



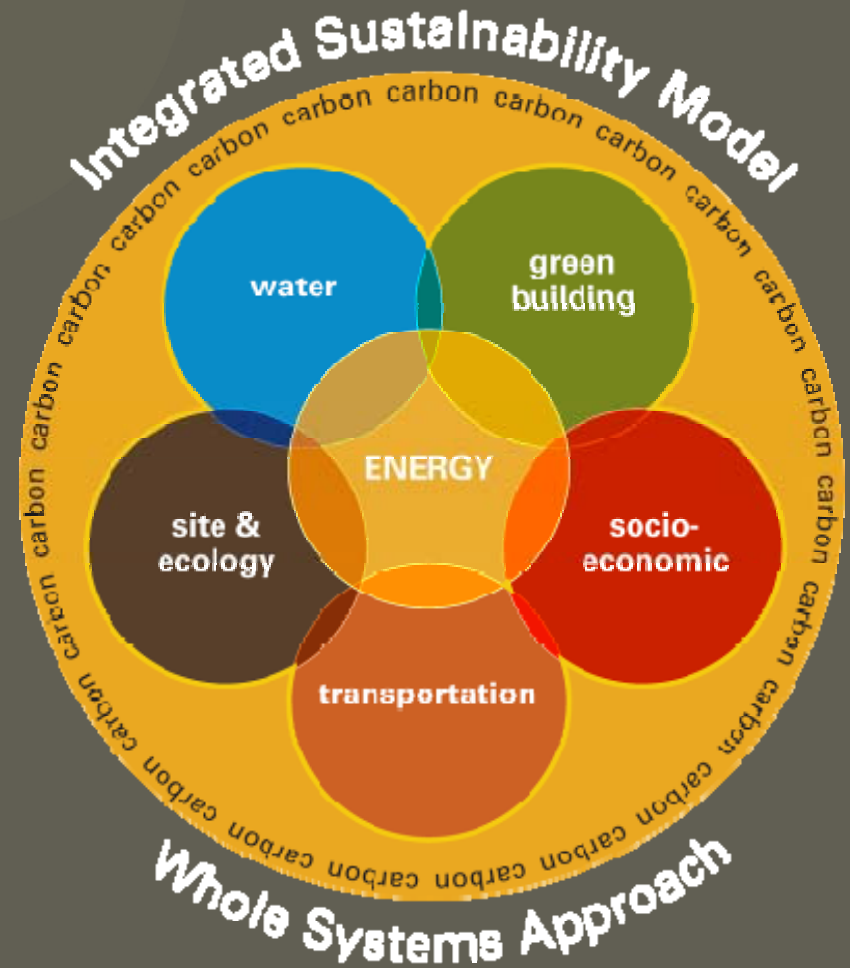
Optimization Approach for Sustainable Communities

EDAW / AECOM Sustainability

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Integrated Whole Systems Thinking

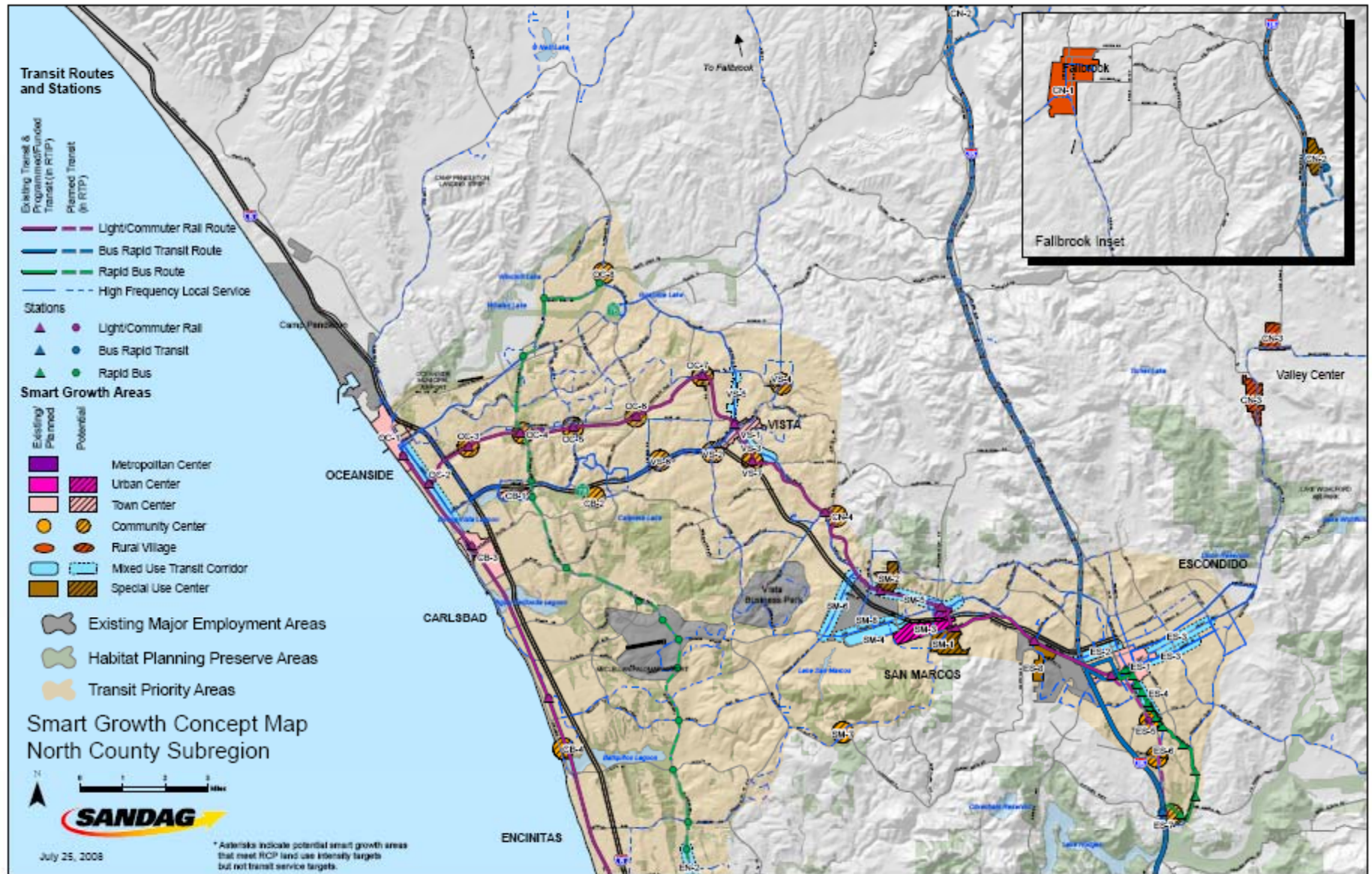
- Ecological Resources
- Energy
- Transportation
- Green Building
- Water
- Socio / Cultural
- Economic



Stage One:
**Community Framework
Optimization**



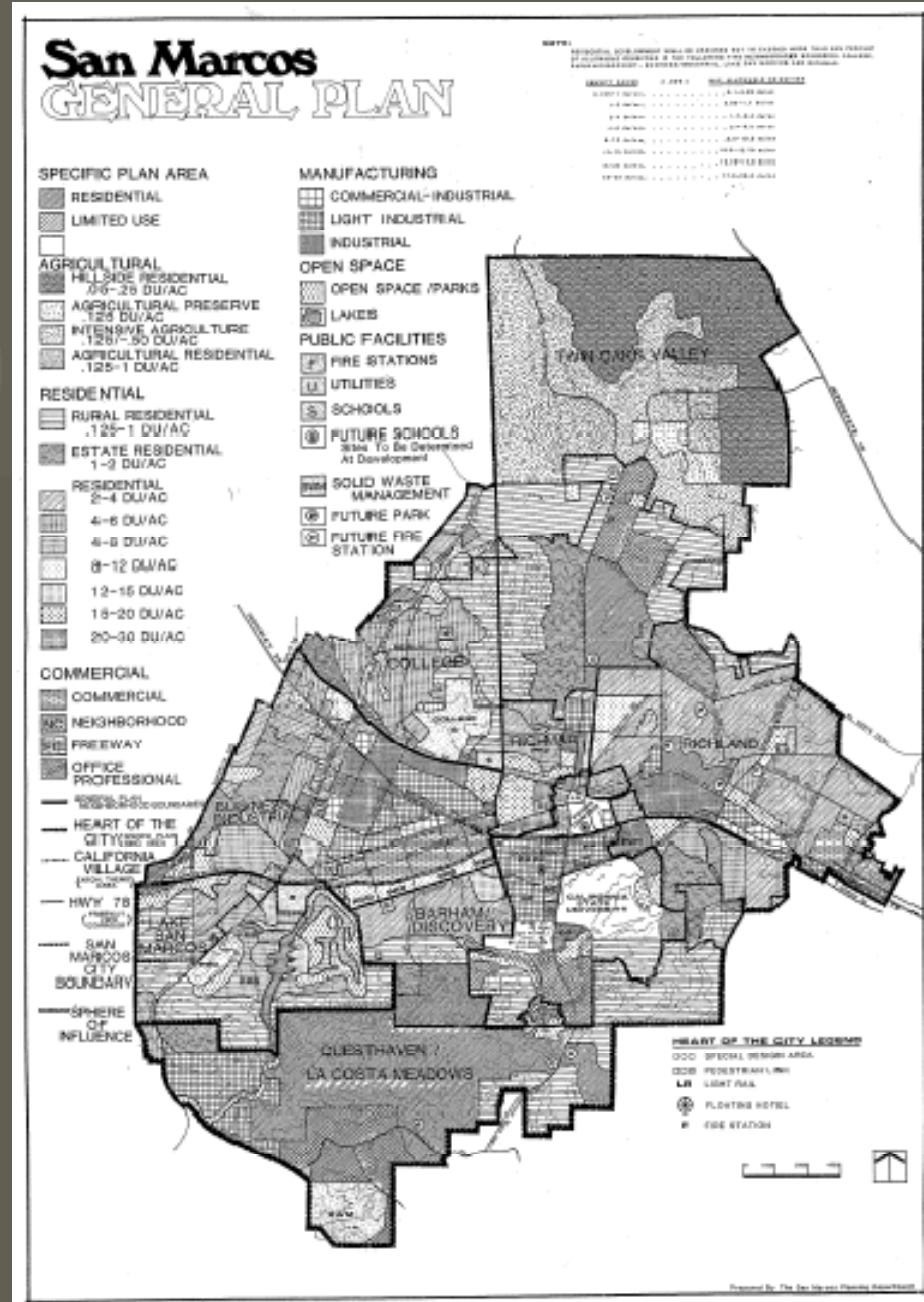
Regional Planning Applications



Existing Community Planning



Smart growth target areas



Typical Place Types

Mature Neighborhoods and Districts Place Types

Residential Districts	Res 1	Res 2	Res 3	Res 4	Res 5
					
	Very Low SFD	Low SFD	Med SFD	Urban Med/High	Urban High

Business Districts	Business 1	Business 2	Business 3	Business 4	Business 5	Business 6
						
	Heavy Indust.	Light Indust.	Logistics/Dist.	Low Office	Med Office	High Office

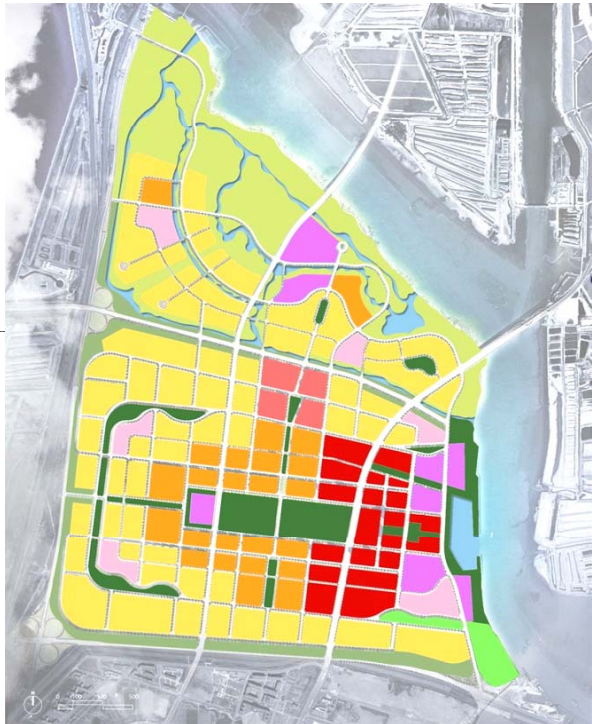
Retail Districts	Retail 1	Retail 2	Retail 3
			
	Reg. Retail	Comm. Retail	Neigh. Retail

Mixed Use Districts	Mixed Use 1	Mixed Use 2	Mixed Use 3	Mixed Use 4
				
	Mix A	Mix B	Mix C	Mix C

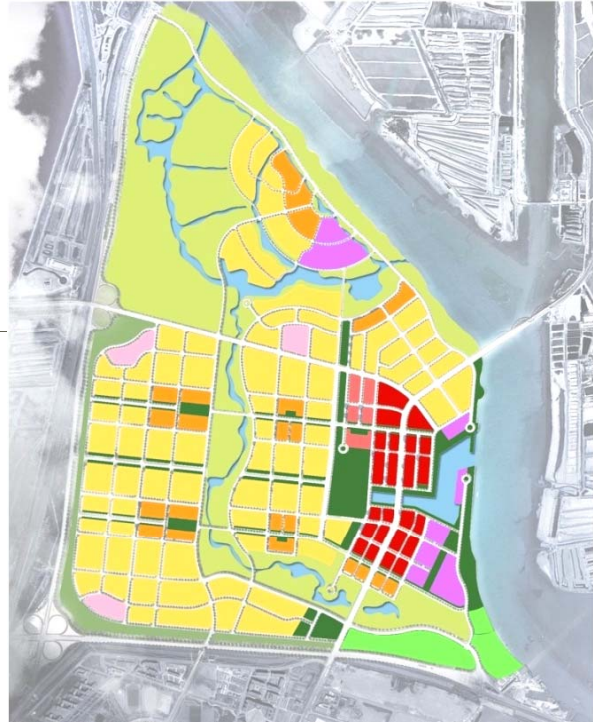
Community Framework Comparison



Scheme 1



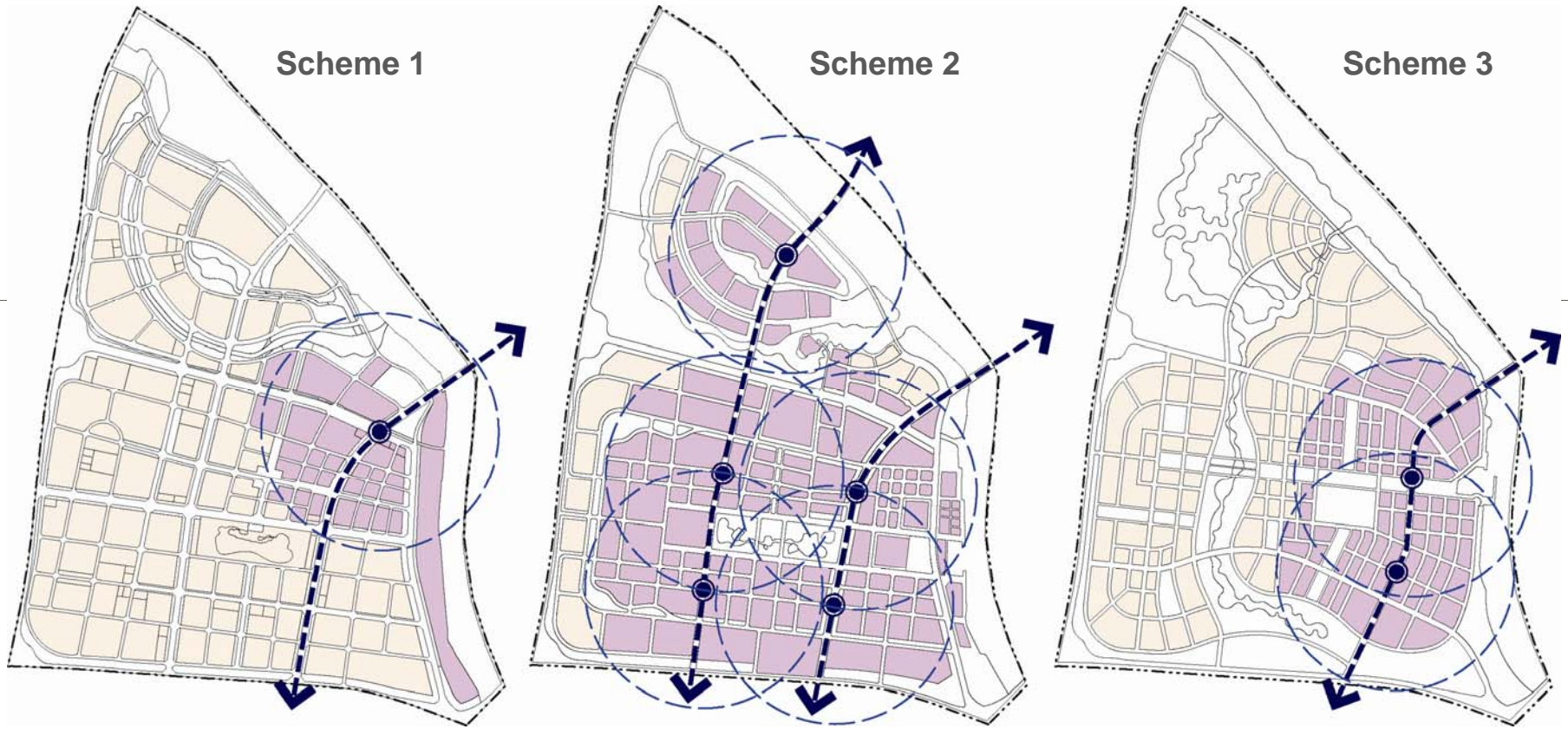
Scheme 2



Scheme 3

Access to Transit

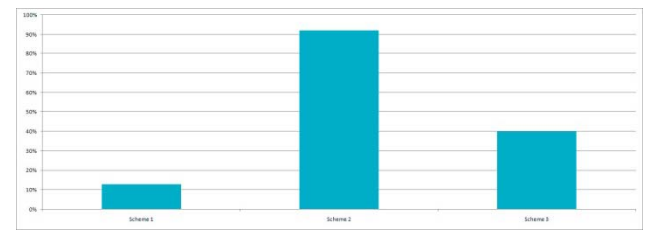
Access to Transit



Coverage Percentage **13%**

92%

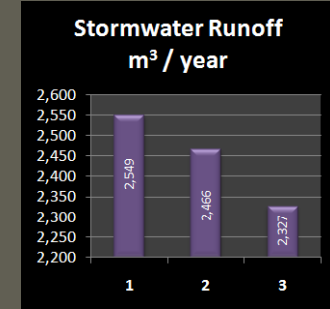
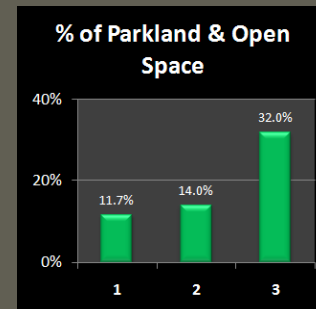
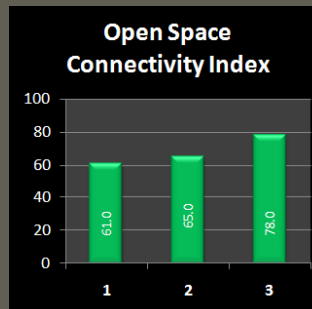
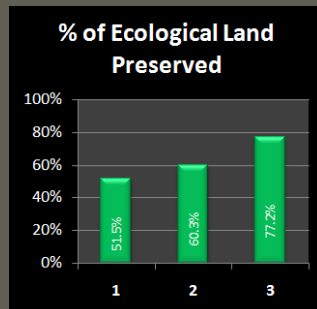
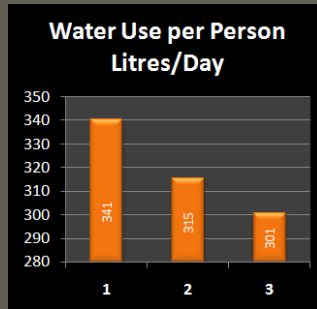
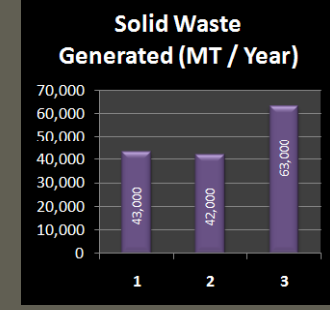
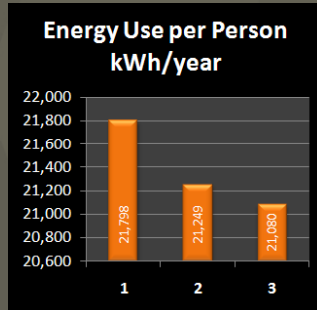
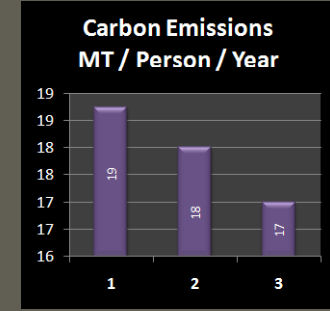
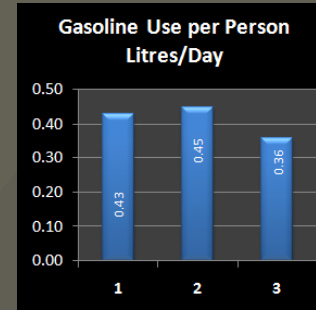
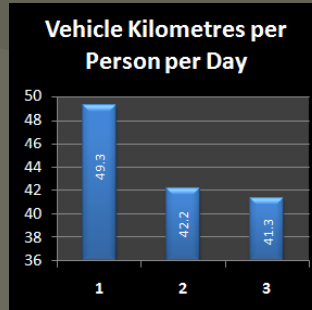
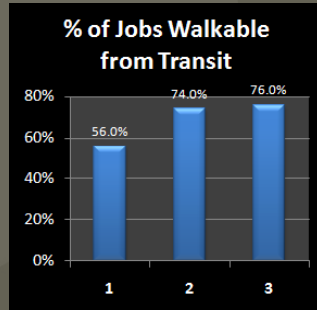
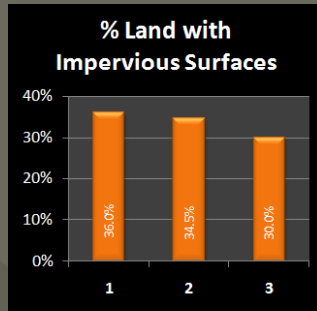
40%



Legend

- Inter-District Light Rail
- LightRail- Interchange Hub
- Proposed Local Public Transport
- Local Public Transport Stops

Key Sustainability Indicators









Preferred Concept Selection



Simulations for Public Outreach

STAGE I SSIM OUTPUTS SUMMARY

			CRP Plan	
HOMES		Residents	persons	16,095
		Dwellings	DU	5,897
		Population Density	Persons/Acre	5.5
		Gross Housing Density	DU/Ac	1
		Net Housing Density	DU/Ac	2
JOBS		Jobs	Employees	6,790
		Jobs to Housing Ratio	Ratio	1.2
		% of Jobs Walkable from Transit	Percent	30%
ECOLOGY		% of Parkland & Open Space	Percent	20.0%
		Parks per 1000 Population	Ac per 1000 Person	5.0
		Open Space Connectivity Index	Index (0-100)	78.0
		% of Ecological Land Preserved	Percent	77.2%
		% Land with Impervious Surfaces	Percent	11.0%
RESOURCE INPUTS		Energy Use per Person	kWhr per capita per year	7,079
		Water Use per Person	Gallons per Capita per Day	301
		Gasoline Consumption per Person	Gallons per Capita per Day	0.97
		VMT per Household	Km per Dwelling/Household	41.3
WASTE OUTPUTS		Carbon Emissions per person	MT per person per year	8
		Stormwater Runoff	ac-ft per year	2,327
		Solid Waste Generated	MT per year	6462
		Air Pollution Index	0	
		Water Quality Threat Index	0	
FINANCE		Reference Cost per capita	\$/person	66,304
		Reference Cost per Ha	\$/Ac	522,325
		Median Home Value	\$	175,000

Stage Two: Primary System Optimization



Existing community



Infill community



Greenfield community



Variables:

- %Bldg Stock Penetration
- % Efficiency Improvement
- Yrs Time Horizon

SSIM Optimization

Land Area Composite Calculations

Variables:

- % Redevelopment/Infill
- % Efficiency Improvement
- Yrs Time Horizon

SSIM Optimization

Land Area Composite Calculations

Variables:

- % Efficiency Improvement
- Yrs Time Horizon

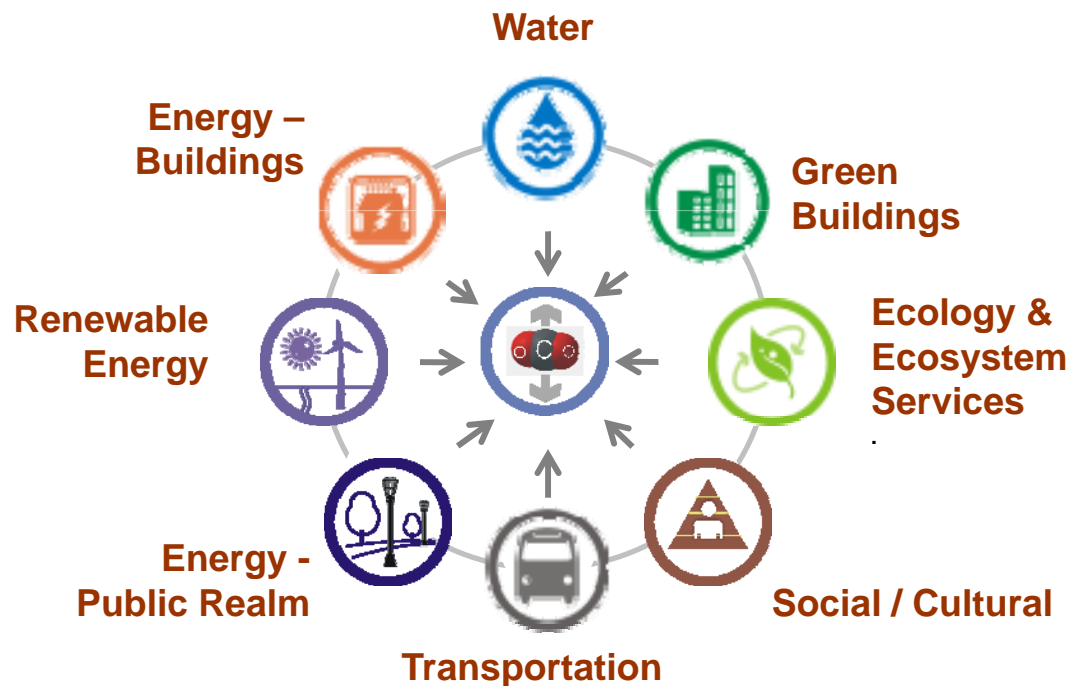
SSIM Optimization

Land Area Composite Calculations

Total Study Area Composite Results

Primary Systems Optimization

Thematic Performance Sub-Models



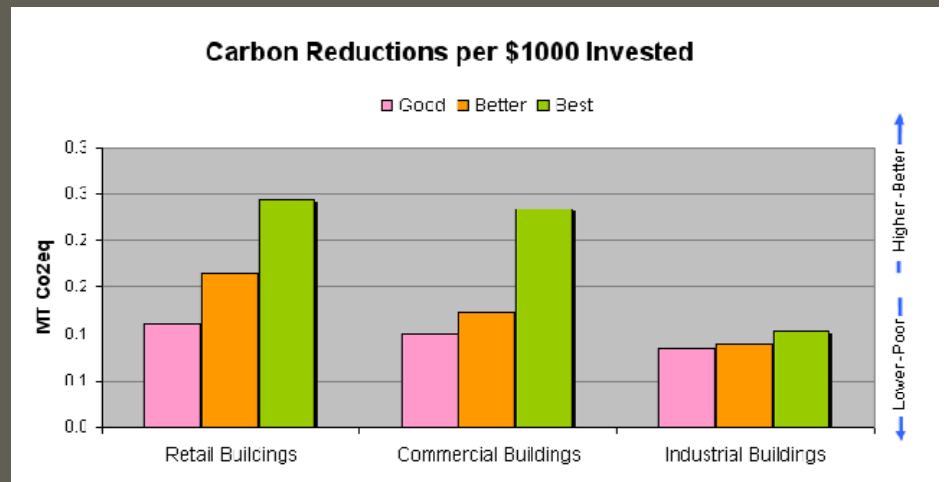
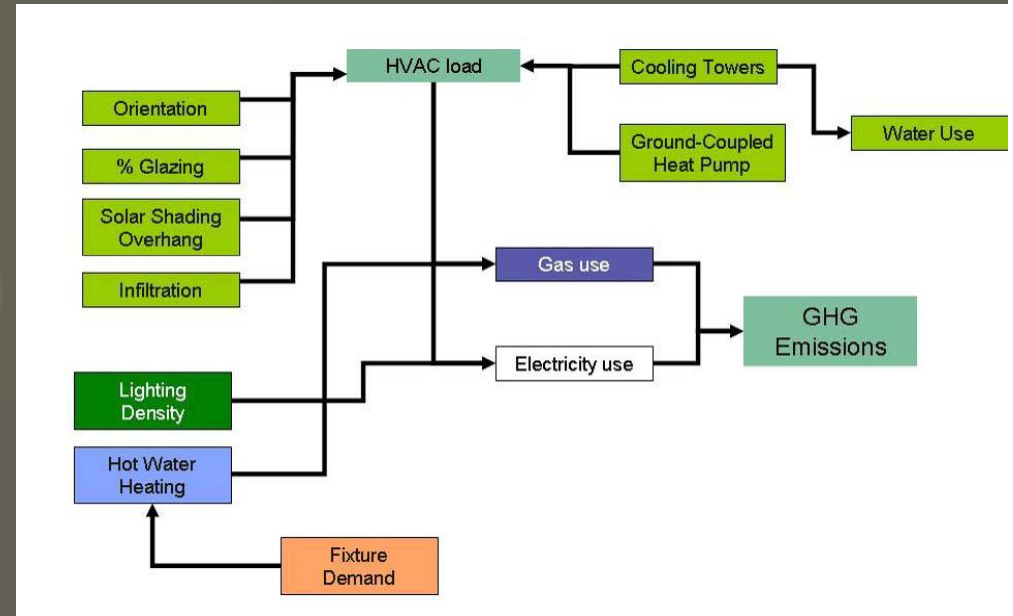
Primary Systems Modeled

- On-site Urban Form
- Residential Building Energy
- Non-Residential Energy
- Transportation
- Public Realm Energy
- Water
- Urban Heat Island Effect
- Ecology
- Freestanding Renewables
- Distributed Generation
- Socio-Cultural

Building Energy

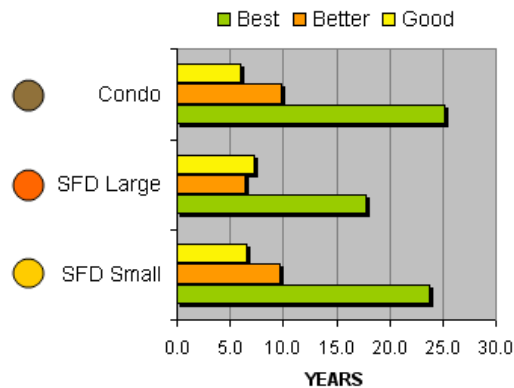
- Building Shell
- Fenestration
- HVAC efficiency
- Water heating
- Appliances
- Lighting
- Passive design
- Bldg orientation
- On-building Photo Voltaics

GHG reduction
2-20%

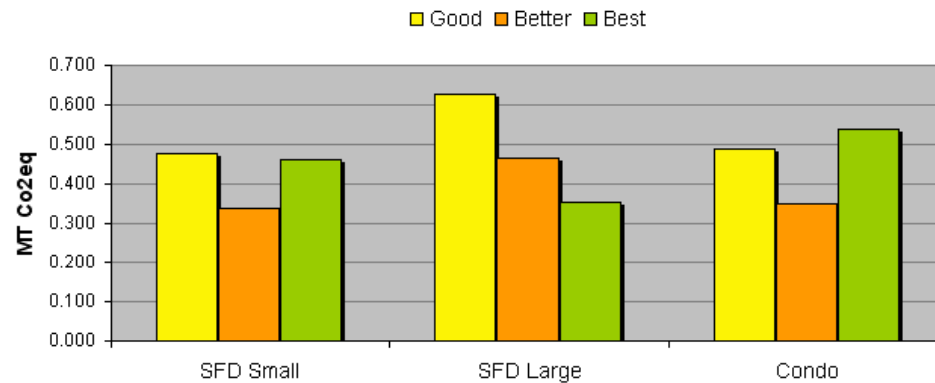


Example Outputs – Residential Energy

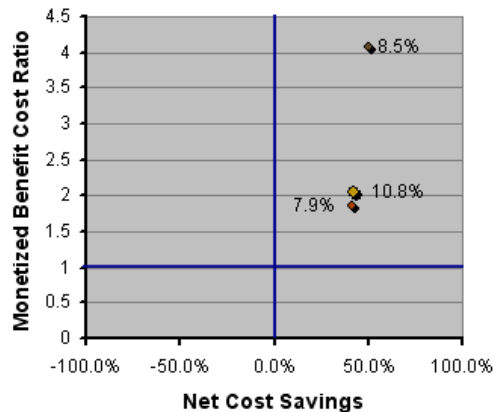
SIMPLE PAYBACK



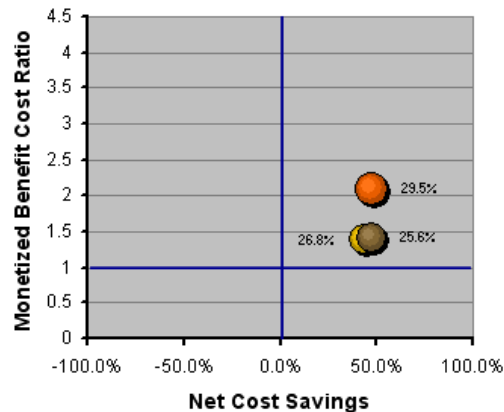
Carbon Reductions per \$1000 Invested



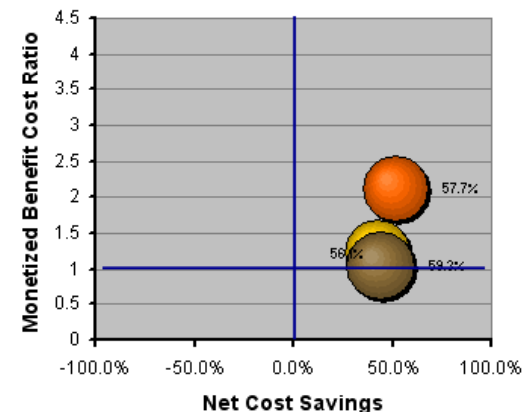
'GOOD' OPTIONS VALUE CHART



'BETTER' OPTIONS VALUE CHART



'BEST' OPTIONS VALUE CHART

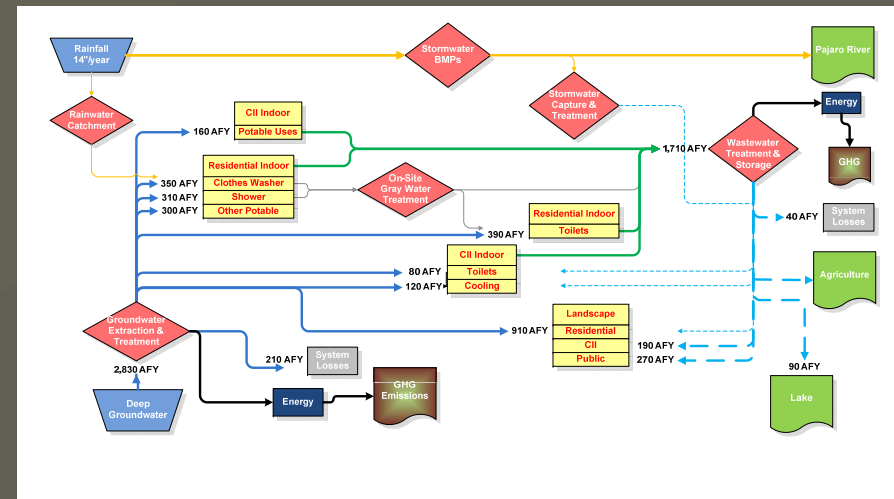


Domestic Water Reduction

- Land Use
- Landscape palettes
- Building Fixtures
- Treated sewage effluent reuse
- Stormwater reuse
- Rainwater capture
- Gray water reuse

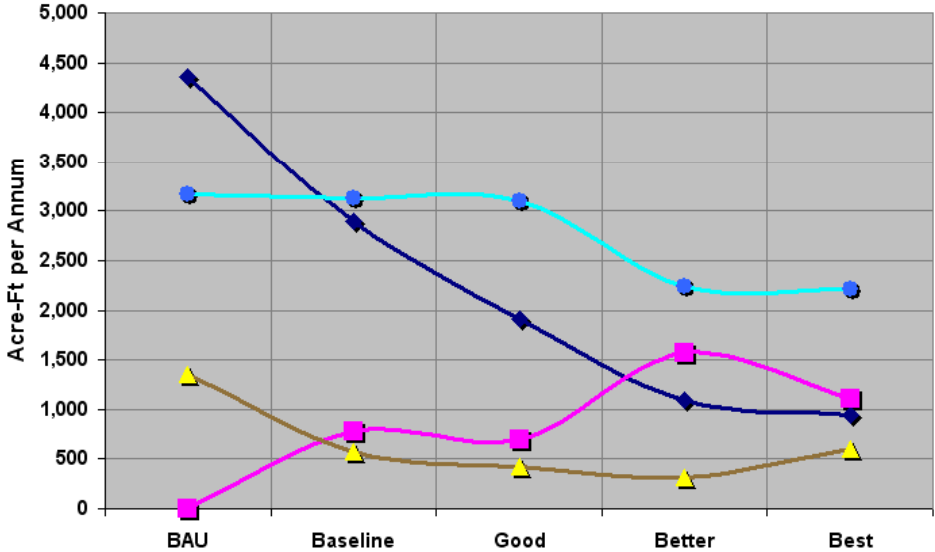
H₂O reduction

30-65%

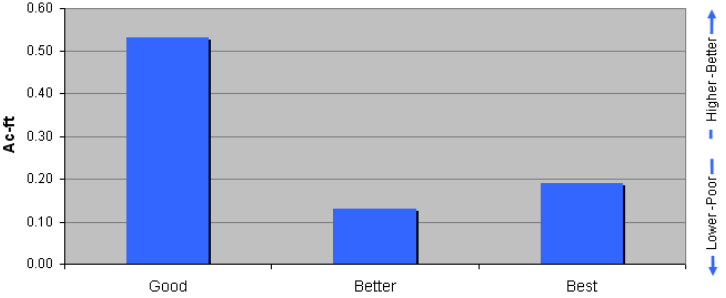


Example Outputs - Water

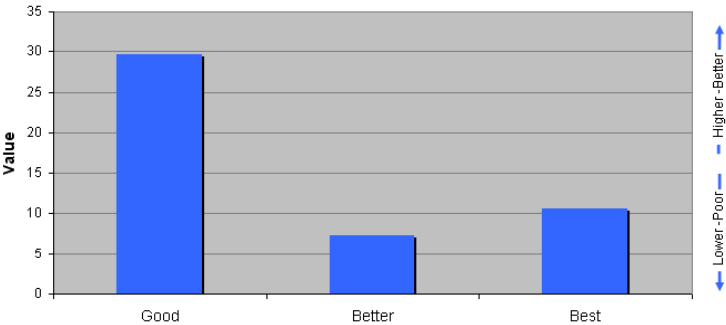
Water and Wastewater



Water Reduction per \$1000 Invested



% Benefit per % Increase in Investment



Urban / Community Form

Cores and Centers

- Central Town Center
- Multiple District Cores

Density

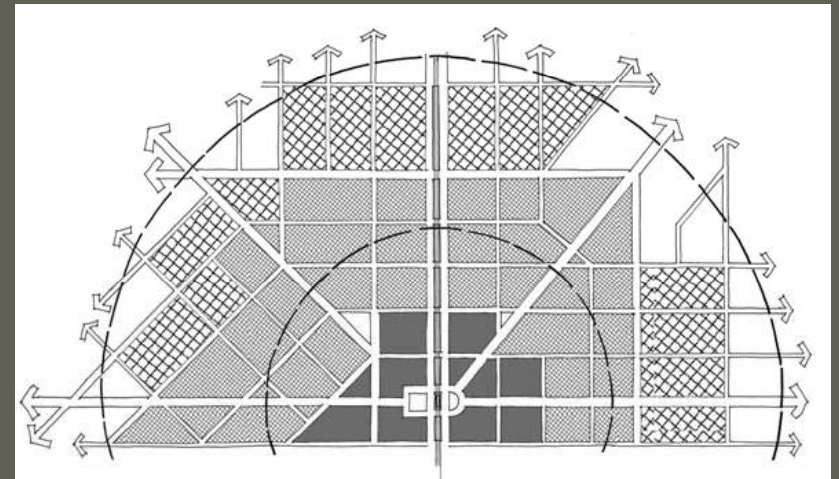
- Compact Design
- Higher density in cores

Diversity of Land Use

- Broad range of housing
- Jobs/housing balance
- Local service provision

GHG reduction

2-25%



Local Transportation

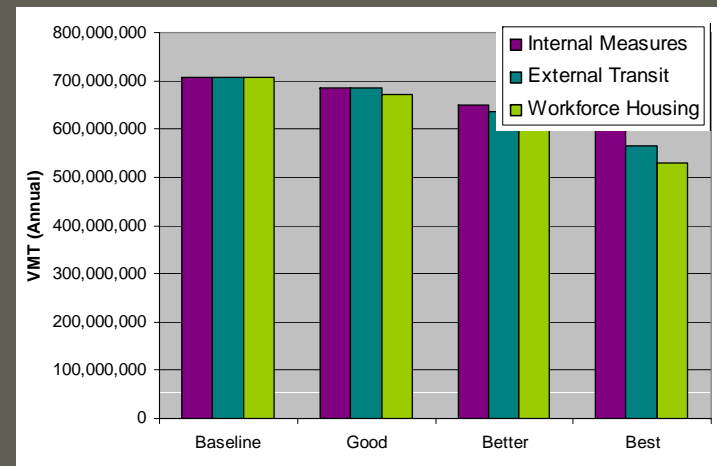
Measures:

- Local Transit
- Bicycle/pedestrian facilities
- Neighborhood Electric Vehicles (NEV's)
- Travel demand management (TDM)

Housing / Employment Linkage Measures

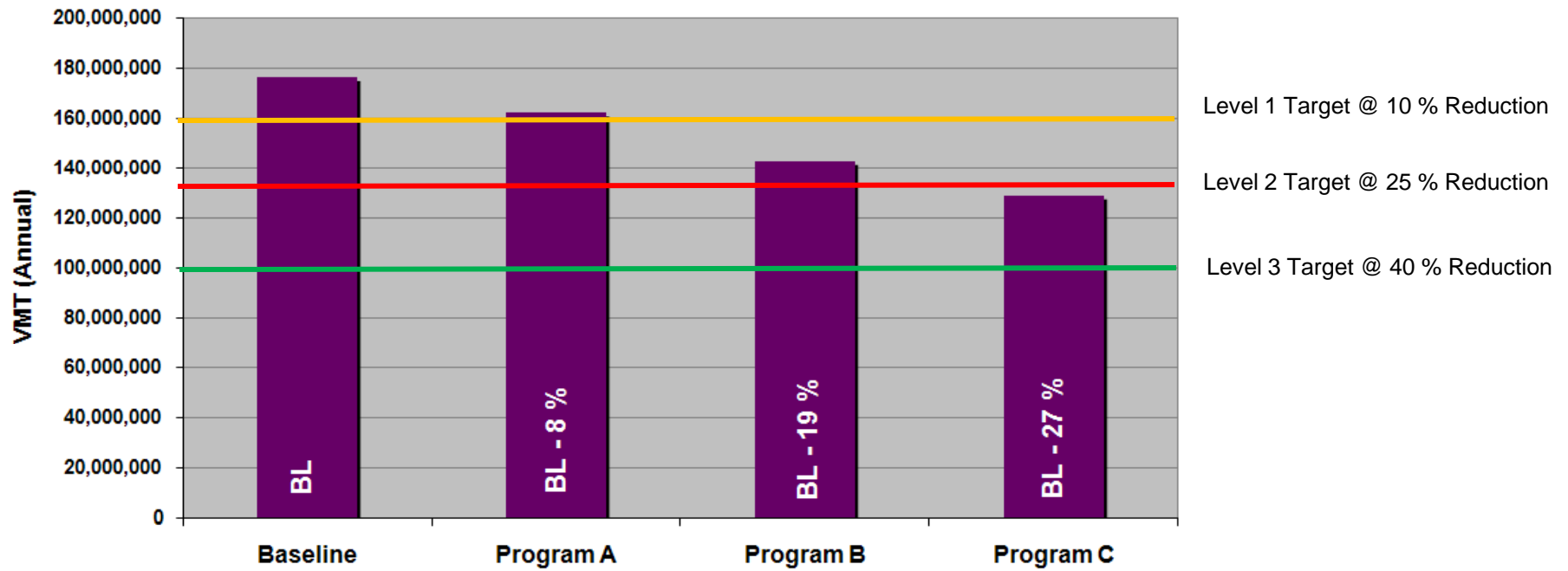
- On-site jobs/housing balance
- Employer proximity subsidy
- 'Google bus'

GHG reduction
3-20%



Reductions Due to Transportation Measures

Total VMT Generated



Public Realm Energy

Street Lighting

- Fixture spacing and foot candles
- Dark sky concepts
- LED options

Parking Lots / Industrial Areas

- Foot candle requirements
- LED options
- Photopic vs. Scotopic Lights

Open Space and Parks

- Lighting levels
- PV on structures

GHG reduction

1-5%



Color rendition under THE
EDGE™ area lights

8,400 Initial delivered photopic
lumens - 141 system watts -
75 CRI

Color rendition under high
pressure sodium

21,000 Initial delivered
photopic lumens - 300 system
watts - 22 CRI

Energy and GHG Offsets: Renewable & Distributed Energy

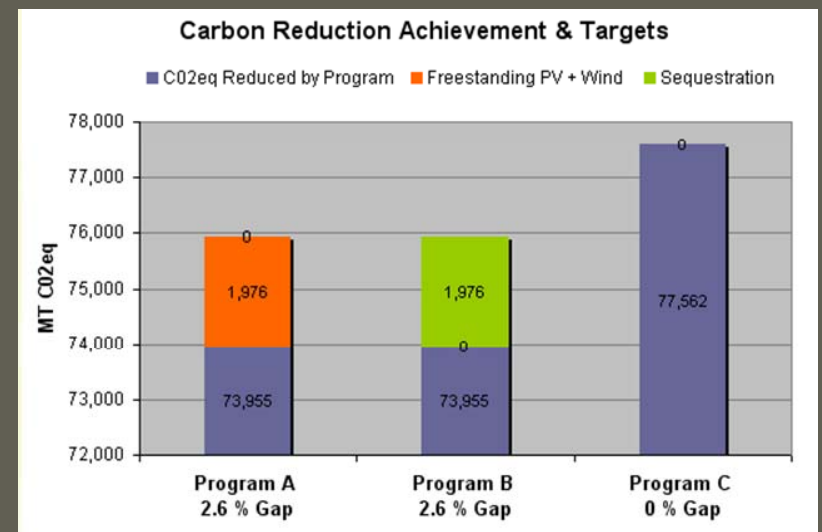
On-Building Renewables

- Photo Voltaic panels
- Thermal hot water

Distributed Energy

- Photo Voltaic plants
- Wind turbine plants
- CHP*
- BioMass*
- BioGas*
- GeoThermal*

GHG reduction
3-12%

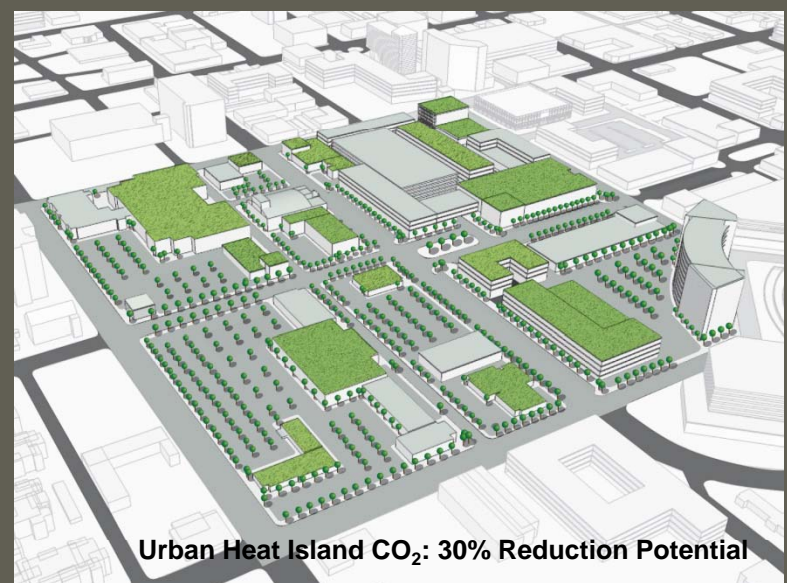


Urban Heat Island

- **Micro-Climate Engineering**
- Building Shading from tree plantings
- Micro-water humidity and cooling
- Materials selection
- **Community Landscape**
- Increased public realm planting
- Integration with bio-diversity concepts
- Materials selection

GHG reduction

3-5%

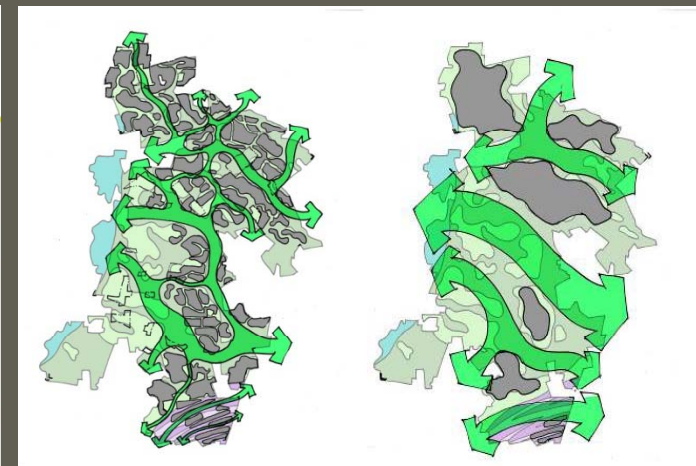


Ecosystem Services

- Biodiversity Enhancement
- Carbon Sequestration
- Local Food Production



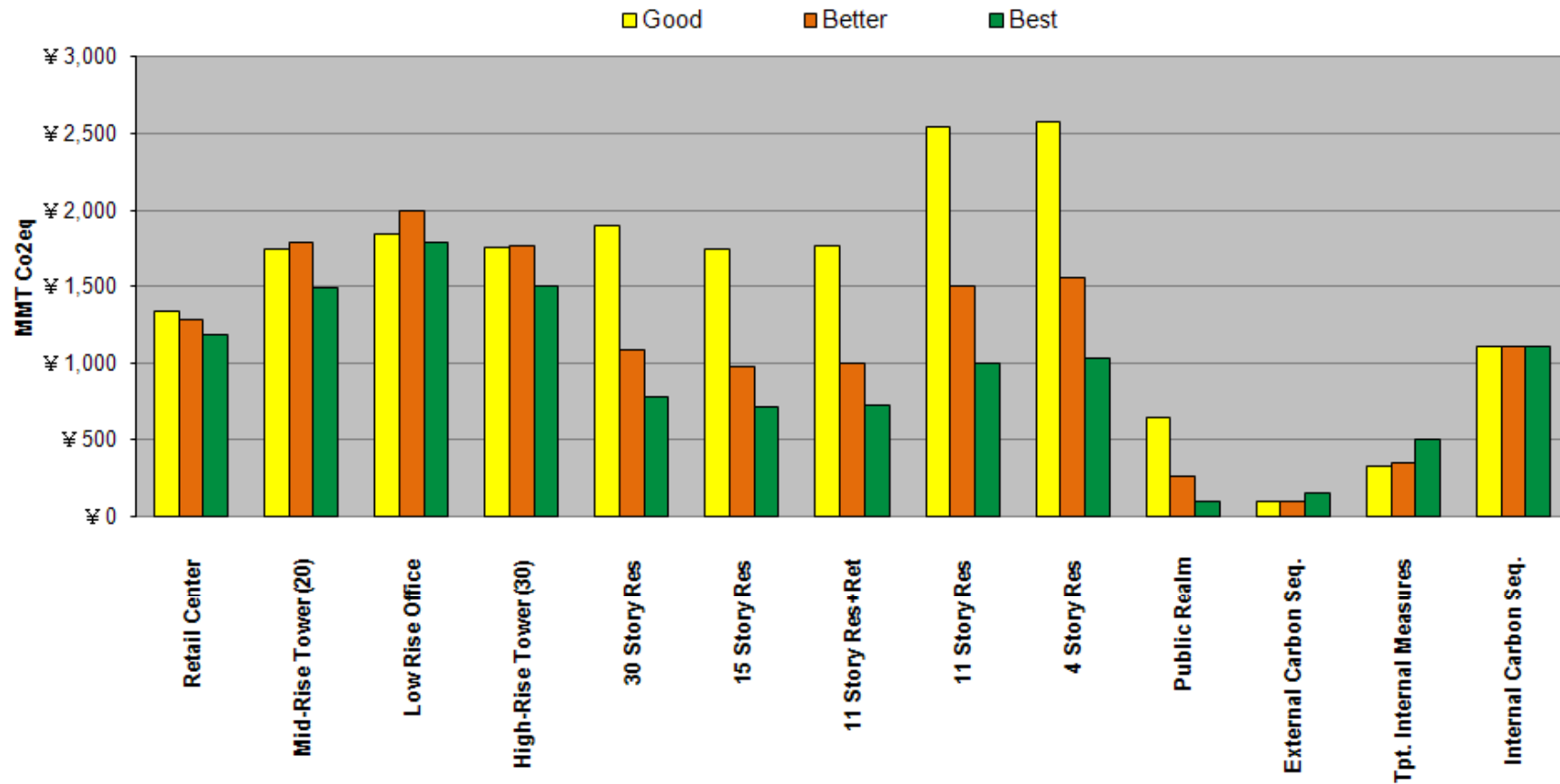
GHG reduction
5-15%



	Community Ag Acres	Food Benefit	Carbon Benefit	First Cost	Operating Cost
BAU	Ad hoc	n/a	n/a	-	-
Good	25 AC	15% of produce need for productive months accommodated on-site (LEED ND Compliance - 80% of households can have CSA membership or garden plot)	260 Tons (220,000eq less delivery miles driven)	\$150,000* *if by farmer \$1M if by developer	\$100,000* *for community farm liaison, farm should be profitable
Better	42 AC	26% of produce need for productive months accommodated on-site (LEED ND Compliance + 30% supplies farmers markets + 10% supplies regional retail/restaurant)	430 Tons (365,000eq less delivery miles driven)	\$150,000* *if by farmer; \$1.7M if by developer	\$100,000* * Same as above
Best	161 AC	100% of produce need for productive months accommodated on-site (footprint neutral for productive months)	1,660 Tons (1.4Meq less delivery miles driven)	\$300,000* *if by farmer \$6.4M if by developer	\$100,000* * Same as above

Relative GHG Reduction by System

Cost per Ton of Carbon Reduction by Theme



Stage Three: Master Program Synthesis



building energy - Mature Districts(1)

RESIDENTIAL NEIGHBORHOODS		Program A	Program B	Program C
Residential One	Very Low SFD	Good	Better	Best
Residential Two	Low SFD	Good	Better	Best
Residential Three	Medium SFD	Good	Better	Best
Residential Four	Urban Medium / High	Good	Better	Best
Residential Five	Urban High	Good	Better	Best
BUSINESS DISTRICTS				
Business One	Heavy Industrial	Good	Better	Best
Business Two	Light Industrial	Good	Better	Best
Business Three	Logistics/Distribution	Good	Better	Best
Business Four	Low Office	Good	Better	Best
Business Five	Medium Office	Good	Better	Best
RETAIL DISTRICTS				
Retail One	Regional Retail	Good	Better	Best
Retail Two	Community Retail	Good	Better	Best
Retail Three	Neighborhood Retail	Baseline	Baseline	Baseline
MXD DISTRICTS				
District One	Mix A	Good	Better	Best
District Two	Mix B	Good	Better	Best
District Three	Mix C	Good	Better	Best
District Four	Mix D	Good	Better	Best

MASTER PROGRAM RESULTS

Total Building Energy Reduction	10.6%	17.8%	31.6%
Total Storm Water Reduction	1.5%	30.5%	38.0%
Total Pollutant Reduction	0.0%	36.3%	53.2%
City Total Cost	0.5%	3.0%	4.8%
Residential Owner Cost	2.1%	5.6%	9.0%
Commercial Owner Cost	5.6%	29.7%	37.5%

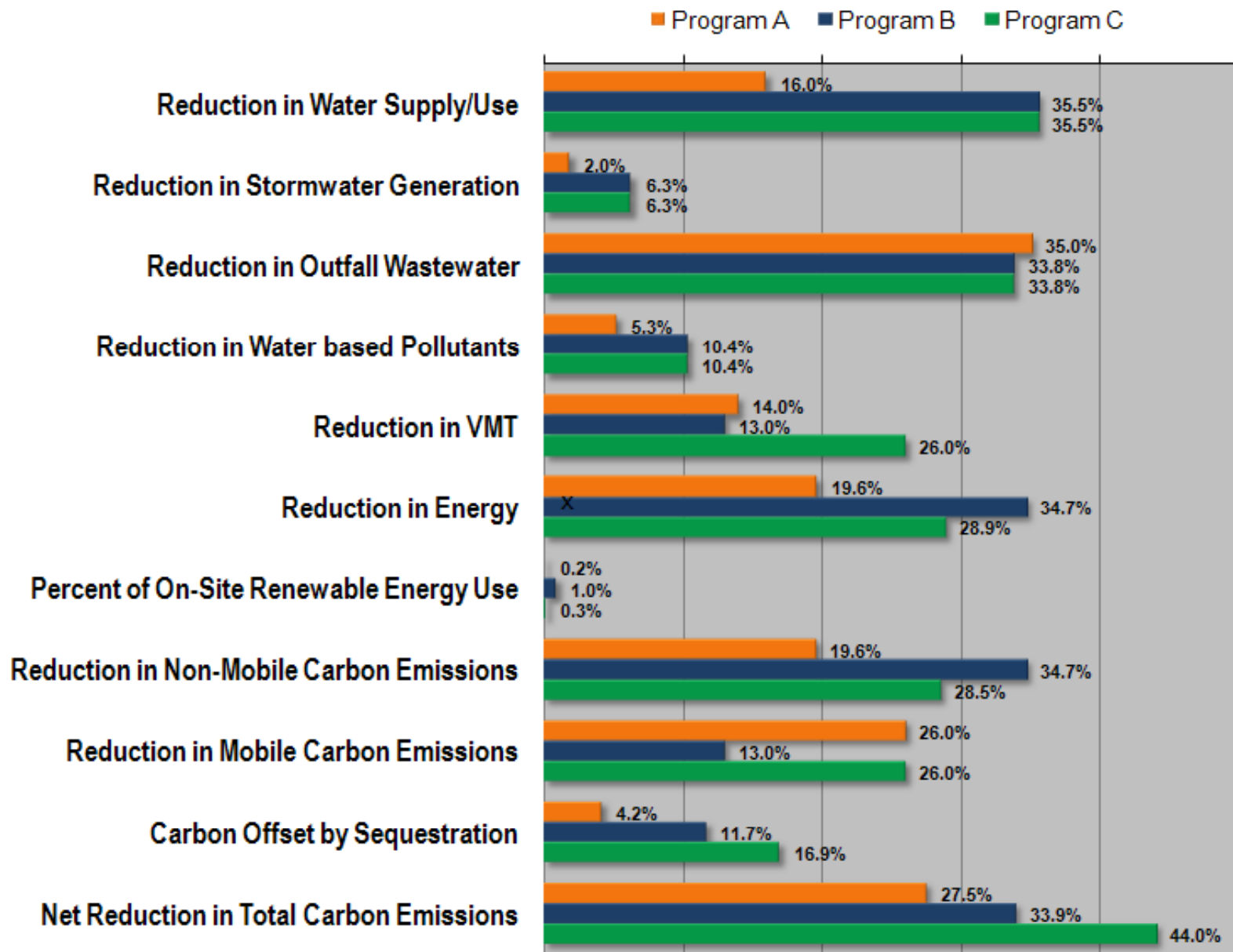
vmt - Mature Districts (1)

RESIDENTIAL NEIGHBORHOODS		Program A	Program B	Program C
Residential One	Very Low SFD	Good	Good	Best
Residential Two	Low SFD	Good	Better	Best
Residential Three	Medium SFD	Good	Better	Best
Residential Four	Urban Medium / High	Good	Better	Best
BUSINESS DISTRICTS				
Business One	Heavy Industrial	Baseline	Baseline	Baseline
Business Two	Light Industrial	Baseline	Good	Good
Business Three	Logistics/Distribution	Baseline	Good	Good
Business Four	Low Office	Baseline	Good	Good
Business Five	Medium Office	Good	Best	Best
RETAIL DISTRICTS				
Retail One	Regional Retail	Baseline	Good	Better
Retail Two	Community Retail	Good	Better	Best
Retail Three	Neighborhood Retail	Baseline	Baseline	Baseline
MXD DISTRICTS				
District One	Mix A	Good	Better	Best
District Two	Mix B	Baseline	Best	Best
District Three	Mix C	Good	Better	Best
District Four	Mix D	Baseline	Baseline	Baseline

MASTER PROGRAM RESULTS

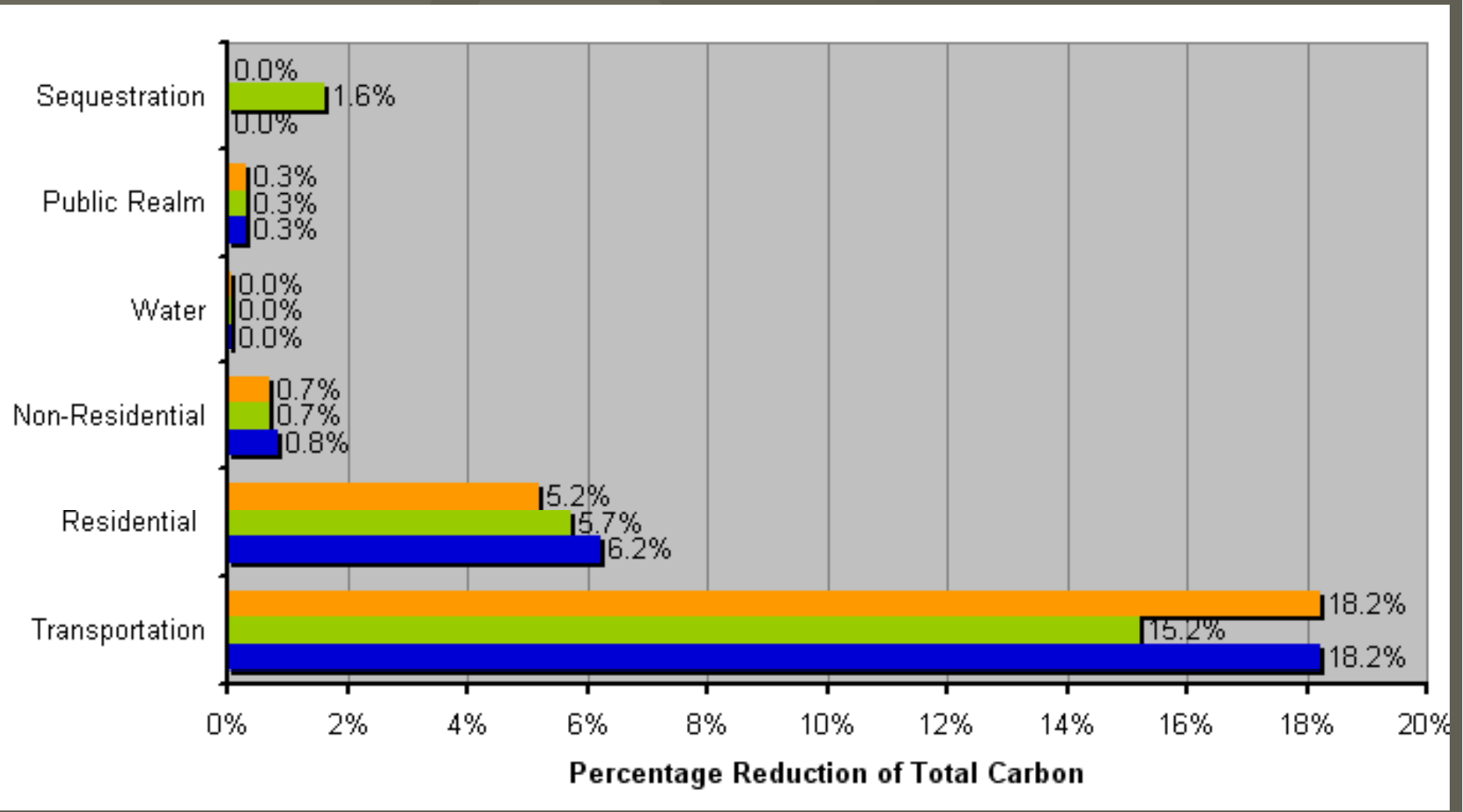
Total VMT Reduction	12.6%	27.9%	41.2%
Total Storm Water Reduction	10.6%	17.8%	31.6%
Total Pollutant Reduction	1.5%	30.5%	38.0%
City Total Cost	0.0%	36.3%	53.2%
Residential Owner Cost	0.5%	3.0%	4.8%
Commercial Owner Cost	2.1%	5.6%	9.0%

Key Sustainability Indicators



Comparative Reduction in GHG Emissions

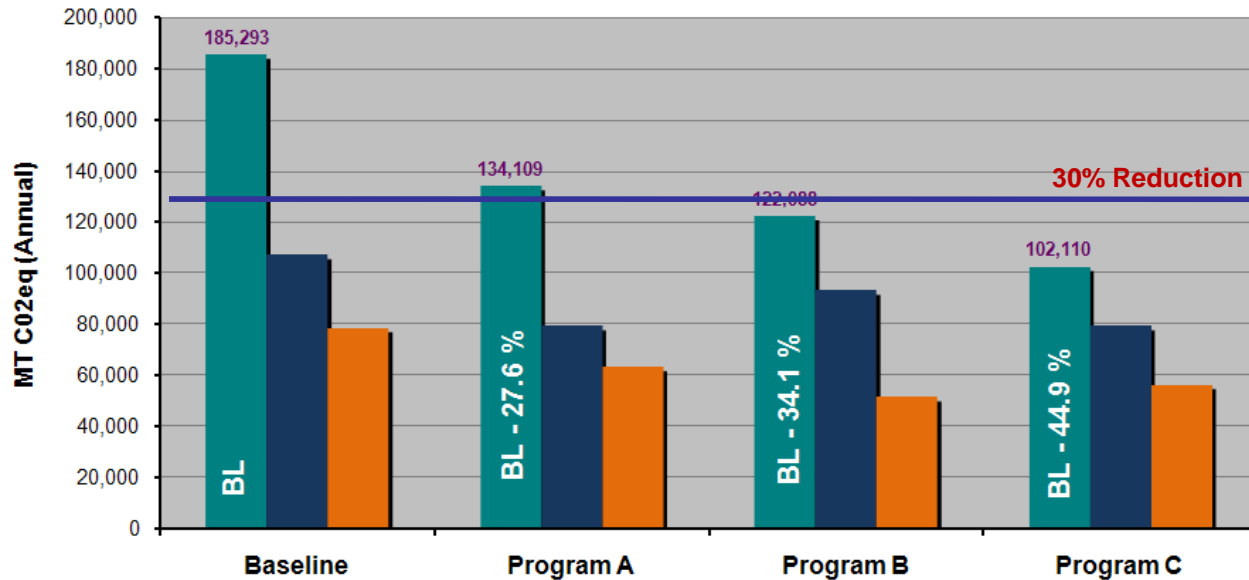
- Program A
- Program B
- Program C



Stage Three: Program Optimization

Total Carbon Emissions Generated

■ Net Carbon Emission ■ Mobile Sources ■ Non-Mobile Sources



* Net Carbon Emission includes offset from carbon sequestration on site but does not include off-site renewable energy offsets

% of Passenger Cars:	90.0%
% of SUVs	5.0%
% of Buses & Trucks	5.0%

Types of Passenger Cars	
Conventional:	98.0%
Hybrid:	2.0%
Electric:	0.0%
CNG:	0.0%

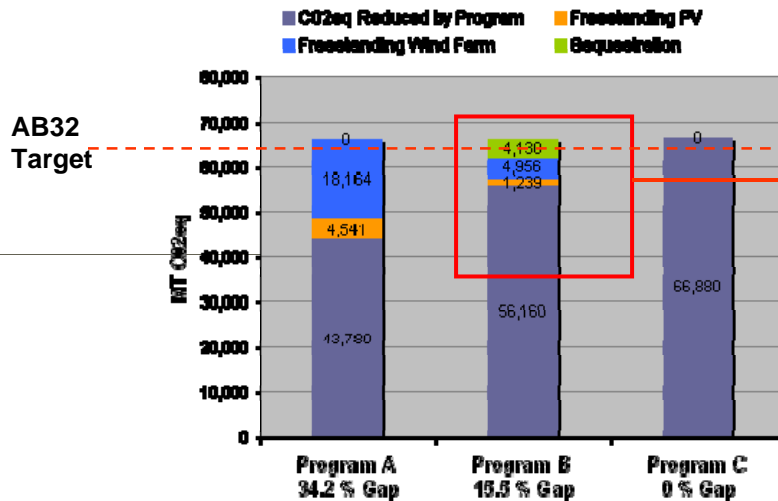
Types of SUVs	
Conventional:	89.0%
Hybrid:	1.0%
CNG:	10.0%

Types of Buses & Trucks	
Conventional:	100.0%
CNG:	90.0%
Electric:	10.0%

Stage Three: Carbon Footprint Targeting

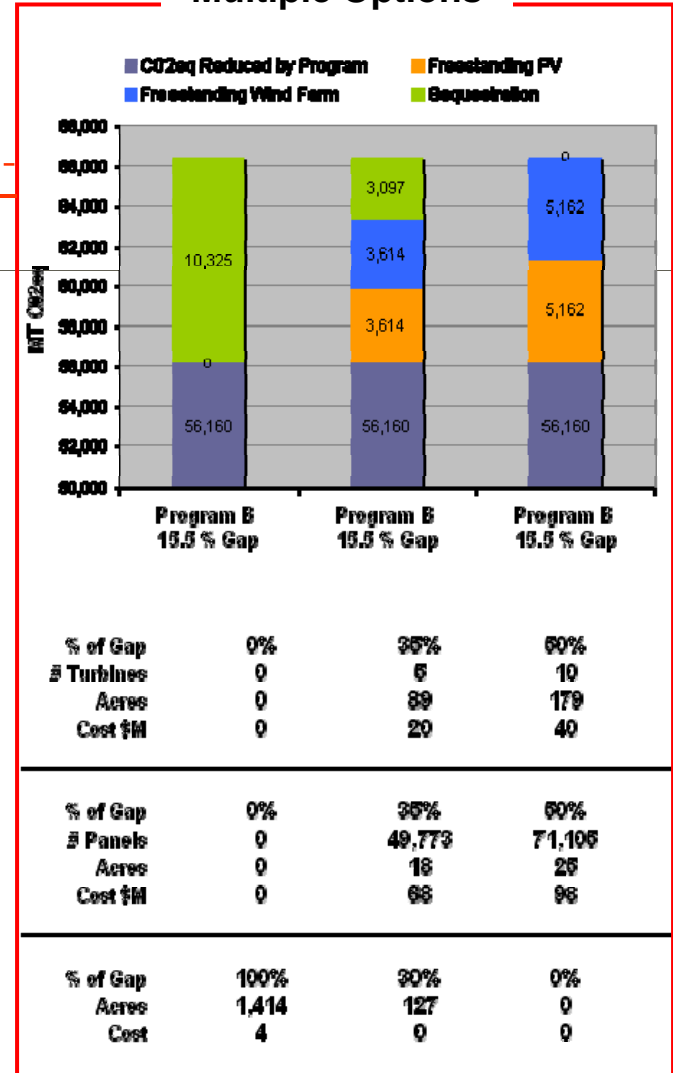
RENEWABLE ENERGY (with Transportation) TARGET : 30% MATCH


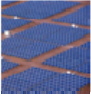

Carbon Reduction Achievement & Targets



AB32
Target

Multiple Options

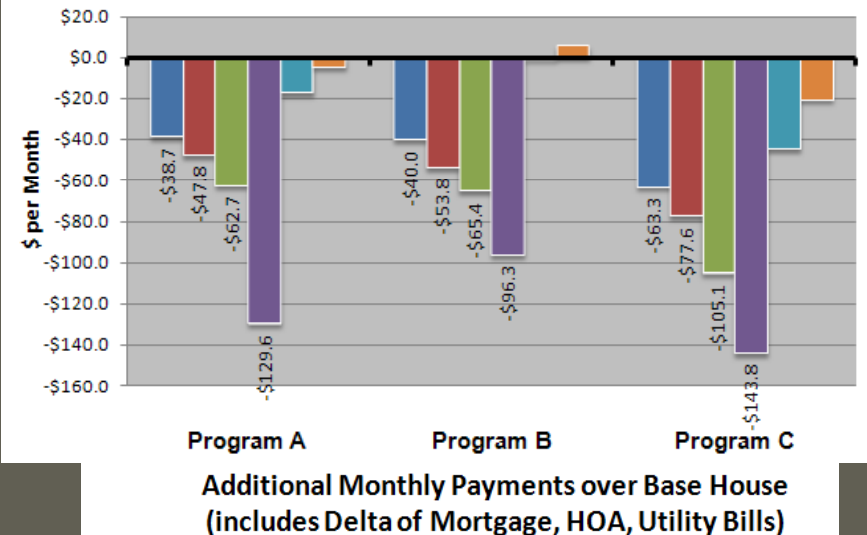
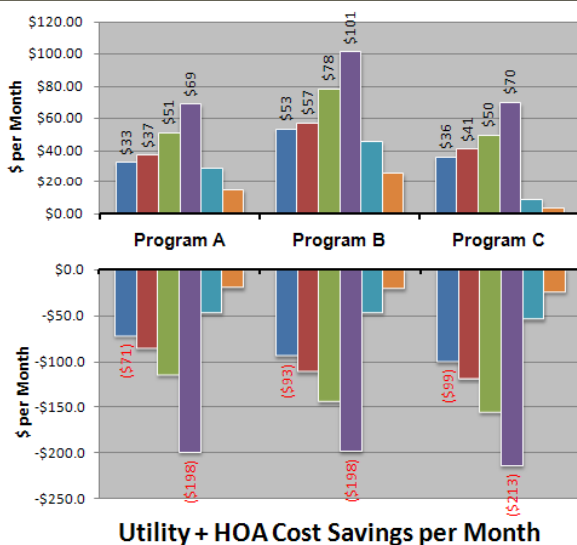


	% of Gap	Program A	Program B	Program C
 Wind Farm	% of Gap	80%	48%	0%
	# Turbines	29	7	0
	Acres	466	126	0
	Cost \$M	104	28	0
 Solar Farm	% of Gap	20%	12%	0%
	# Panels	62,544	17,066	0
	Acres	22	6	0
	Cost \$M	88	23	0
 Sequestration	% of Gap	0%	40%	0%
	Acres	0	226	0
	Cost	0	0	0

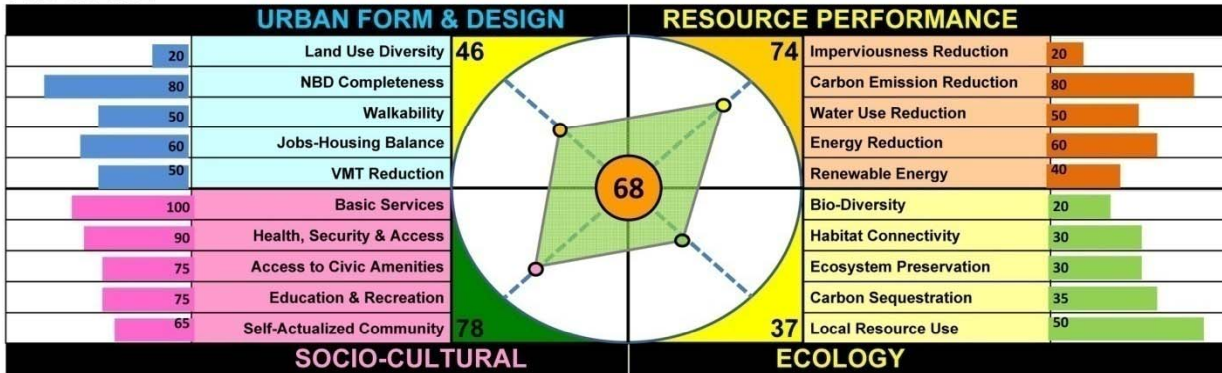
	Program B	Program B	Program B
% of Gap	0%	35%	50%
# Turbines	0	6	10
Acres	0	89	179
Cost \$M	0	20	40
% of Gap	0%	35%	50%
# Panels	0	49,773	71,106
Acres	0	18	26
Cost \$M	0	68	96
% of Gap	100%	30%	0%
Acres	1,414	127	0
Cost	4	0	0

Cost Impact on Individual Building Types

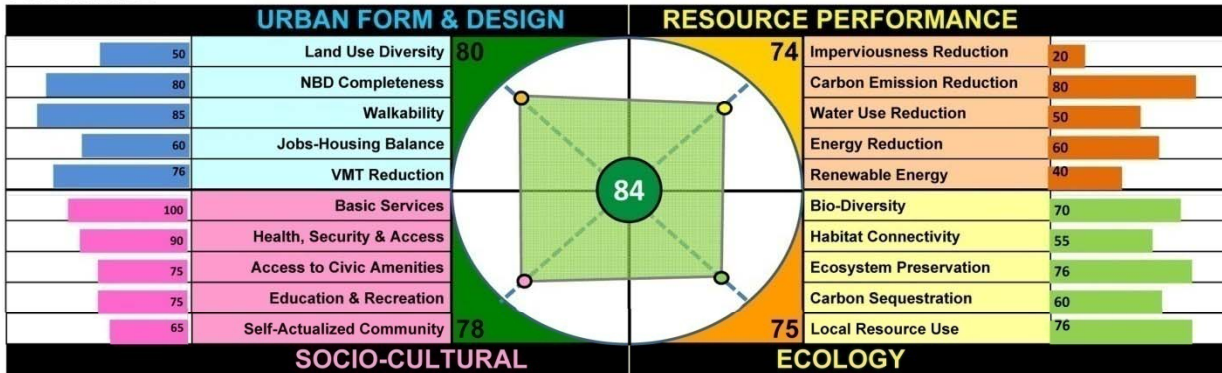
	PROGRAM A			PROGRAM B			PROGRAM C		
	\$ per sq ft per unit	% over Baseline	Increase per Unit	per sq ft per unit	% over Baseline	Increase per Unit	per sq ft per unit	% over Baseline	Increase per Unit
Small SFD	4.2	4.09%	6,017	6.87	6.75%	9,921	4.66	4.57%	6,725
Med SFD	3.7	4.30%	6,920	5.65	6.58%	10,576	4.07	4.74%	7,615
Large SFD	3.7	4.12%	9,505	5.63	6.32%	14,593	3.57	4.01%	9,248
Large SFD Rural	3.5	4.31%	12,820	5.08	6.35%	18,881	3.49	4.36%	12,967
Townhomes	3.3	3.12%	5,444	5.13	4.89%	8,517	0.98	0.93%	1,627
Low Rise Condos	3.4	2.71%	2,805	5.86	4.69%	4,849	0.73	0.59%	608
Retail	0.0	0.00%	0	13.83	16.86%	414,860	7.35	8.97%	220,572
Industrial	2.4	3.16%	316,318	8.68	11.27%	1,126,597	2.44	3.16%	316,318
Commercial	1.5	1.14%	110,477	8.41	6.52%	630,872	1.47	1.14%	110,477
Mixed Use (Off + Ret)	3.6	2.87%	430,905	13.49	10.79%	1,618,626	3.59	2.87%	430,905
Mixed Use (Res + Ret)	2.5	2.13%	62,093	4.07	3.45%	100,855	3.26	2.77%	80,795



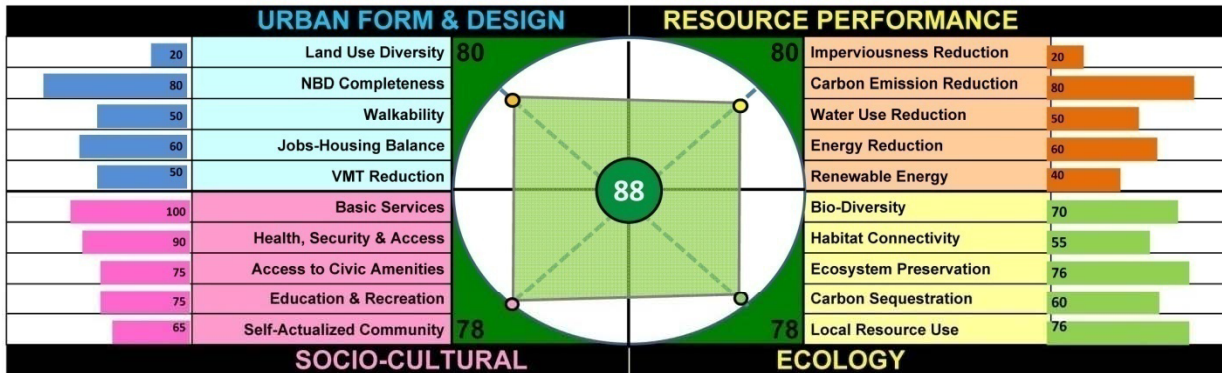
PROGRAM A



PROGRAM B



PROGRAM C



Integrated Whole Systems Thinking

<i>GHG Emissions Reduction</i>		Mature Neigh. / Districts	Infill / Redev. Districts	Greenfield Develop.	
	Transportation - VMT Reduction	1.2%	3.1%	5.4%	
A	Residential Energy	5.4%	8.6%	7.3%	
L	Non-Residential Energy	0.0%	3.0%	3.0%	
T	Water	0.1%	0.2%	0.1%	
	Public Realm Energy	0.9%	0.8%	0.9%	
O	Sequestration - Public Landscape	0.0%	2.0%	4.0%	
N	Sequestration - Urban Forestry	0.0%	0.0%	0.0%	
E	Free Standing Renewable Energy	0.0%	0.0%	0.0%	
	District Energy / CPH / CCPH	0.0%	0.0%	0.0%	
	Total % Reduction	7.6%	17.7%	20.7%	
	% of Total SF	65.0%	12.0%	23.0%	100.0%
	Net Reduction	4.9%	2.1%	4.8%	11.8%
Total Community GHG Reduction					
11.8%					
	Transportation - VMT Reduction	1.2%	3.1%	5.4%	
A	Residential Energy	9.8%	14.4%	14.4%	
L	Non-Residential Energy	2.7%	6.3%	4.4%	
T	Water	0.1%	0.2%	0.1%	
	Public Realm Energy	0.9%	0.8%	0.9%	
T	Sequestration - Public Landscape	4.9%	3.5%	6.5%	
W	Sequestration - Urban Forestry	0.0%	0.0%	2.9%	
O	Free Standing Renewable Energy	0.0%	0.0%	6.9%	
	District Energy / CPH / CCPH	0.0%	12.0%	0.0%	
	Total % Reduction	19.6%	40.3%	41.5%	
	% of Total SF	65.0%	12.0%	23.0%	100.0%
	Net Reduction	12.7%	4.8%	9.5%	27.1%
Total Community GHG Reduction					
27.1%					
	Transportation - VMT Reduction	1.2%	3.1%	5.4%	
A	Residential Energy	14.0%	8.0%	9.0%	
L	Non-Residential Energy	12.0%	5.0%	5.0%	
T	Water	0.0%	0.0%	0.0%	
	Public Realm Energy	12.0%	4.0%	3.0%	
T	Sequestration - Public Landscape	2.0%	6.0%	8.0%	
H	Sequestration - Urban Forestry	0.0%	0.0%	6.0%	
R	Free Standing Renewable Energy	0.0%	0.0%	6.9%	
E	District Energy / CPH / CCPH	0.0%	12.0%	0.0%	
E	Total % Reduction	41.2%	38.1%	43.3%	
	% of Total SF	65.0%	12.0%	23.0%	100.0%
	Net Reduction	26.8%	4.6%	10.0%	41.3%
Total Community GHG Reduction					
41.3%					



Optimization Approach for Sustainable Communities

EDAW / AECOM Sustainability

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