An Introduction to the Integrated Transport and Health Impact Model (ITHIM)

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ITHIM Timeline in California and the US

2009   Lancet Publication

2010-2011 Feasibility study and demonstration

2012-2013 Statewide regional calibration

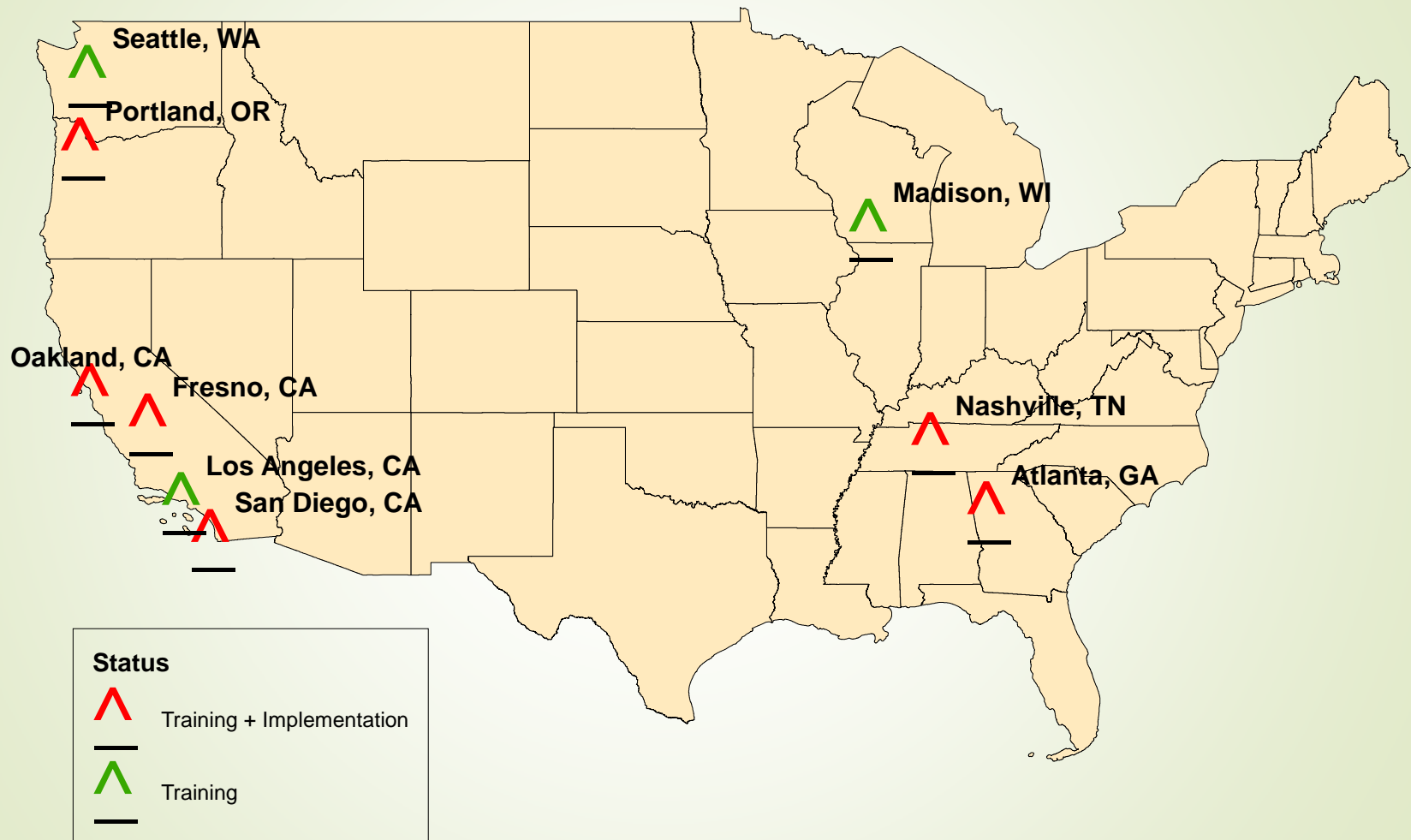| SAS/R Program	Excel Output	Standardized Database	Calibration Worksheet

2014-16   Trainings and MPO implementations

2016-   Implementation in R

ITHIM Training and Implementations in the US

- 7 training events (2013-2016)
  - ~105 transportation and health professionals
  - 5 MPOs
  - Centers for Disease Control
  - 3 state health departments
  - State agencies (CARB Research Division, CalTrans Districts)
  - 14 local health departments
  - University of Wisconsin
- Implementations
  - MTC
  - FresnoCOG
  - SANDAG
  - Nashville, TN MPO
  - Portland
  - USA

ITHIM Training and Implementation Sites, US, 2016

Seattle, WA

Portland, OR

Madison, WI

Oakland, CA

Fresno, CA

Nashville, TN

Los Angeles, CA

Atlanta, GA

San Diego, CA

Status

Training + Implementation

Training

N Maizlish - 2016/06/19

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Climate Change and Public Health

- Climate change no. 1 public health threat
- California, world's 14th largest greenhouse gas emitter
- Transportation is the largest source of GHGs in California – 37% of total (173 MMT CO_2e in 2013)
- How can we reduce GHG emissions?
  - Increase efficiency of vehicles and fuels
  - Reduce vehicle miles traveled

?   ?   ?   ?

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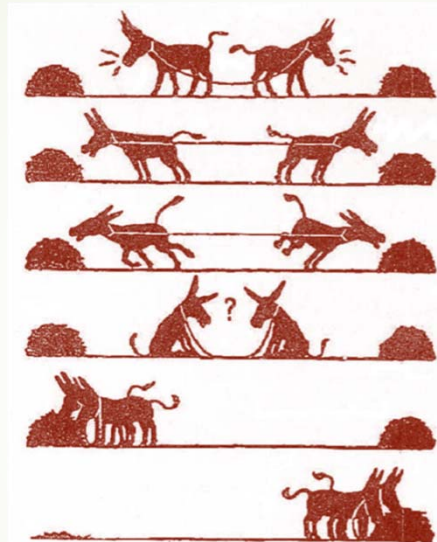
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5

Smart Strategies Solve Multiple Problems

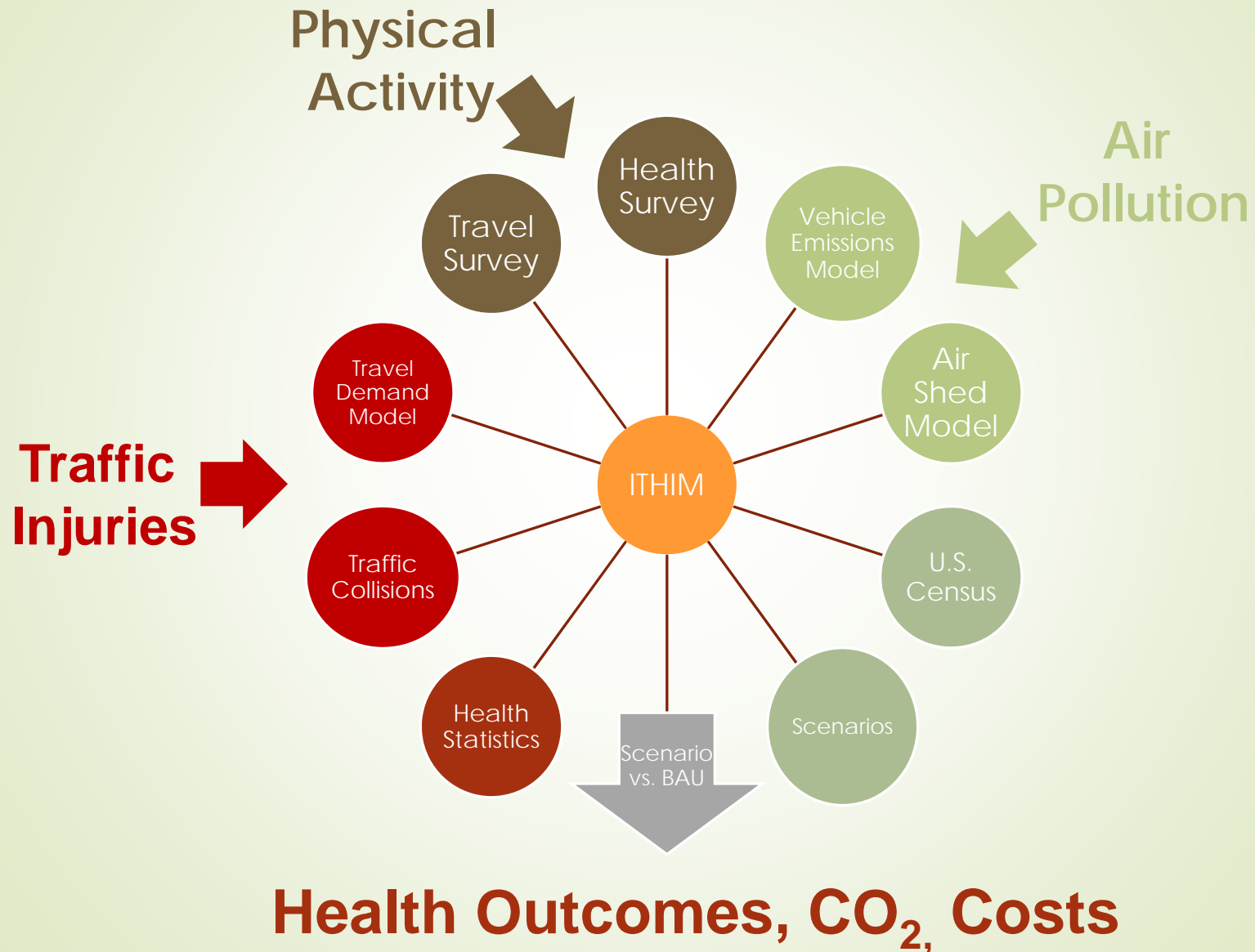Chronic disease accounts for 93% of health burden

GHGs

Chronic Disease

Do the strategies generate co-benefits or harms?

What strategies yield significant health co-benefits?

How do we measure this?

ITHIM Integrates Data on Health and Travel

Physical Activity

Air Pollution

Traffic Injuries

- Travel Survey
- Health Survey
- Vehicle Emissions Model
- Travel Demand Model
- Air Shed Model
- ITHIM
- Traffic Collisions
- U.S. Census
- Health Statistics
- Scenario vs. BAU
- Scenarios

Health Outcomes, CO_2, Costs

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- **Physical Activity**
  - Ischemic Heart Disease
  - Hypertensive Heart Disease
  - Stroke
  - Diabetes
  - Dementia (Alzheimer's)
  - Depression
  - Colon Cancer
  - Breast Cancer

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Characteristics of Physical Activity Model

- Variation in exposures
  - Age & Gender
  - Distributions or individual level data not means
  - Combining different domains
- Non-linear relative risks

ITHIM Health Pathways, Diseases, and Injuries

- ## Air pollution
  - Cardio-pulmonary disease, asthma, inflammatory heart disease
  - Acute respiratory diseases in children

- ## Road Traffic Injuries
  - On-public roads, single and multi-party collisions
  - Severe and fatal

Leading Causes of Death, United States, 2014

	Cause of Death	N
	All causes	2,626,418
1.	**Heart disease**	**614,348**
2.	**Cancer**	**591,699**
3.	**Chronic respiratory**	**147,101**
4.	**Unintentional injury**	**136,053**
5.	**Stroke**	**133,103**
6.	**Alzheimer's disease**	**93,541**
7.	**Diabetes mellitus**	**76,488**
8.	Influenza/pneumonia	55,227
9.	Nephritis	48,146
10.	Suicide	42,773

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Attributable Fraction of Disease Burden Due to . . .

- Change in the level of transportation-related physical activity through walking, bicycling alone and associated with transit

- Change in air pollution levels from shifting short car trips to active transport
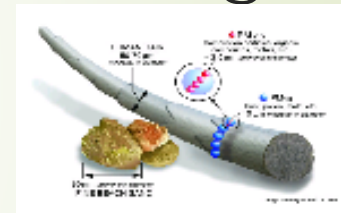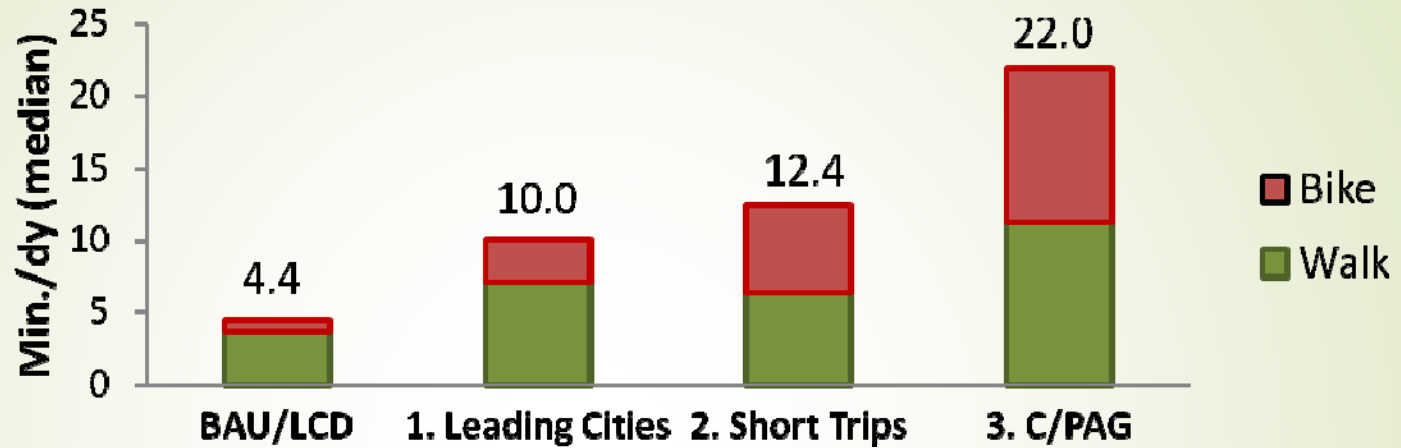
- Change in road traffic injuries as distances shift more to active modes

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Time

BAU = Business-as-Usual

Distance
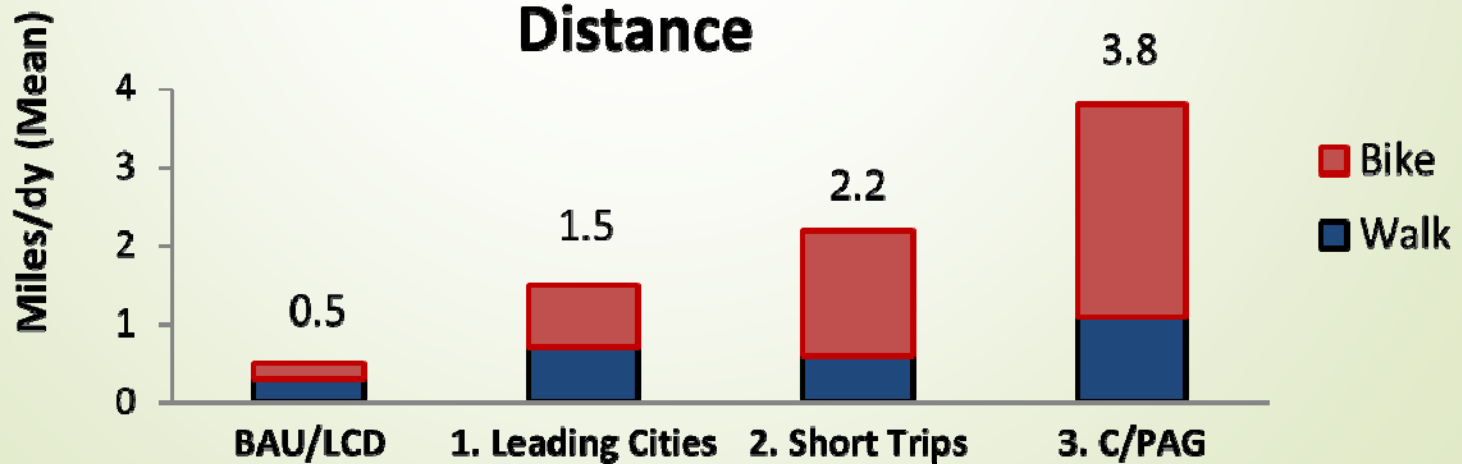
Health Impacts of Active Transport Scenarios, Bay Area

	Change in disease burden		Change in premature deaths
Cardiovascular Dis.	6-15%	⬇	724-1895*
Diabetes	6-15%	⬇	73-189
Depression	2-6%	⬇	<2
Dementia	3-10%	⬇	63-218
Breast cancer	2-5%	⬇	15-48
Colon Cancer	2-6%	⬇	17-53
Road traffic crashes	10-19%	⬆	60-113

* Range reflects range of physical activity in scenarios

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Annual Health Benefits of Active Transport and Low Carbon Driving in the Bay Area: Predictions from the ITHIM Model

Source of Health Benefit or Harm

■ Injuries   ■ Air Pollution   ■ Physical Activity

Y-axis: **Disability Adjusted Life Years Gained per Million Population** (compared to business as usual)

5000
4000
3000
2000
1000
0
-1000

5,939

13 Air Pollution   33

-783

Walking/Bicycling   Low Carbon Driving

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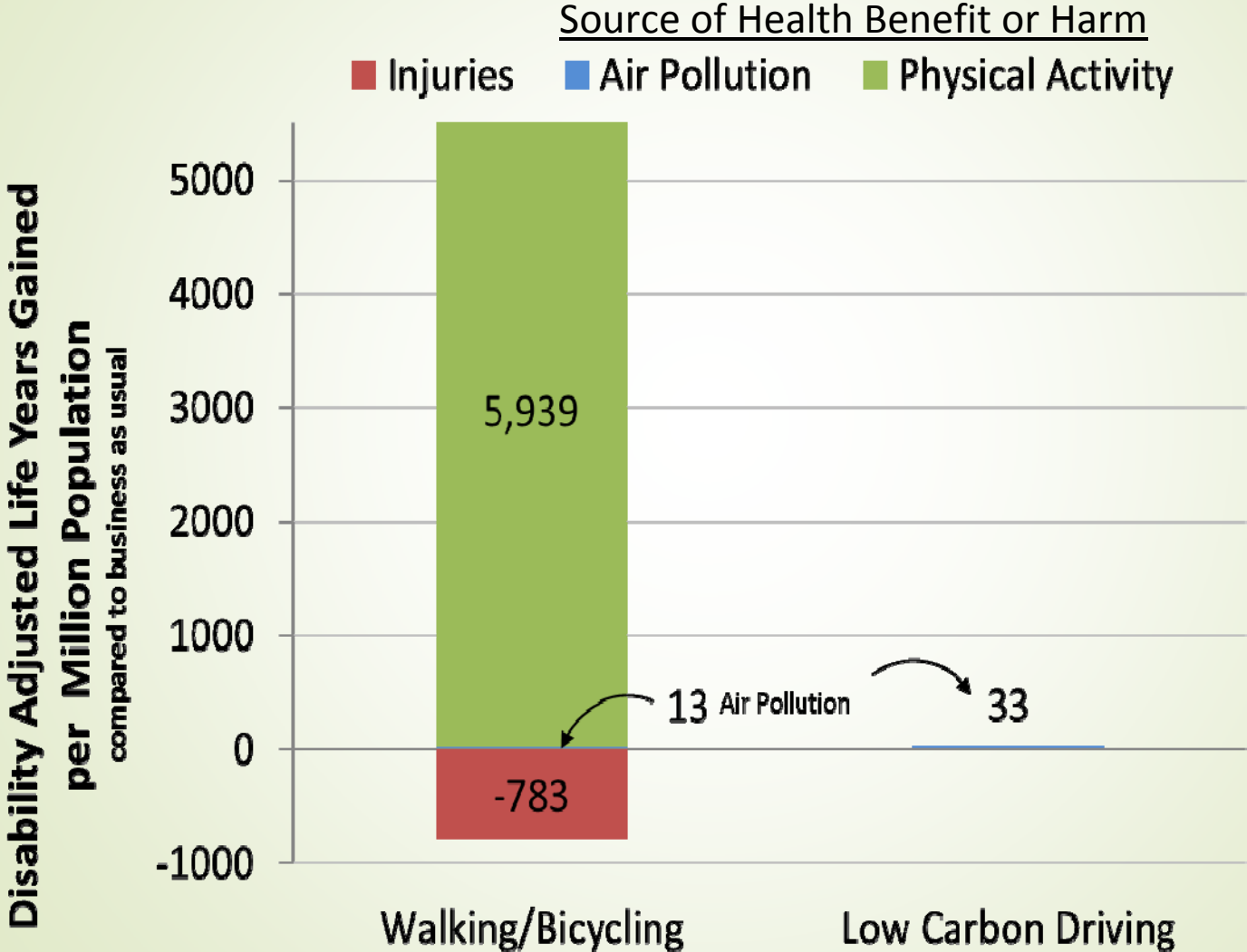
Annual Aggregate Reductions in Passenger Vehicle Greenhouse Gas Emissions from Different Transport Scenarios
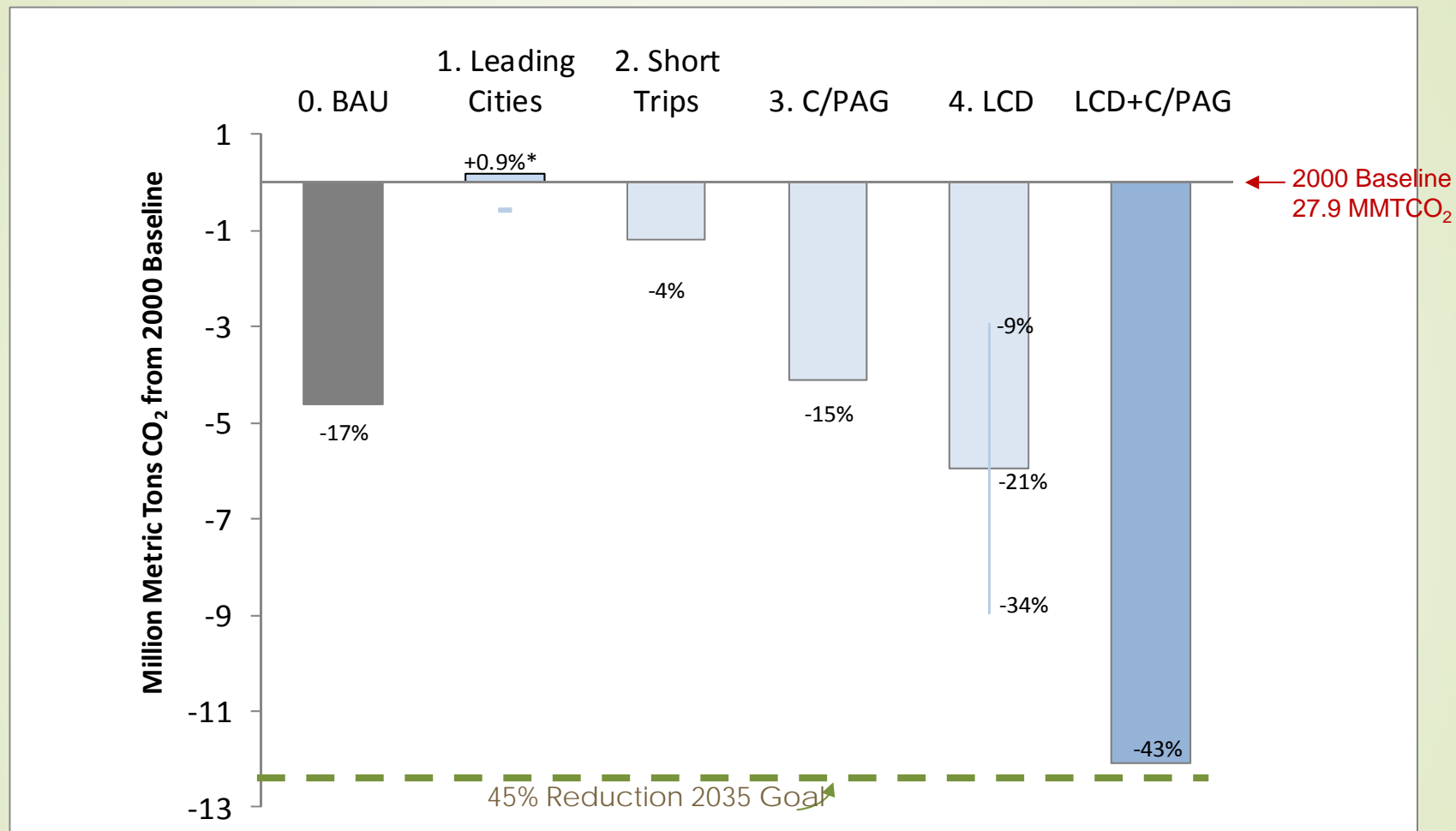
Based on car VMT*BASSTEGG emission factor
* Per capita reduction of 26%
† Adjusted for double counting of mode choice
BAU, Business-as-Usual; LCD, Low Carbon Driving; C/PAG, Carbon/Physical Activity Goal

Summary of Findings

A shift in active transport from a median of 4.4 to 22 minutes/day (2% to 15% distance mode share):

➡ Disease reductions

⬇14% of heart disease, stroke, and diabetes

⬇6-7% of dementia and depression

⬇5% of breast and colon cancer

➡Major public health impact

➡Adds about 9.5 months of life expectancy

➡>$1.4-$22 billion annual Bay Area health cost savings

ITHIM – Other Versions

- USA in policy (ITHIM 1)

  - Spreadsheet + extensive input data calibration

  - Multiple implementations e.g. Nashville, California, Oregon

  - Maintained and developed by Dr Neil Maizlish

- Research (ITHIM 2)

  - Analytica software package

  - Implementations include London Bike Sharing scheme 'Boris Bikes' & Sau Paulo, Brazil

- ITHIM 3 open source web based version in development

ITHIM 2

London Cycle Hire Health Impact Model

Created by James Woodcock CEDAR, University of Cambridge
jw745@cam.medschl.ac.uk with Anna Goodman LSHTM

The model

Acknowledgements in development of model
Anna Goodman
Zaid Chalabi
Phil Edwards
Neil Maizlish
Marko Tainio

Health outcome — **Calc** mid — Risk per billion hours — **Calc**

Burden summary for all cause death — **Calc** mid — DALYs summed — **Calc**

gains per million hours by age & gender all cause? — **Calc** mid

gains per million hours by age & gender by disease? — **Calc** mid

Male age structure — **Normal**

Age structure women — Normal(30)

% male — 0.71

% trips newly generated by LBSS — **Triangular**

Physical activity data entry

Speed_by_age__gende (km/day) **Edit Table**

Population size — 578.6K

Cycle time variability — LogNormal(mean:1, stddev:0.958352192)

Mode shift (% shift) **Edit Table**

LBSS Cycle Time Variability — LogNormal(mean:1, stddev:2.493631466)

Cycle hire minutes per person per week by gender and age **Edit Table**

Proportion pop cycl (fraction) **Edit Table**

Overreporting non-travel physical activity (Fraction) **Triangular**

Injury risk data entry

Injury underreporting scaling **Edit Table**

LBSS specific risk on =1, Version C=2 — 0

Air pollution data entry

Ventilation rates (Ratios) **Edit Table**

PM2.5 concentrations in the Underground (PM 2.5) **Triangular**

Harms from PM2.5 exposure in the Underground (Ratio) **Uniform**

Air pollution off =1 — 0

Performance Profiler

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London Hire Bikes

Woodcock J, Tainio M, Cheshire J, O'Brien O, Goodman A. *Health effects of the London bicycle sharing system: health impact modelling study.* **BMJ** 2014;348

Aim

- ITHIM 3 USA
- ITHIM 3 UK
- ITHIM 3 GLOBAL

Development Steps

- Methods
  - Individual level modelling (inequalities)
  - Propensity based scenarios
- Improving Evidence Base
  - Physical Activity
  - Injury
- Adding New pathways
  - NOx & Ozone
  - Noise

Development Steps

- Open source in R language + Web based GUI
- Better integration with transport models

Open Source Model in R & Shiny

www.pct.bike

Integration with Transport Models
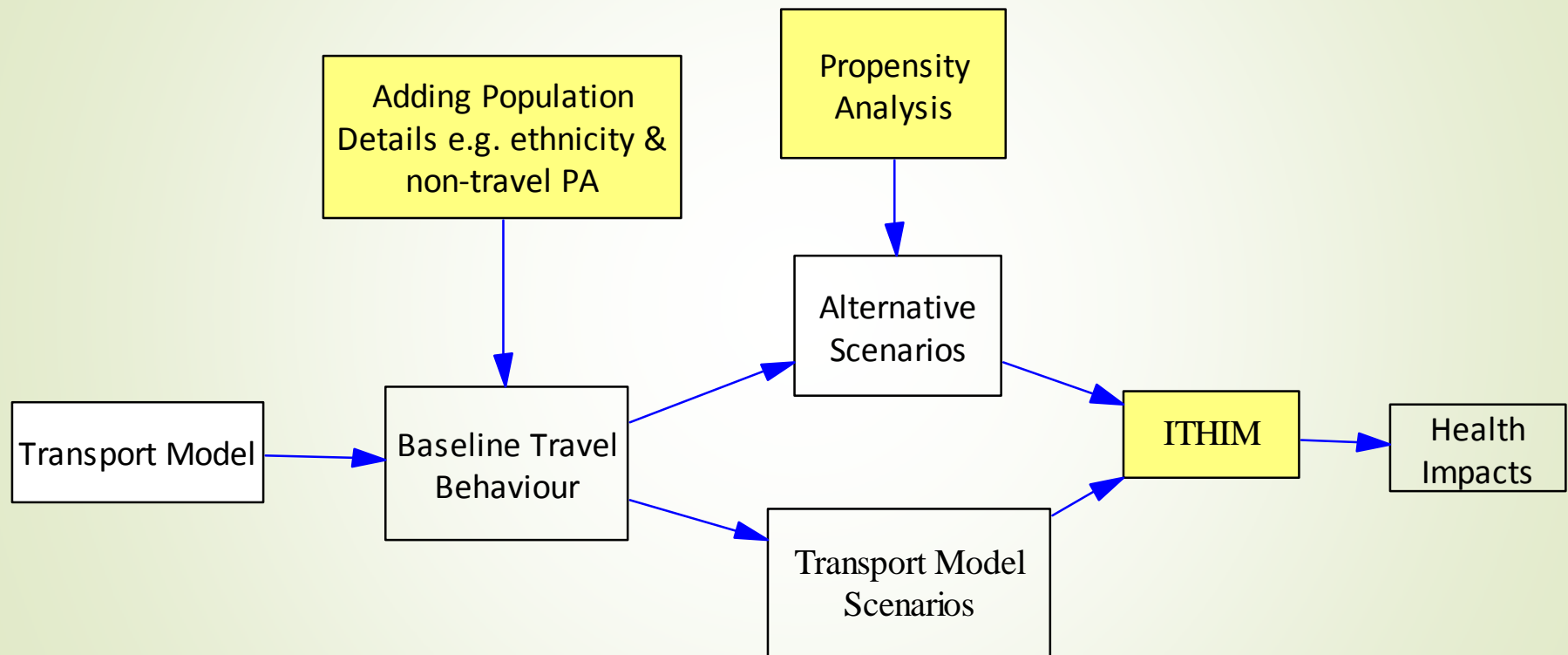
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Options Part 2

- Modelling the pathways
  - Physical activity
  - Injuries
  - Air Pollution
- Data driven scenarios
  - Propensity & potential
- Integration with transport models
- Current & planned California implementations

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