0.0001
 - Desktop Tool: Coverage Gap and other data provided with precision to 0.000001
- Significant differences in values do not occur at such high precision
- CHIT's hot spot analysis, priority area determinations, and visualization in the online map seek to identify meaningful differences in values
- Use of CHIT in the GFO process was similarly informed, using the Natural Breaks method to determine meaningful differences between CHIT values
- Natural Breaks is a statistics-based method that minimizes the total variation within ranges. The effect is to identify groups of statistically similar values. In practice, groups are often separated by gaps in data values.

Classification of Data

- During scoring rounds of GFO 15-605, the Natural Breaks classification system was as an information resource by the Evaluation Team when they made qualitative assessments of CHIT values.
- The information considered by the team included:
 - Ranges of CHIT values statistically similar to each other
 - The proportion of CHIT values in each range
 - CHIT ranges and proportions evaluated on the basis of all evaluation cells across the state
- This evaluation was repeated after every "CHIT round"
- CARB and the Energy Commission collaborated closely throughout all CHIT Rounds and evaluations

Classification of Data

- After every proposed station award was selected, the entire distribution of coverage gap scores, classes, and size of classes were re-evaluated to reflect the changing interpretation of given Location Values
- For example, a Location Value of 0.311 may have been more rare and in a higher-ranked group after 12 rounds of awards than prior to any award selections
- In early rounds, a value of 0.311 may have been statistically similar to all values 0.2-0.4. After several awards, the distribution may have shifted, such that 0.311 was similar to values 0.282-0.333.
- These data were considered each round by all scorers to adjust their interpretation of Location Value scores

CHIT and Market Viability

From GFO-15-605, Section IV (C)

"The Energy Commission Evaluation Team will score the application using a combination of the CHIT Station Coverage Value, the CHIT Station Capacity Value, and the market viability as part of one Evaluation Criterion 'Coverage, Capacity, and Market Viability.'

Proposed locations that have low CHIT Station Coverage and CHIT Station Capacity Values, according to CHIT, have the opportunity to document, demonstrate, and bolster the CHIT Station Coverage and CHIT Station Capacity Values with the market viability of a proposed station and potentially be successful under this solicitation in accordance with the Evaluation Criteria."



Third Bullet Point

"The proposed station provides refueling service that meets the hydrogen refueling needs for the projected vehicle demand (light duty vehicle traffic count and patterns)."

- Possible responses
 - Fuel cell electric vehicle projections from CARB's AB 8 Annual Evaluation
 - Proximity and traffic flow to freeways, major streets
 - How serves origins and destinations
 - Consistency with regional transportation plan, general plan, alternative fuel readiness plan
 - Characteristics of local residential area, employment centers
 - Applicant's own observations about market potential



Third Bullet Point, Continued

"The proposed station provides refueling service that meets the hydrogen refueling needs for the projected vehicle demand (light duty vehicle traffic count and patterns)."

- Possible responses
 - Information from:
 - » Auto manufacturers or dealerships
 - » Location owner/operator
 - » Local governments
 - » FCEV drivers or prospective drivers



Fourth Bullet Point

"The proposed station provides redundancy and back-up in a location needing fueling capacity."

- Possible responses
 - Proximity to the nearest funded stations (open or planned)
 - Usage of those nearest stations
 - Is the proposed station near another station you are proposing? How do they support each other?
 - Is the station a redundant system?



Fifth Bullet Point

"The proposed station provides refueling service for local fleets, as practicable."

- Possible responses
 - List of identified local fleets and their potential refueling needs
 - Number of FCEVs
 - Estimated date needed
 - Time of day of refueling
 - Fleets are not part of the applicant's business model
 - Reasons why



Sixth Bullet Point

"The proposed station provides refueling service that is available during peak fueling periods for light duty vehicles passing the station (daily, weekly, or during other time periods) and the peak fueling periods for the location do not conflict with timeframes allowed by local ordinances."

- Possible responses
 - How the station meets or exceeds the minimum technical requirement for peak fueling capacity
 - Fuel sales in the local area (gasoline and hydrogen)
 - Hours of operation allowed by the local jurisdiction



Seventh Bullet Point

"The proposed station meets the needs of a higher average number of fills over a 1- and 12-hour period."

- Possible responses
 - How the station meets or exceeds the minimum technical requirements for daily fueling capacity and peak fueling capacity
 - Site design features (space to increase capacity)
 - Station design features (multiple fueling positions; compression, storage and dispensing systems)
 - Alignment of station design with anticipated demand



Eighth Bullet Point

"The proposed station provides refueling service for vehicles tested and deployed at automotive parts assembly, testing, distribution, and demonstration facilities."

- Possible responses
 - Partnerships the applicant has identified
 - Business agreement(s)
 - How the agreement(s) will enhance station viability
 - These types of facilities are not part of the applicant's business model
 - Reasons why
 - Other customer bases



Ninth Bullet Point

"The proposed station's refueling service complements the coverage and capacity of the network of existing and planned hydrogen refueling stations in Table 1 and any other new stations proposed for funding by the Applicant under this solicitation."

- Possible responses
 - How the proposed station location responds to the AB 8 reports' (CARB's Annual Evaluation or the Joint Report) findings related to coverage and capacity needs of the station network
 - How the proposed station location supports the needs identified through discussions with auto manufacturers, local stakeholders, and based on applicant's own analyses



Coverage, Capacity, and Market Viability Sub-Bullets

- Any comments or questions about them?
- Anything you like or dislike about them?
- In the future
 - How should CHIT be used?
 - What market viability factors should be included or excluded?
 - Why?



General Discussion

Questions Comments Suggestions

