Agenda

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Overview
The Challenge

“How can infrastructure improvements help us achieve our sustainability targets?”

“What are the economic and environmental implications of our transport plans?”

“How quickly do we need to build infrastructure to meet our targets?”
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 CO₂eq 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](https://m.youtube.com/watch?v=d5ncYa8Okjs)
CyPT Outcomes

GHG

Air quality

Economy

- CO₂
- NOₓ
- So₂*
- PB*
- Ben-zene*
- PM10
- PM2.5*
- CO*

Jobs
Recognized by the world’s leading institutes
How CyPT Works
## CyPT Process
### Typical Timeline

<table>
<thead>
<tr>
<th>Data Collection</th>
<th>Data Analysis – Round 1</th>
<th>Data Analysis – Round 2</th>
<th>Infrastructure Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>City provides its data and targets, which is used to customize the model.</td>
<td>The model calculates the city’s environmental baseline.</td>
<td>The model calculates the infrastructure technology impacts.</td>
<td>Siemens works with city to develop an infrastructure strategy based on future scenarios.</td>
</tr>
<tr>
<td><strong>3 to 5 Months</strong></td>
<td><strong>1 Month</strong></td>
<td><strong>1 Month</strong></td>
<td><strong>2 Months</strong></td>
</tr>
</tbody>
</table>
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

* Water, waste and industrial excluded from the CyPT results.
Data collection
350+ data points

General
- Population: City population, density and growth
- Emission targets: Targets for CO₂, NOₓ and PM₁₀

Energy
- 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
- 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
- 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

- Fuel
- Raw Materials
- Imported / Exported Goods and Services
- Wastewater Treatment
- Private Transport
- Residential
- Road Freight
- Transit
- Agriculture & Land Use Change
- Commerce
- Industry
- Water Supply
- Waste Management
- Electricity, Steam, Heating / Cooling

Symbols:
- City Boundary
- Transport
- Energy
- Buildings
- Waste, Water, Industrial
Example: Data Collection
San Francisco

**PG&E Electricity Mix**
- 12% Hydro
- 6% Wind
- 5% Geothermal
- 5% Photovoltaic
- 18% Import / Others
- 22% Natural Gas

**SFPUC Electricity Mix**
- 0.1% Biomass
- 0.5% Wind
- 0.2% Photovoltaic
- 99.2% Hydro
- 16% Natural Gas
- 5% Nuclear
- 21% Photovoltaic

**Non-Residential Building Stock Using PG&E Electricity**
- 86% (209.3 million ft²)

**Non-Residential Building Stock Using SFPUC Electricity**
- 14% (33.3 million ft²)

**Transport Options Using PG&E Electricity**
- BART
- Electric Cars
- Electric Car Share

**Transport Options Using SFPUC Electricity**
- Muni Rail
- Muni Bus
- Muni Rapid Transit

**Population**
- 849,744

**Average Residential Unit Size**
- 1,280 ft²

**Total Non-Residential Building Footprint**
- 2.42M ft²

**Average Miles Traveled Per Person, Per Day**
- 20.6 Miles / Person / Day

**% of Total Passenger Miles Traveled**
- 61.8% Car
- 7% Walking
- 1.7% Bicycle
- 0.8% CalTrain
- 3% BART
- 7.3% Muni Rail
- 0% Bus Rapid Transit
- 16.2% Muni Bus
- 2.2% Taxis and TNCs
Example: Data Collection
Phoenix

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

NO. OF CARS ON THE ROAD
1.5 million

AVERAGE FUEL ECONOMY
23.9 MPG

Source: Passenger miles based on Acharya (2005) study 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 Maricopa county; fuel economy is national average
Example: Data Collection

Los Angeles

### Residential Data
- **Avg Residential Unit Size**: 1,263 ft²
- **Total Commercial Building Ft**: 661M ft²
- **Total Electricity Consumption**: 8,437 GWh
- **Total Energy Use Intensity**: 44 kBtu/ft²
- **Avg Energy Use Intensity**: 112 kBtu/ft²

### Non-Residential Data
- **Breakdown of Sq Footage of Commercial Buildings**
  - Residential: 22.2%
  - Other Non-Residential: 77.8%

### Passenger Transport
- **Avg Miles Traveled Per Person, Per Day**: 14.9 miles / person / day
- **No. of Cars on the Road (Cars Per Household)**: 2.5M (2)
- **Avg Fuel Economy**: 23.5 MPG
- **Avg. Daily No. of Trips To/From Port of Los Angeles**: 11K (trucks); 30 trains

### Freight Transport
- **Annual Freight-Ton Miles / Vehicle Miles Traveled**: 2.6 ton-miles / person / day (520 million VMT)

### Mobility

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 Angelinos 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.
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

* Water, waste and industrial excluded from the CyPT results.
Example: Emission Baseline Results
Los Angeles

ANNUAL EMISSIONS

- Transport: 6,461,213
- Buildings: 14,196,857

Today

- Transport: 2,441,616
- Buildings: 7,257,017

2050 BAU

(1) LADWP IRP for 77% renewable electricity
(2) Mode share shift
(3) Statewide fuel efficiency mandates

- Transport: 15,416,616
- Buildings: 17,257,017

- 51%
- 62%
- 45%

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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Siemens Cities Center of Competence
Example: Emission Baseline Results
Los Angeles

ANNUAL EMISSIONS

<table>
<thead>
<tr>
<th>Category</th>
<th>Emissions (metric tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td>6,461,213</td>
</tr>
<tr>
<td>Buildings</td>
<td>14,196,857</td>
</tr>
</tbody>
</table>

**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*

**Emissions for industrial buildings are 1.3 million metric tons, or roughly 9% of all emissions from buildings.**
**Example: Emission Baseline Results**

Los Angeles

**ANNUAL EMISSIONS**

- Transport: 6,461,213
- Buildings: 14,196,857

**BREAKDOWN FOR TRANSPORTATION**

- Car: 85.43%
- Motorcycle: 0.19%
- Taxi: 0.46%
- Bus: 0.46%
- BRT: 0.04%
- Street Car: 0.21%
- Metro: 0.06%
- Regional Train: 0.29%
- Freight: 12.83%

*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
## CyPT Methodology
### How CyPT Model Calculates Impacts

<table>
<thead>
<tr>
<th>Modal shift</th>
<th>Fuel</th>
<th>Increasing Efficiency</th>
</tr>
</thead>
</table>
| ![Car to bicycle](image)  
A change in transport modal share as a consequence of either more attractive or less attractive transport mode. | ![Coal to wind](image)  
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. | ![Building efficiency](image)  
Building Efficiency  
Fuel Efficiency  
Grid Efficiency |
## CyPT Methodology

### How CyPT Model Calculates Impacts

<table>
<thead>
<tr>
<th>Modal shift</th>
<th>Examples</th>
<th>Corresponding Technologies in CyPT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A change in transport modal share as a consequence of either more attractive or less attractive transport mode.</td>
<td><strong>Cycle Highway</strong>&lt;br&gt;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.</td>
<td>▪ Metro - New line&lt;br▪ Metro - Reduced headway&lt;br▪ Tram - New line&lt;br▪ e-BRT - New line&lt;br▪ Cycle highway&lt;br▪ Bike share&lt;br▪ Public Transport - E-ticketing&lt;br▪ Reduction in car demand&lt;br▪ Electric car sharing&lt;br▪ Car &amp; Motorcycle - City tolling&lt;br▪ Intermodal traffic management&lt;br▪ Freight tram – Line upgrade</td>
</tr>
<tr>
<td></td>
<td><strong>City Tolling</strong>&lt;br&gt;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.</td>
<td></td>
</tr>
</tbody>
</table>
CyPT Methodology
How CyPT Model Calculates Impacts

<table>
<thead>
<tr>
<th>Fuel shift</th>
<th>Examples</th>
<th>Corresponding Technologies in CyPT</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Coal to Wind" /></td>
<td><strong>Rooftop PV</strong>&lt;br&gt;Replacing x% of the annual electric consumption mix with PV for all fossil energy sources.</td>
<td>▪ Alternative Fuel (Electric, CNG) buses&lt;br▪ BRT (Bus Rapid Transit) - Electrification&lt;br▪ Alternative Fuel (CNG, Electric, Hydrogen plug-in hybrid) cars&lt;br▪ Electric taxis&lt;br▪ Electric car sharing&lt;br▪ Freight Train - Electrification&lt;br▪ E-Highways&lt;br▪ Harbors - Onshore Power Supply&lt;br▪ Wind Power&lt;br▪ PV&lt;br▪ Combined Cycle Gas Turbine&lt;br▪ Combined Heat and Power</td>
</tr>
<tr>
<td><img src="image" alt="Coal to Wind" /></td>
<td><strong>Electric Buses</strong>&lt;br&gt;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.</td>
<td></td>
</tr>
</tbody>
</table>

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.
# CyPT Methodology
## How CyPT Model Calculates Impacts

### 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)
## CyPT Methodology
### How CyPT Model Calculates Impacts

<table>
<thead>
<tr>
<th>Fuel Efficiency</th>
<th>Examples</th>
<th>Corresponding Technologies in CyPT</th>
</tr>
</thead>
</table>
| ![Energy Meter](image) | **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. | - 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 |

Reducing the demand for electricity or heating through improved building characteristics, automation or expert consulting.
### CyPT Methodology
How CyPT Model Calculates Impacts

<table>
<thead>
<tr>
<th>Grid Efficiency</th>
<th>Examples</th>
<th>Corresponding Technologies in CyPT</th>
</tr>
</thead>
</table>
| Reducing losses in electric grid during transport and distribution | **Smart Grid**
| | Reduces distribution losses by increased monitoring, planning and optimization of distributed energy resources. | - Network Optimization
| | **Smart Metering** | - Smart Grid for Monitoring and Control
| | Reducing emissions linked to non-technical losses within the low voltage grid power system by monitoring meters in every home. | - Power System Automation
| | | - Smart Metering |
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
Example: Emission Baseline Results

Boston
Example: Emission Impact of 2 New Metro Lines

Boston

Overall GHG Reduction
4% reduction from 2050 Baseline

Total Pkm remain the same
Impacts from increase in rail pkm are distributed proportionally between other modes including non-motorized

19% increase in Rail passenger km
12.1% increase in GHG

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Page 29 04.23.2018
Siemens Cities Center of Competence
CyPT Outcomes
Between Today and 2050: How to Achieve Emissions Reductions

Technology Impacts

5.8M
Potential CO₂eq
Reduction (in metric tons) from 2050 BAU

-84%
Potential CO₂eq
Reduction (%) from 2050 BAU

$55B
Capital and Operating Expenditures between Today and 2050

647K
Full-time Equivalents Generated between Today and 2050
### Reaching Targets

**80x50 Portland**

**Portland Can Reach 80x50**

<table>
<thead>
<tr>
<th>Technologies</th>
<th>CO2eq Emissions</th>
<th>Particulate Matter</th>
<th>Full-time Equivalent Positions</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>-82%</td>
<td>-48%</td>
<td>+2.5M</td>
</tr>
</tbody>
</table>

- **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

1990 Baseline
- 26.3M CO₂eq
- 21.5% GHG Emissions Reduction

LA2035
- $113B Capital and Operating Expenditures between Today and 2035
- 620K Full-Time Equivalents Generated between Today and 2035

LA2050
- $315B Capital and Operating Expenditures between Today and 2050
- 1.8K Full-Time Equivalents Generated between Today and 2050
Top-Performing Technologies
San Francisco

TRANSPORT: -30.8% CO₂eq
- Electric Car Sharing
- Electric Buses
- Electric Taxis
- Muni Rail (New Lines)
- Hybrid Electric Cars
- Reduction in Car Demand
- e-BRT: Bus Rapid Transit (New Line)

BUILDINGS: -32.6% CO₂eq
- Home Automation
- Building Envelope (Non-Residential)
- Building Envelope (Residential)
- Building Performance Optimization (BPO) (Non-Residential)
- Building Remote Monitoring (BRM) (Non-Residential)
- Building Automation, BAS B (Non-Residential)
- Building Efficiency Monitoring (BEM) (Residential)
- Smart Energy Management
- Solar (Residential)
- Electric Heat Pumps

ENERGY: -17.2% CO₂eq
- Rooftop PV
## Top-Performing Technologies

### Boston

<table>
<thead>
<tr>
<th>GHG Reduction</th>
<th>Air Quality Improvement</th>
<th>Job Creation</th>
<th>Cost Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Residential – Glazing</td>
<td>Non-Residential - Building Automation (BACS B)</td>
<td>Subway – New Lines</td>
<td>Cycle Highway</td>
</tr>
<tr>
<td>Non-Residential – Wall Insulation</td>
<td>Non-Residential – Building Remote Monitoring</td>
<td>Non-Residential – Building Remote Monitoring</td>
<td>City Tolling</td>
</tr>
</tbody>
</table>

### Reductions

- **Non-Residential – Glazing**: 4.1m metric tons
- **Non-Residential – Room Automation (HVAC+Blinds)**: 3.0m kg

### Emissions

- **Reduction in Annual CO2eq Emissions from 2050 BAU**: 142k Full-Time Equivalents
- **Direct, Indirect, and Induced FTEs between Today and 2050**: 6.55 kg CO2eq savings / CapEx + OpEx
Top-Performing Technologies
Portland

<table>
<thead>
<tr>
<th>GHG Reduction</th>
<th>Air Quality Improvement</th>
<th>Job Creation</th>
<th>Cost Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Cars</td>
<td>Electric Cars</td>
<td>New MAX Metrorail Lines</td>
<td>Congestion Charging</td>
</tr>
<tr>
<td>Roof Solar PV</td>
<td>Electric Buses</td>
<td>Room Automation for Commercial and Municipal Buildings</td>
<td>Electric Taxis</td>
</tr>
</tbody>
</table>

- **Electric Cars**
  - Reduction in Annual CO2eq Emissions from 2050 BAU: 0.7M metric tons
  - Reduction in Annual NOx Emissions from 2050 BAU: 0 kg

- **Rooftop Solar PV**
  - 1.1M kg

- **Congestion Charging**
  - 841k Full-Time Equivalents
  - Direct, Indirect, and Induced FTEs between Today and 2050: 0
  - kgCO2eq savings / CapEx + OpEx: 2.67
## Top-Performing Technologies
### Los Angeles

<table>
<thead>
<tr>
<th>GHG Reduction</th>
<th>Air Quality Improvement</th>
<th>Job Creation</th>
<th>Cost Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Pump</td>
<td>Electric cars</td>
<td>Metro New lines</td>
<td>High-Occupancy Tolling</td>
</tr>
<tr>
<td>Electric cars</td>
<td>E-Highways</td>
<td>Electric car sharing</td>
<td>Congestion Charging</td>
</tr>
<tr>
<td>Metro Reduced Headway</td>
<td>Rooftop PV Panels</td>
<td>Room Automation: HVAC+Lighting</td>
<td>Intelligent Traffic Light Management</td>
</tr>
<tr>
<td>Rooftop PV Panels</td>
<td>Metro Reduced headway</td>
<td>Power System Automation</td>
<td></td>
</tr>
<tr>
<td>Metro New Lines</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Reduction in Annual CO2eq Emissions from 2050 BAU (tons)
- Heat Pump: 0 metric tons
- Electric cars: 2.2m
- Metro Reduced Headway: 0 kg

### Reduction in Annual NOx Emissions from 2050 BAU (tons)
- Heat Pump: 0 kg
- Electric cars: 2.2k

### Direct, Indirect, and Induced FTEs between Today and 2050
- Metro New lines: 722k
- Room Automation: HVAC+Lighting: 0

### kgCO2eq savings / CapEx + OpEx
- High-Occupancy Tolling: 3.71
CyPT AQ Forecasting & Management
CyPT Air: Identify and Reduce Traffic related Air Pollution at Hot Spots
Short Term Emission Forecasting

Crawled historic air pollution data

Artificial neural network prediction

5-Day air quality forecast

Now

Weather

Weekday

Traffic

History Forecast
Video

CyPTAir – Air Quality Forecast
### Short term measures at Hotspot

#### Transport

<table>
<thead>
<tr>
<th>Improve Traffic Flow</th>
<th>Distribute Traffic (fleet / modal shift)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmentally-Conscious Traffic Management</td>
<td>Low Emission Zone for Diesel Cars</td>
</tr>
<tr>
<td>Speed Limit</td>
<td>Driving Ban for Diesel Cars</td>
</tr>
<tr>
<td>Eco-Driving Training</td>
<td>Hotspot CNG-Bus Lines</td>
</tr>
<tr>
<td><strong>Reduce Traffic</strong></td>
<td>Hotspot Euro 6 Diesel-Bus Lines</td>
</tr>
<tr>
<td>Ramp Metering of Road Traffic</td>
<td>Hotspot e-Bus Lines</td>
</tr>
<tr>
<td>Temporary Driving Ban of Trucks at Hotspot</td>
<td>Public Transport Ticket on Air Quality Alert Days</td>
</tr>
<tr>
<td><strong>Passive Measure</strong></td>
<td>Public Transport Ticket valid for Air Pollution Season</td>
</tr>
<tr>
<td>Green Facades</td>
<td>City Tolling</td>
</tr>
<tr>
<td><strong>Temp. L.E.Z. for Diesel Cars</strong></td>
<td>Measure reduces traffic related air pollution at Hotspot</td>
</tr>
<tr>
<td><strong>Temporary Driving Ban by License Plate for Cars</strong></td>
<td>Measure reduces traffic related air pollution as part of urban background (however only specified in CyPT-Air long term Consulting or additional offer required)</td>
</tr>
<tr>
<td><strong>Temporary Driving Ban for Diesel Cars</strong></td>
<td></td>
</tr>
</tbody>
</table>

Measure applied only on days with exceedance of daily or hourly air pollution limits.
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

Private
- Bikeshare
- Public Transport - E-ticketing
- 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
Contact

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www.siemens.com/cypt
## Technologies

### 6 Residential Building Technologies

<table>
<thead>
<tr>
<th>RESIDENTIAL</th>
<th>Residential - Wall insulation</th>
<th>annual share of total residential stock fitted</th>
<th>IR1</th>
<th>IR2</th>
<th>IR3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Residential - Glazing</td>
<td>annual share of total residential stock fitted</td>
<td>1%</td>
<td>3%</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>Residential - Efficient lighting technology</td>
<td>annual share of total residential stock fitted</td>
<td>3%</td>
<td>5%</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td>Residential - Home Energy Monitoring</td>
<td>annual share of total residential stock fitted</td>
<td>3%</td>
<td>5%</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td>Residential - Home Automation</td>
<td>annual share of total residential stock fitted</td>
<td>1%</td>
<td>3%</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>Residential - Building Envelope</td>
<td>annual share of total residential stock fitted</td>
<td>1%</td>
<td>3%</td>
<td>5%</td>
</tr>
</tbody>
</table>
## Non-Residential Building Technologies

### Technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Annual Share of Total Commercial Stock Fitted</th>
<th>IR1</th>
<th>IR2</th>
<th>IR3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Residential - Wall insulation</td>
<td>Annual share of total commercial stock fitted</td>
<td>1%</td>
<td>3%</td>
<td>5%</td>
</tr>
<tr>
<td>Non-Residential - Glazing</td>
<td>Annual share of total commercial stock fitted</td>
<td>1%</td>
<td>3%</td>
<td>5%</td>
</tr>
<tr>
<td>Non-Residential - Efficient lighting technology</td>
<td>Annual share of total commercial stock fitted</td>
<td>3%</td>
<td>5%</td>
<td>8%</td>
</tr>
<tr>
<td>Non-Residential - Demand oriented lighting</td>
<td>Annual share of total commercial stock fitted</td>
<td>3%</td>
<td>5%</td>
<td>8%</td>
</tr>
<tr>
<td>Non-Residential - Building Efficiency Monitoring (BEM)</td>
<td>Annual share of total commercial stock fitted</td>
<td>1%</td>
<td>3%</td>
<td>5%</td>
</tr>
<tr>
<td>Non-Residential - Building Performance Optimization (BPO)</td>
<td>Annual share of total commercial stock fitted</td>
<td>1%</td>
<td>3%</td>
<td>5%</td>
</tr>
<tr>
<td>Non-Residential - Demand controlled ventilation</td>
<td>Annual share of total commercial stock fitted</td>
<td>1%</td>
<td>3%</td>
<td>5%</td>
</tr>
<tr>
<td>Non-Residential - Heat recovery</td>
<td>Annual share of total commercial stock fitted</td>
<td>1%</td>
<td>3%</td>
<td>5%</td>
</tr>
<tr>
<td>Non-Residential - Building Envelope</td>
<td>Annual share of total commercial stock fitted</td>
<td>1%</td>
<td>3%</td>
<td>5%</td>
</tr>
<tr>
<td>Non-Residential - Building Automation, BACS C</td>
<td>Annual share of total commercial stock fitted</td>
<td>1%</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>Non-Residential - Building Automation, BACS B</td>
<td>Annual share of total commercial stock fitted</td>
<td>1%</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>Non-Residential - Building Automation, BACS A</td>
<td>Annual share of total commercial stock fitted</td>
<td>1%</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>Non-Residential - Efficient Motors</td>
<td>Annual share of total commercial stock fitted</td>
<td>3%</td>
<td>5%</td>
<td>8%</td>
</tr>
<tr>
<td>Non-Residential - Room Automation, HVAC</td>
<td>Annual share of total commercial stock fitted</td>
<td>1%</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>Non-Residential - Room Automation, HVAC+lighting</td>
<td>Annual share of total commercial stock fitted</td>
<td>1%</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>Non-Residential - Room Automation, HVAC+blind</td>
<td>Annual share of total commercial stock fitted</td>
<td>1%</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>Non-Residential - Building Remote Monitoring (BRM)</td>
<td>Annual share of total commercial stock fitted</td>
<td>3%</td>
<td>5%</td>
<td>8%</td>
</tr>
</tbody>
</table>
# Public Transport Technologies

## Technologies

### 18 Public Transport Technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>IR1</th>
<th>IR2</th>
<th>IR3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automated train operation (ATO) Metro</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metro - new lines</td>
<td>30%</td>
<td>50%</td>
<td>70%</td>
</tr>
<tr>
<td>Metro - New vehicles</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Metro - Regenerative braking</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
<td>Metro - Reduced headway</td>
<td>360</td>
<td>240</td>
<td>180</td>
</tr>
<tr>
<td>Automated train operation (ATO) Regional Train</td>
<td>30%</td>
<td>50%</td>
<td>70%</td>
</tr>
<tr>
<td>Street Car/Tram - New line</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Street Car/Tram - Automated train operation (ATO)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Street Car/Tram - Regenerative braking</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
<td>Street Car/Tram - New vehicles</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
<td>Hybrid electric buses</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
<td>Electric buses</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
<td>Buses - New CNG vehicles</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
<td>e-BRT (Bus Rapid Transit) - New line</td>
<td>3</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>BRT (Bus Rapid Transit) - Electrification</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
<td>Public Transport - E-ticketing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bikeshare</td>
<td>3</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Cycle highway</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

### Technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>IR1</th>
<th>IR2</th>
<th>IR3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automated train operation (ATO) Metro</td>
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<td></td>
<td></td>
</tr>
<tr>
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<td>50%</td>
<td>70%</td>
</tr>
<tr>
<td>Metro - New vehicles</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Metro - Regenerative braking</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
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<td>180</td>
</tr>
<tr>
<td>Automated train operation (ATO) Regional Train</td>
<td>30%</td>
<td>50%</td>
<td>70%</td>
</tr>
<tr>
<td>Street Car/Tram - New line</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Street Car/Tram - Automated train operation (ATO)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Street Car/Tram - Regenerative braking</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
<td>Street Car/Tram - New vehicles</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
<td>Hybrid electric buses</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
<td>Electric buses</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
<td>Buses - New CNG vehicles</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
<td>e-BRT (Bus Rapid Transit) - New line</td>
<td>3</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>BRT (Bus Rapid Transit) - Electrification</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
<td>Public Transport - E-ticketing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bikeshare</td>
<td>3</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Cycle highway</td>
<td>1</td>
<td>3</td>
<td>5</td>
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</tbody>
</table>
## Technologies

### Private Transport Technologies, 5 Road Infrastructure Technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>IR1</th>
<th>IR2</th>
<th>IR3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNG cars</td>
<td>20%</td>
<td>50%</td>
<td>70%</td>
</tr>
<tr>
<td>Electric cars</td>
<td>20%</td>
<td>50%</td>
<td>70%</td>
</tr>
<tr>
<td>Hydrogen cars</td>
<td>20%</td>
<td>50%</td>
<td>70%</td>
</tr>
<tr>
<td>Hybrid electric cars</td>
<td>20%</td>
<td>50%</td>
<td>70%</td>
</tr>
<tr>
<td>Plug-in hybrid electric cars</td>
<td>20%</td>
<td>50%</td>
<td>70%</td>
</tr>
<tr>
<td>Electric car sharing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric taxis</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
<td>Car - Eco-Driver Training and consumption awareness</td>
<td>30%</td>
<td>50%</td>
<td>80%</td>
</tr>
<tr>
<td>Car &amp; Motorcycle - City tolling</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td>LED Street lighting</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
<td>Demand-oriented street lighting</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
<td>Smart Street Lighting</td>
<td>20%</td>
<td>50%</td>
<td>70%</td>
</tr>
<tr>
<td>Intermodal traffic management</td>
<td>30%</td>
<td>70%</td>
<td>90%</td>
</tr>
<tr>
<td>Intelligent traffic light management</td>
<td>30%</td>
<td>70%</td>
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</tbody>
</table>
### Technologies

#### 5 Freight Technologies

<table>
<thead>
<tr>
<th><strong>FREIGHT</strong></th>
<th><strong>IR1</strong></th>
<th><strong>IR2</strong></th>
<th><strong>IR3</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Freight tram - Line upgrade</td>
<td>% of total route length that has been upgraded</td>
<td>10%</td>
<td>20%</td>
</tr>
<tr>
<td>Freight Train - Electrification</td>
<td>% of total route length that has been electrified</td>
<td>30%</td>
<td>70%</td>
</tr>
<tr>
<td>Lorries/Trucks - Low emission zone</td>
<td>% of city area included in low emission zone at target year</td>
<td>30%</td>
<td>70%</td>
</tr>
<tr>
<td>E-Highways</td>
<td>% of hybrid diesel-electric trucks and highways with overhead power lines at target year</td>
<td>30%</td>
<td>70%</td>
</tr>
<tr>
<td>Harbors - Onshore Power Supply</td>
<td>% of vessels operated using onshore power supply in target year</td>
<td>30%</td>
<td>70%</td>
</tr>
<tr>
<td>Energy Technology</td>
<td>IR1</td>
<td>IR2</td>
<td>IR3</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Wind</td>
<td>20%</td>
<td>30%</td>
<td>50%</td>
</tr>
<tr>
<td>PV</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td>Combined Cycle Gas Turbine</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td>Combined Heat and Power</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td>Network Optimization</td>
<td>50%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
<td>Smart Grid for Monitoring and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power System Automation</td>
<td>50%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
<td>Smart Metering</td>
<td>50%</td>
<td>70%</td>
<td>100%</td>
</tr>
</tbody>
</table>
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

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