

Siemens: City Performance Tool

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Agenda





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The Challenge





City Performance Tool (CyPT)



Allows urban decision makers to optimize infrastructure technology investments based on estimated economic and environmental impacts

Using exclusive data to analyze the effects of more than 70+ diverse technologies, CyPT calculates the impact on CO_2eq emissions and air quality improvements. It also identifies new local jobs each technology can create in a city. CyPT Video: https://m.youtube.com/watch?v=d5ncYa8Okjs



* Available in CyPT-Air China only

CyPT Outcomes











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SIEMENS Ingenuity for life



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Orlando

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Mississauga

Pittsburgh



How CyPT Works





Data Collection	Data Analysis – Round 1	Data Analysis – Round 2	Infrastructure Strategy
City provides its data and targets, which is used to customize the model.	The model calculates the city's environmental baseline.	The model calculates the infrastructure technology impacts.	Siemens works with city to develop an infrastructure strategy based on future scenarios.
Buildings Bet-data points including: Floor space Energy consumption Building envelope Data Collection Data Collection Data Collection Data Collection Consumption Consumption Process specific data	To the second se	Which technologies should we use? When should our plans be implemented? What are the storylines for our city?	<text></text>
3 to 5 Months	1 Month	1 Month	2 Months

The City Performance Tool (Step 1)





Step 1: Data Inputs

- 350 data inputs
- Residential and commercial buildings, passenger and freight transport
- Emissions baseline for energy consumption using 2012 GPC Protocol for Community-Wide Emissions

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Data collection 350+ data points





General

5 data points

Population City population, density and growth

Emission targets

Targets for CO₂, NO_x and PM₁₀



Energy

50+ data points

Consumption City's annual energy consumption from electricity, heating and cooling.

Source mix

City's consumption source mix for electricity, heating and cooling.

Grid losses

City's transmission and distribution losses per KW generated power.



Transport

120+ data points

Passenger

Annual passenger kilometer travelled inside the city borders and the split between travel modes.

Freight

Ton kilometers of goods transported within the city borders annually, with split between road and rail.

Public transport service

Length of network, number of vehicles and capacity utilization for passenger transport modes.

Vehicles and fuel source Private vehicles, taxis and trucks fleet distribution.

Roads and infrastructure Road network, traffic management and streetlights



Buildings

80+* data points

Floor space

City's total floor space, per building category.

Electricity usage

The share of electricity split between lighting, ventilation appliances, per building category.

Building envelope

The share of losses from heating and cooling building space, per building category.

*per building category

CyPT Scope



Example: Data Collection San Francisco





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Example: Data Collection Phoenix



AVERAGE MILES TRAVELED PER PERSON, PER DAY 22.1 miles / person / day

NO. OF CARS ON THE ROAD

AVERAGE FUEL ECONOMY



% OF TOTAL ANNUAL PASSENGER MILES TRAVELED, BY MODE

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Source: Passenger miles based on <u>Acharya (2005) study</u> correlating per capita p-km to urban density Mode Shares calculated based on information from the City for miles per trip Total number of cars based on scaled number from <u>Maricopa county</u>; fuel economy is national average

Example: Data Collection Los Angeles





Mobility is the name of the game in Los Angeles. With the world's 10th busiest port, 4th busiest airport, and most congested streets, Los Angeles and Angelenos rely on cars and trucks not just for getting around, but also for supporting their livelihood. Stringent statewide fuel efficiency regulations have led to increasing efficiency and lower emissions for vehicles of all types, but air quality in LA is still poor, and even sunny days can be marred by smog.

The City Performance Tool (Step 2)





Step 2: CyPT Results

- Baselines BAU today and future
- 73 technologies, each with 3 customizable implementation rates
- Focus on:

1) clean underlying energy mix,

2) improve energy efficiency in buildings

and transport, and

3) induce modal shift



* Building emissions include Residential and commercial buildings including fugitive emissions Neither of the GPC emissions include scope 3

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Example: Emission Baseline Results

§ Transport Emissions include On-road transportation excluding diesel light & heavy trucks * Building emissions include Residential and commercial buildings including fugitive emissions Neither of the GPC emissions include scope 3

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Modal shift

A change in transport modal share as a consequence of either more attractive or less attractive transport mode.

Examples

Cycle Highway

Every new km of cycle network makes cycling increasingly attractive and will shift transport demand from other transport modes in the same proportion as their original modal share.

City Tolling

Reducing car modal share by a certain percentage will distribute the total demand over all other transport modes in the same proportion as their original modal share.

Corresponding Technologies in CyPT

- Metro New line
- Metro Reduced headway
- Tram New line
- e-BRT New line
- Cycle highway
- Bike share
- Public Transport E-ticketing
- Reduction in car demand
- Electric car sharing
- Car & Motorcycle City tolling
- Intermodal traffic management
- Freight tram Line upgrade

Replacing existing part of the energy mix with new energy source, by equally replacing the fossil parts of the energy mix with the new energy source.

Examples

Rooftop PV

Replacing x % of the annual electric consumption mix with PV for all fossil energy sources.

Electric Buses

Replacing x% of bus fleet with electric buses, ultimately changing from combustion motors to electric motors shifts the fuel use from liquid fuel to local electricity mix.

Corresponding Technologies in CyPT

- Alternative Fuel (Electric, CNG) buses
- BRT (Bus Rapid Transit) Electrification
- Alternative Fuel (CNG, Electric, Hydrogen plug-in hybrid) cars
- Electric taxis
- Electric car sharing
- Freight Train Electrification
- E-Highways
- Harbors Onshore Power Supply
- Wind Power
- PV
- Combined Cycle Gas Turbine
- Combined Heat and Power

Building Energy Efficiency

Reducing the demand for electricity or heating through improved building characteristics, automation or expert consulting.

Examples

Residential Window Glazing

Reduction of heating and cooling demand through double/triple glazed glass window panes

Non-Residential Building Automation

Reducing emissions from electric power utilization in building through automatic demand control and energy monitoring

Corresponding Technologies in CyPT

- Residential
 - Wall insulation & Glazing
 - Efficient lighting technology
 - Home Energy Monitoring
 - Home Automation
 - Building Envelope
- Non-Residential
 - Wall insulation & Glazing
 - Efficient lighting technology
 - Demand oriented lighting
 - Building Efficiency Monitoring (BEM)
 - Building Performance Optimization
 - Demand controlled ventilation
 - Heat recovery
 - Building Envelope
 - Room Automation, BACS A, B and C
 - Efficient Motors
 - Room Automation
 - Building Remote Monitoring (BRM)

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Fuel Efficiency

Reducing the demand for electricity or heating through improved building characteristics, automation or expert consulting.

Examples

Regenerative breaking

Increases the overall efficiency of metro by recuperation of energy when braking.

New Vehicles

New vehicles for metro and tram have a higher fuel efficiency that the older ones, increasing the overall fuel efficiency of the fleet

Corresponding Technologies in CyPT

- Automated train operation (ATO) Metro, Regional train, Tram
- New vehicles Metro, Tram
- Metro Reduced headway
- New Lines Metro, Tram, eBRT
- Regenerative Braking Metro and Tram
- Hybrid electric buses
- Hybrid electric cars
- Plug-in hybrid electric cars
- Car Eco-Driver Training and consumption awareness
- Occupancy-dependent Congestion Pricing
- Intelligent traffic light management

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CyPT Technology Example: Metro New Line

Description:

The worldwide demand for mobility keeps rising. Building additional/new metro line improves the public transport attractiveness and offering to answer the need of sustainable mobility in urban areas. Mobility as a single source supplier and system integrator combines the expertise necessary for sustainable solutions in urban rail transportation. These solutions include the infrastructures: tracks, electrification, the rail automation and telecommunication and rolling stocks. The lever describes the build of a new metro line, inducing a modal shift from less efficient mode to metro

Key success factors

- Improved energy efficiency based on low kWh / passenger-km
- Reduced emissions
- Noise reduction
- Improved attractiveness and comfort for Passengers

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Example: Emission Baseline Results Boston

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Example: Emission Impact of 2 New Metro Lines Boston

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CyPT Outcomes

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Reaching Targets 80x50 San Francisco

Annual GHG Emissions

Reaching Targets Carbon Neutral Boston?

Technology Impacts

Between Today and 2050: How to Achieve Emissions Reductions

GHG Emissions (Metric Tons CO, eq) **5.8M** 8M -84% $\rightarrow \rightarrow$ Potential CO₂eq 2050 BAU 7M Potential CO₂eq 6.92M Reduction Reduction (%) from CO,eq (in metric tons) from 2050 BAU 6M 2050 BAU 5M -84.4% **GHG** Emissions \$55B Electricity Reduction Decarbonization 647K 4M -34.0% CO₂eq Capital and Operating **Full-time Equivalents** 3M Heating Electrification Ā Expenditures Generated between -22.8% CO,eq between Today and Today and 2050 10 Building 2M Technologies 2050 -10.1% CO,eq 80x50 1M 21 Transport 1.07M Active Technologies CO,eq **Transport** -0.4% CO₂eq -17.1% CO,eq 2050 "Sustainable

Boston"

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Business-as-Usual

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Reaching Targets 80x50 Portland

Portland Can Reach 80x50 -48% -82% +2.5M 27 Full-time Equivalent Technologies CO2eq Emissions Particulate Matter Positions GHG Emissions (Metric Tons CO, eq) 7M6.58M 6.34M CD_eq 6M CO,eq Behavioral and Market Forces 624,679 5M -82% GHG Emissions 4M Reduction ЗM Policy 3,168,954 2M Technology Investment and Adoption 121M 1M CO,eq 1,345,755 0 1990 Today 2050 Baseline

• Behavioral Change

10% reduction in residential unit size

Policy

- Renewable Portfolio standards,
- 10% rooftop PV
- Technology Investment and adoption
 - 16 transport technologies
 - 11 building technologies

Reaching Targets Deep Carbon Reductions for Los Angeles

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Top-Performing Technologies San Francisco

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Top-Performing Technologies Boston

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GHG Reduction	Air Quality Improvement	Job Creation	Scost Efficiency
Non-Residential – Glazing	Non-Residential - Building Automation (BACS B)	Subway – New Lines	Cycle Highway
Non-Residential – Room Automation (HVAC+Blinds)	Non-Residential – Glazing	Non-Residential – Room Automation (HVAC+Blinds)	Subway – Regenerative Braking
Residential – Home Automation	Residential – Home Automation	Non-Residential – Heat Recovery	Intermodal Traffic Management
Non-Residential – Wall Insulation	Non-Residential – Building Remote Monitoring	Non-Residential – Building Remote Monitoring	City Tolling
Non-Residential – Building Remote Monitoring	Non-Residential – Wall Insulation	Non-Residential – Efficient Lighting Technology	Electric Taxis
0 metric tons 4.1m	0 kg 3.0m	0 Full-Time Equivalents 142k	0 6.55
Reduction in Annual CO2eq Emissions from 2050 BAU Restricted © Siemens AG 2018	Reduction in Annual NOx Emissions from 2050 BAU	Direct, Indirect, and Induced FTEs between Today and 2050	kgCO2eq savings / CapEx + OpEx

Top-Performing Technologies Portland

Top-Performing Technologies Los Angeles

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CyPT AQ Forecasting & Management

CyPT Air: Identify and Reduce Traffic related Air Pollution at Hot Spots

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Crawled historic air pollution data

Artificial neural network prediction

5-Day air quality forecast

Video

CyPTAir – Air Quality Forecast

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Short term measures at Hotspot

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Mid. and Long-term Infrastructure Technologies

Public

- Automated train operation (ATO) Metro
- Hybrid electric buses
- Automated train operation (ATO)

Metro - New line

Metro - New vehicles

Metro - Reduced headway

Tram - New line

e-BRT (Bus Rapid Transit) - New line

Tram - New vehicles

Buses - New CNG vehicles

BRT (Bus Rapid Transit) - Electrification

- Tram Automated train operation (ATO)
- Metro Regenerative braking
- Tram Regenerative braking
- Cycle highway

Bikeshare

Public Transport - E-ticketing

Private

- Reduction in car demand
- CNG cars
- Electric cars
- Hydrogen cars
- Hybrid electric cars
- Plug-in hybrid electric car
- Electric taxis
- Electric car sharing
- Car & Motorcycle City tolling
- Car Eco-Driver Training and consumption awareness
- Occupancy-dependent Congestion Pricing

Freight

- Freight tram Line upgrade
- Freight Train Electrification
- Lorries/Trucks Low emission zone
- E-Highways
- Harbors Onshore Power Supply

Summary

Measuring Impacts of Technologies on Urban Sustainability

- Critical data to collect population, electricity mix, building square footage, passenger miles traveled
- Focus levers and technologies clean the electricity mix, electric vehicle charging infrastructure
- Stakeholder engagement Infrastructure scenario modeling, appropriate technologies and implementation rates
- GHG & more economic impacts, AQ forecasting and management

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Appendix

Technologies 6 Residential Building Technologies

		IR1	IR2	IR3
Residential - Wall insulation	annual share of total residential stock fitted	1%	3%	5%
Residential - Glazing	annual share of total residential stock fitted	1%	3%	5%
Residential - Efficient lighting technology	annual share of total residential stock fitted	3%	5%	8%
Residential - Home Energy Monitoring	annual share of total residential stock fitted	3%	5%	8%
Residential - Home Automation	annual share of total residential stock fitted	1%	3%	5%
Residential - Building Envelope	annual share of total residential stock fitted	1%	3%	5%

Technologies 17 Non-Residential Building Technologies

NON-RESIDENTIAL

		IR1	IR2	IR3
Non-Residential - Wall insulation	annual share of total commercial stock fitted	1%	3%	5%
Non-Residential - Glazing	annual share of total commercial stock fitted	1%	3%	5%
Non-Residential - Efficient lighting technology	annual share of total commercial stock fitted	3%	5%	8%
Non-Residential - Demand oriented lighting	annual share of total commercial stock fitted	3%	5%	8%
Non-Residential - Building Efficiency Monitoring (BEM)	annual share of total commercial stock fitted	1%	3%	5%
Non-Residential - Building Performance Optimization (BPO)	annual share of total commercial stock fitted	1%	3%	5%
Non-Residential - Demand controlled ventilation	annual share of total commercial stock fitted	1%	3%	5%
Non-Residential - Heat recovery	annual share of total commercial stock fitted	1%	3%	5%
Non-Residential - Building Envelope	annual share of total commercial stock fitted	1%	3%	5%
Non-Residential - Building Automation, BACS C	annual share of total commercial stock fitted	1%	2%	3%
Non-Residential - Building Automation, BACS B	annual share of total commercial stock fitted	1%	2%	3%
Non-Residential - Building Automation, BACS A	annual share of total commercial stock fitted	1%	2%	3%
Non-Residential - Efficient Motors	annual share of total commercial stock fitted	3%	5%	8%
Non-Residential - Room Automation, HVAC	annual share of total commercial stock fitted	1%	2%	3%
Non-Residential - Room Automation, HVAC+lighting	annual share of total commercial stock fitted	1%	2%	3%
Non-Residential - Room Automation, HVAC+blind	annual share of total commercial stock fitted	1%	2%	3%
Non-Residential - Building Remote Monitoring (BRM)	annual share of total commercial stock fitted	3%	5%	8%

Technologies 18 Public Transport Technologies

₫ PUBLIC

		IR1	IR2	IR3
Automated train operation (ATO) Metro	share of lines equipped	30%	50%	70%
Metro - new lines	number of new lines	1	2	3
Metro - New vehicles	share of fleet replaced	30%	70%	100%
Metro - Regenerative braking	share of lines equipped	30%	70%	100%
Metro - Reduced headway	peak-time headway [s]	360	240	180
Automated train operation (ATO) Regional Train	share of lines equipped	30%	50%	70%
Street Car/Tram - New line	number of new lines	2	3	4
Street Car/Tram - Automated train operation (ATO)	share of lines equipped	30%	70%	100%
Street Car/Tram - Regenerative braking	share of lines equipped	30%	70%	100%
Street Car/Tram - New vehicles	share of fleet replaced	30%	70%	100%
Hybrid electric buses	share of fleet replaced	30%	70%	100%
Electric buses	share of fleet replaced	30%	70%	100%
Buses - New CNG vehicles	share of fleet replaced	30%	70%	100%
e-BRT (Bus Rapid Transit) - New line	number of new lines	3	5	7
BRT (Bus Rapid Transit) - Electrification	share of lines equipped	30%	70%	100%
Public Transport - E-ticketing	users as share of travelers	30%	70%	100%
Bikeshare	bikes per 1000 inhabitants	3	5	7
Cycle highway	km of new cycling highway per 100.000 inhabitants	1	3	5

Technologies 9 Private Transport Technologies, 5 Road Infrastructure Technologies

		IR1	IR2	IR3
CNG cars	share of car fleet replaced	20%	50%	70%
Electric cars	share of car fleet replaced	20%	50%	70%
Hydrogen cars	share of car fleet replaced	20%	50%	70%
Hybrid electric cars	share of car fleet replaced	20%	50%	70%
Plug-in hybrid electric cars	share of car fleet replaced	20%	50%	70%
Electric car sharing	cars pr 1000 inhabitants	1	2	3
Electric taxis	share of taxi fleet replaced	30%	70%	100%
Car - Eco-Driver Training and consumption awareness	share of driving license holders trained	30%	50%	80%
Car & Motorcycle - City tolling	reduction in road traffic	10%	20%	30%
LED Street lighting	share of street lights replaced	30%	70%	100%
Demand-oriented street lighting	share of street lights replaced	30%	70%	100%
Smart Street Lighting	share of street lights replaced	20%	50%	70%
Intermodal traffic management	Users as share of travelers	30%	70%	90%
Intelligent traffic light management	share of coordinated traffic lights	30%	70%	100%

5 Freight Technologies

FREIGHT

		IR1	IR2	IR3
Freight tram - Line upgrade	% of total route length that has been upgraded	10%	20%	30%
Freight Train - Electrification	% of total route length that has been electrified	30%	70%	100%
Lorries/Trucks - Low emission zone	% of city area included in low emission zone at target year	30%	70%	100%
E-Highways	% of hybrid diesel-electric trucks and highways with overhead power lines at target year	30%	70%	100%
Harbors - Onshore Power Supply	% of vessels operated using onshore power supply in target year	30%	70%	100%

Technologies

Technologies 9 Energy Technologies

Energy

		IR1	IR2	IR3
Wind	% of total energy generation in target year	20%	30%	50%
PV	% of total energy generation in target year	10%	20%	30%
Combined Cycle Gas Turbine	% of total energy generation in target year	10%	20%	30%
Combined Heat and Power	% of total energy generation in target year	10%	20%	30%
Network Optimization	% of network optimized in target year	50%	70%	100%
Smart Grid for Monitoring and	% of medium and low voltage grid monitored and automated by smart grid in			
Control	target year	50%	70%	100%
Power System Automation	% of grid automated and optimized in target year	50%	70%	100%
Smart Metering	% of housing connections with smart metering applied in target year	50%	70%	100%

CyPT Products CyPT, CyPT Air, CyPT Portal

City Performance Tool (CyPT)

- Tool developed by Siemens to help cities make informed infrastructure investment decisions and to identify which technologies from the transport, building, and energy sectors best fit a city's emission baseline
- Provided to the city as a consulting service
- Average timeline for full CyPT project ~ 9-12 months
- www.siemens.com/cypt

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CyPT Air

- Extended version of CyPT with focus on air quality from transport sector currently offered only in Europe
- Also includes air quality for industrial sector for limited types of industries (Cement and Steel) only in China.

CyPT Portal

- Free online scaled down version of CyPT suitable for cities with pop.100k – 10M
- Based on 5 key parameters that best describe city profile, cities can build an emission baseline and apply 40 technologies to view the impacts
- Output pdf report can be downloaded immediately
- https://www.cyptportal.siemens.com/

CyPT Self-Service Portal Tool Demo

CyPT Portal gives cities around the world access to a simplified version of the City Performance Tool.

With help of most relevant default data, users can identify which solutions/technologies will have highest impact on reducing GHG emissions, improving air quality and creating jobs.

https://www.cyptportal.siemens.com

