International Transport Forum

Decarbonising Transport Initiative

IKI INTERNATIONAL CLIMATE INITIATIVE

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Decarbonising Transport in Emerging Economies (DTEE) - Azerbaijan

National passenger model training session

OECD

Wuppertal Institut

Recalling the context

- The ITF team has worked with the Azerbaijan Ministry of Digital Development and Transport and the Baku Transport Authority to build 3 tools that allow to assess the impact of policy measures on transport demand and related emissions to 2050.
- The 3 tools are MS Excel-based and cover:
  - Passenger transport in Baku
  - Passenger transport in Azerbaijan (excl. Baku) **[FOCUS OF THIS PRESENTATION]**
  - Freight transport in Azerbaijan
- The tools (incl. training material) are made available to any interested stakeholders

Recalling the context

- The tools should **help policy makers put in place efficient policy measures** to reduce carbon emissions from transport.
- Results may feed national or international policy documents (e.g. national transport plans or updates of Azerbaijan's NDC).

- The tools were developed in the context of the Decarbonising Transport in Emerging Economies project (www.itf-oecd.org/dtee)

1. **Introduction**
2. **Model components**
   - Scope
   - Modelling structure
   - Main functions
   - Model Inputs
   - Model components

Purpose of this meeting

Present the passenger modelling tool in detail, explain its structure and how its components interact

Goal of todays meeting:

- Model users are able to understand and use the tool easily
- Model “handlers” are able to update modelling assumptions
- Use this presentation as a manual for future users

This manual should be used together with the model methodology note

The Modeling tool

General information about the model

The model is built in Microsoft Excel (macro enabled workbooks)

A run takes a few seconds with a standard computer

The model estimates passenger transport for Azerbaijan, excluding Baku

The model relies on local sources, such as national statistics. Where local data is unavailable, data from ITF global models or other external sources is used

General information about the model

It is a **strategic modelling tool** allowing to assess the impact of CO2 mitigation measures, including:

- **Infrastructure developments** (e.g. new highways, new rail lines)
- **Improvements in existing services** (e.g. train line electrification, improved train frequency, improved bus service quality)
- **Other policies** (e.g. car sharing, eco-driving)
- **Vehicle technology adoption** (e.g. electric vehicle uptake)

Allows the user to develop different policy scenarios to 2050 and assess resulting transport activity, mode shares, and related emissions

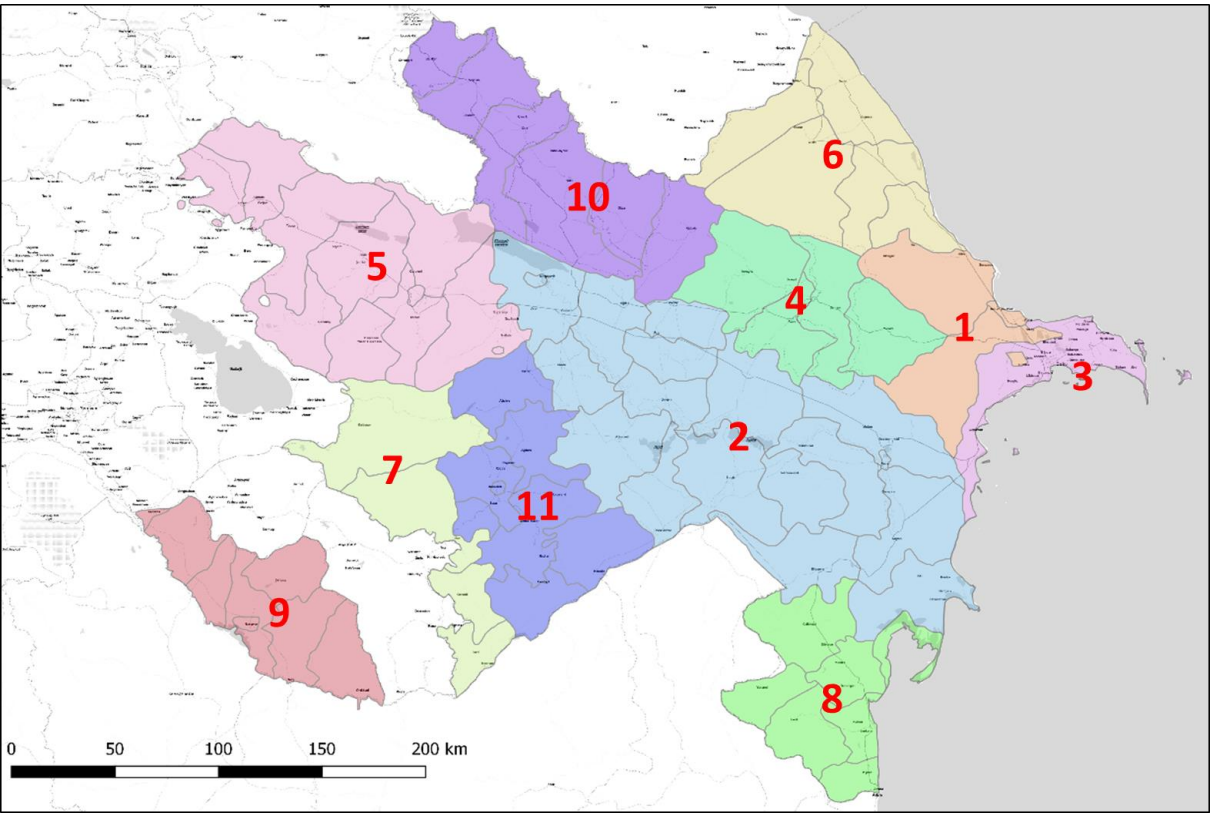
1. **Introduction**
2. **Model components**
   - **Scope**
   - Modelling structure
   - Main functions
   - Model Inputs
   - Model components

Level of disaggregation

The model differentiates:

- 11 zones
- 4 modes of transport: Car, Rail, Bus, Air
- 5 fuel types (gasoline, diesel, electric, methane, H2)
- 5 years step from 2015 to 2050

Zonal System



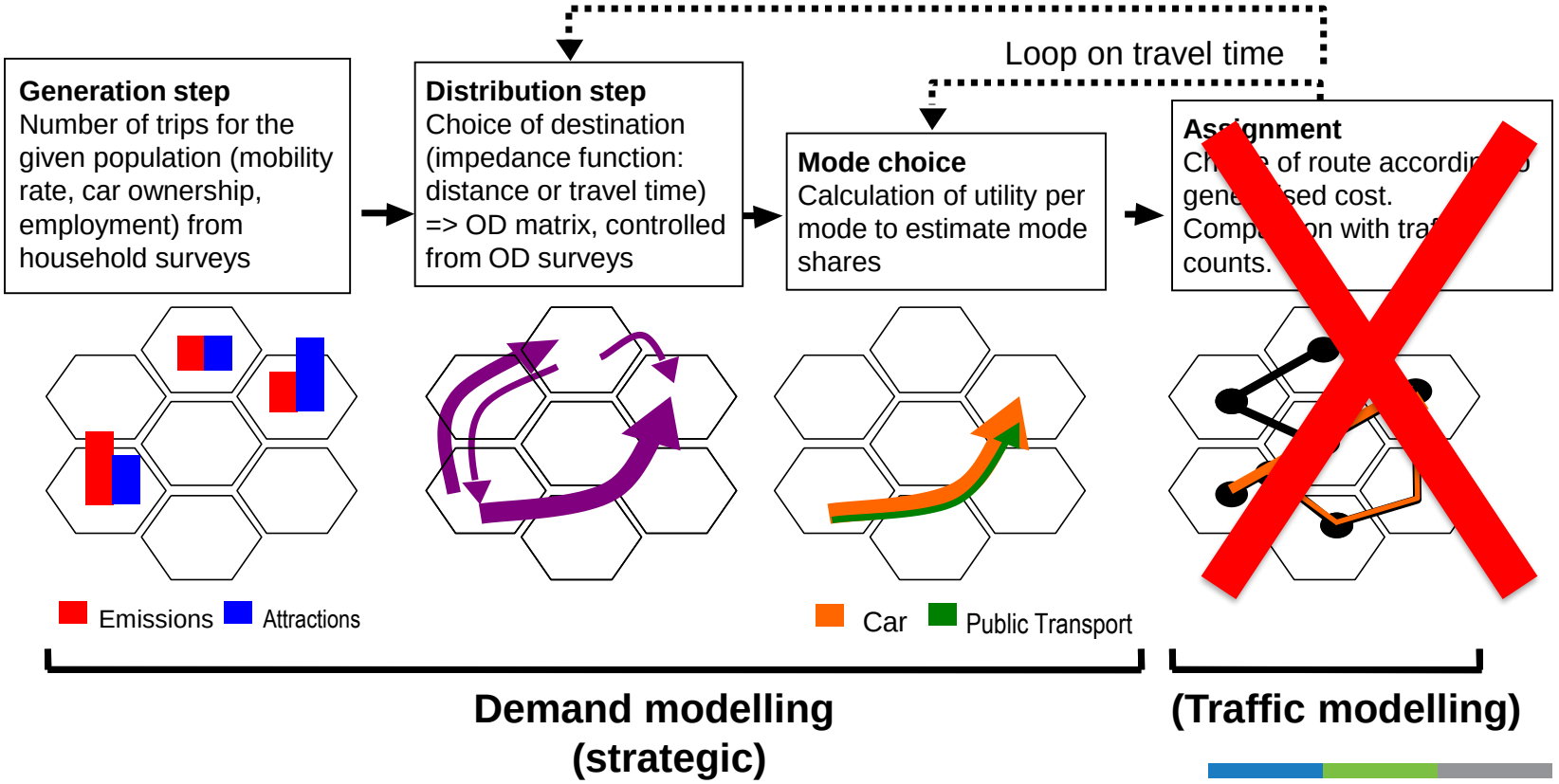
Model Zones (11)

Azerbaijan's Economic Regions

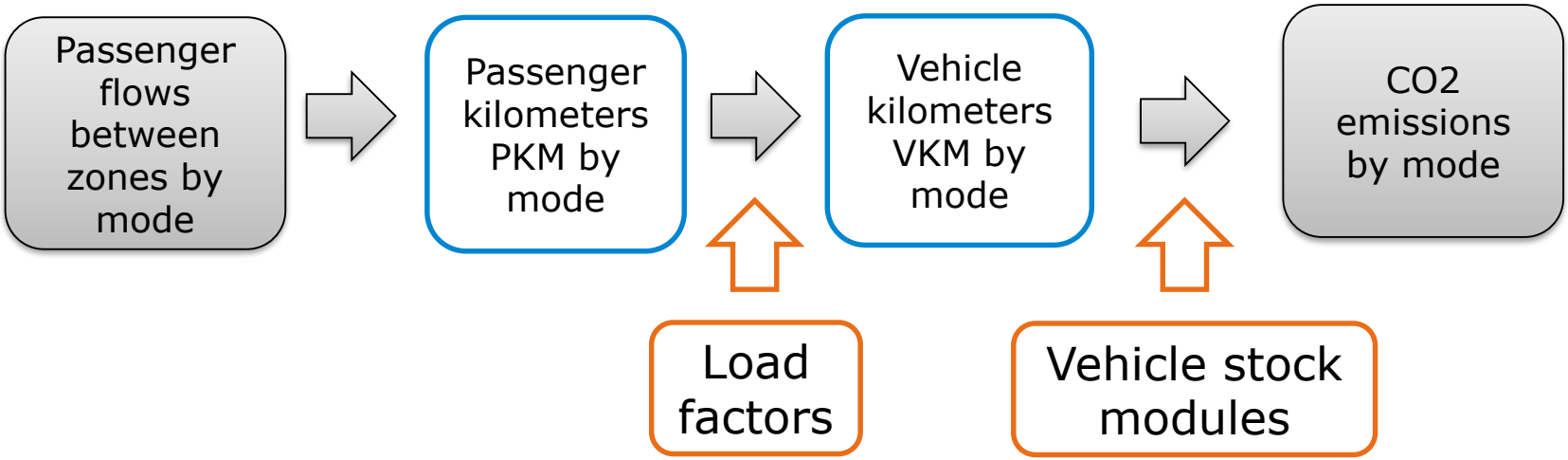
- Models were calibrated on these zones
- Policies will have an effect at this level

1. **Introduction**
2. **Model components**
   - Scope
   - **Modelling structure**
   - Main functions
   - Model Inputs
   - Model components

The principle of the 4-steps transport model



From transport activity to CO2 estimates



Main Model Sections

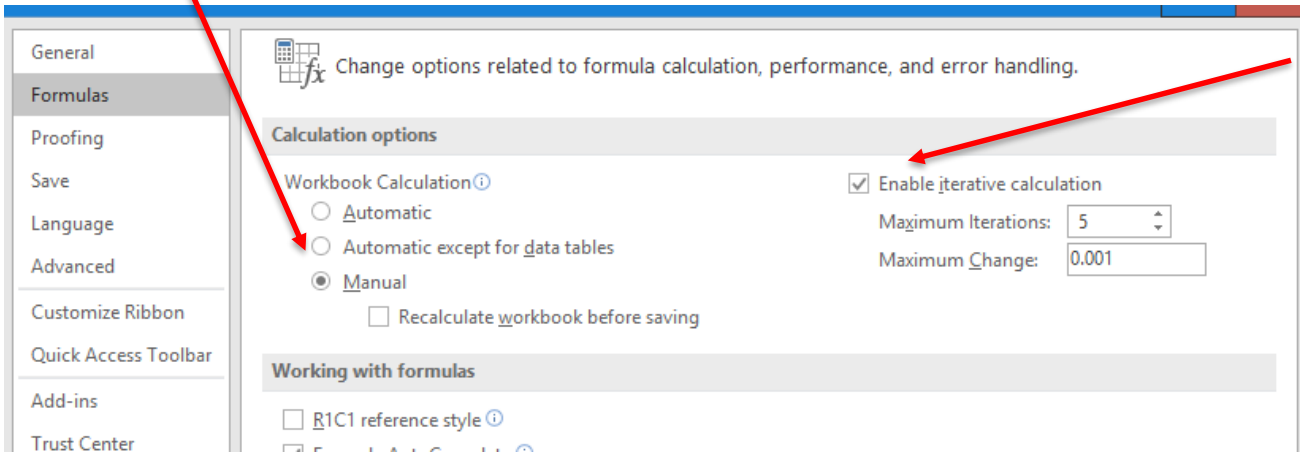
- Introduction
- Data explorer
- Scenario building and key output 
- Model Inputs 
- Model components 

1. **Introduction**
2. **Model components**
   - Scope
   - Modelling structure
   - **Main functions**
   - Model Inputs
   - Model components

Before you run the model(!)

Always enable manual calculation of formulas – otherwise each edits triggers a computation of the model.

How? Go to options, formulas, select manual.



Also enable iterative calculation
Set your maximum iterations (5 is added by default)

Intro sheet

NATIONAL MOBILITY MODEL FOR AZERBAIJAN

Version: 1.0
Last update: 05/11/2021

INTRODUCTION

The National Mobility Model for Azerbaijan is a tool developed by the ITF for the Decarbonising Transport in Emerging Economies project. Its aim is to help stakeholders identify efficient pathways for the mitigation of passenger transport CO_2 emissions in the country of Azerbaijan. It allows the users to easily test different policy packages through the building of scenarios. While the tool aims to be as comprehensive as possible in the set of policies and measures which can be tested, the three following elements are of particular interest:

- Enhancement of transport infrastructure

- Policies aimed in shifting intercity travel towards more environmentally friendly modes, such as buses and trains, or encouraging the uptake of shared car trips.

MODEL SCOPE

This model is for the country of Azerbaijan excluding trips taking place within the urban area of the capital, Baku. The country is divided in the 11 economic regions which serve as the zoning level for the model. The model captures aggregate relationships at the zone level. It simulates the overall long-term trends for the country and the evolution of passenger movement during the study period.
The outputs are best interpreted at the country level. Relationships between variables are calibrated from observed data, whenever possible, and from existing

TEAM

Project Oversight	**Elisabeth Windisch, ITF**
Model Design and Development	**Dimitrios Papaioannou, ITF**
Model Development	**Mallory Trouve, ITF**

Go to Data Explorer

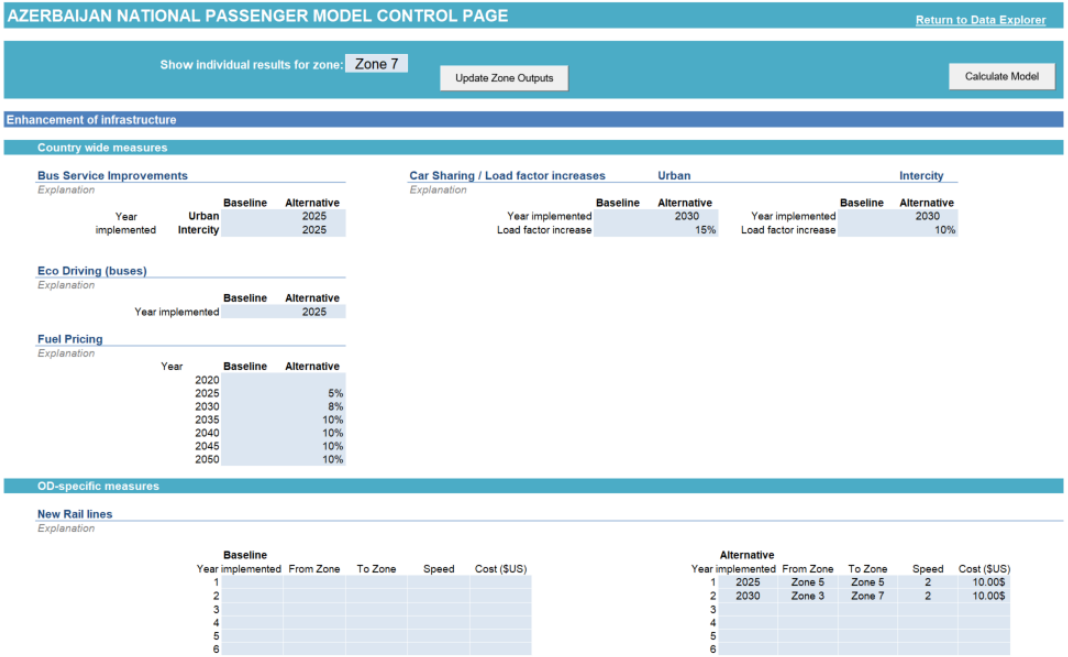
Generic information about the model

Data Explorer

Data Explorer		
Sheet	**Variables / description**	**Link**
Scenario building and key outputs		
Scenario building	Define scenarios	Link
Visual summary - country	Visualise key mobility and emission outputs for baseline and alternative scenarios for the entire study area	Link
Visual summary - zone	Visualise key mobility and emission outputs for baseline and alternative scenarios for a specific zone	Link
Output summary - country	Summarise key outputs by scenario for the entire country	Link
Output summary - zone	Summarise key outputs by scenario for the a specific zone	Link
Full model outputs	Detailed model outputs by OD pair, scenario, and year	Link
Model Inputs		
Input summary	Summarise key inputs	Link
Model parameters	Groups and summarises model parameters	Link
Model Components		
Trip generation	Trip generation and attraction sheet - Baseline	Link
	Trip generation and attraction sheet - Alternative	Link
Trip distribution	Trip distribution sheet - Baseline	Link
	Trip distribution sheet - Alternative	Link
Mode choice	Summary sheet	Link
	Computation sheet	Link
Vehicle stock & CO2	Private car stock module and CO2 factors - Baseline	Link
	Private car stock module and CO2 factors - Alternative	Link
	Public transport and taxis stock module and CO2 factors	Link
Other	Load factors	Link

Contains links to the various sheets of the model

Scenario builder



AZERBAIJAN NATIONAL PASSENGER MODEL CONTROL PAGE

Return to Data Explorer

Show individual results for zone: Zone 7

Update Zone Outputs

Calculate Model

Enhancement of infrastructure

Country wide measures

Bus Service Improvements

Explanation

		Baseline	Alternative
Year implemented	Urban		2025
	Intercity		2025

Car Sharing / Load factor increases

Explanation

	Urban Baseline	Urban Alternative	Intercity Baseline	Intercity Alternative
Year implemented		2030		2030
Load factor increase		15%		10%

Eco Driving (buses)

Explanation

	Baseline	Alternative
Year implemented		2025

Fuel Pricing

Explanation

Year	Baseline	Alternative
2020		
2025		5%
2030		8%
2035		10%
2040		10%
2045		10%
2050		10%

OD-specific measures

New Rail lines

Explanation

Baseline

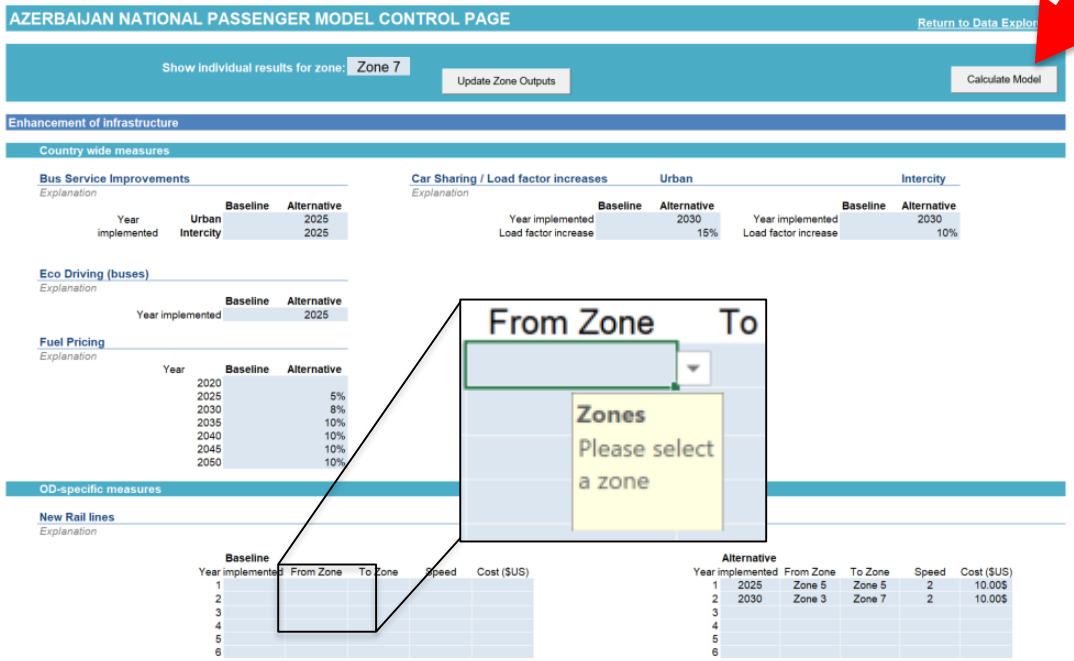
	Year implemented	From Zone	To Zone	Speed	Cost ($US)
1					
2					
3					
4					
5					
6					

Alternative

	Year implemented	From Zone	To Zone	Speed	Cost ($US)
1	2025	Zone 5	Zone 5	2	10.00$
2	2030	Zone 3	Zone 7	2	10.00$
3					
4					
5					
6					

- This sheet is used to define the two scenarios to be tested.
- The pre-agreed upon scenarios (baseline and alternative) are prefilled
- To calculate the results

Scenario builder



- Always use Calculate Model to run the model
- Input cells (in light blue) have instructions and dropdown menus to select. Error messages will block you from selecting a different value
- Zones are added as: “Zone 1” in all fields where a zone input is required

Outputs

[Outputs, Results city, results zone, visual outputs city, visual outputs zone]

Results city – aggregated results for the entire country

Key outputs are summarized for the entire country for both scenarios

Mobility indicators for the entire country

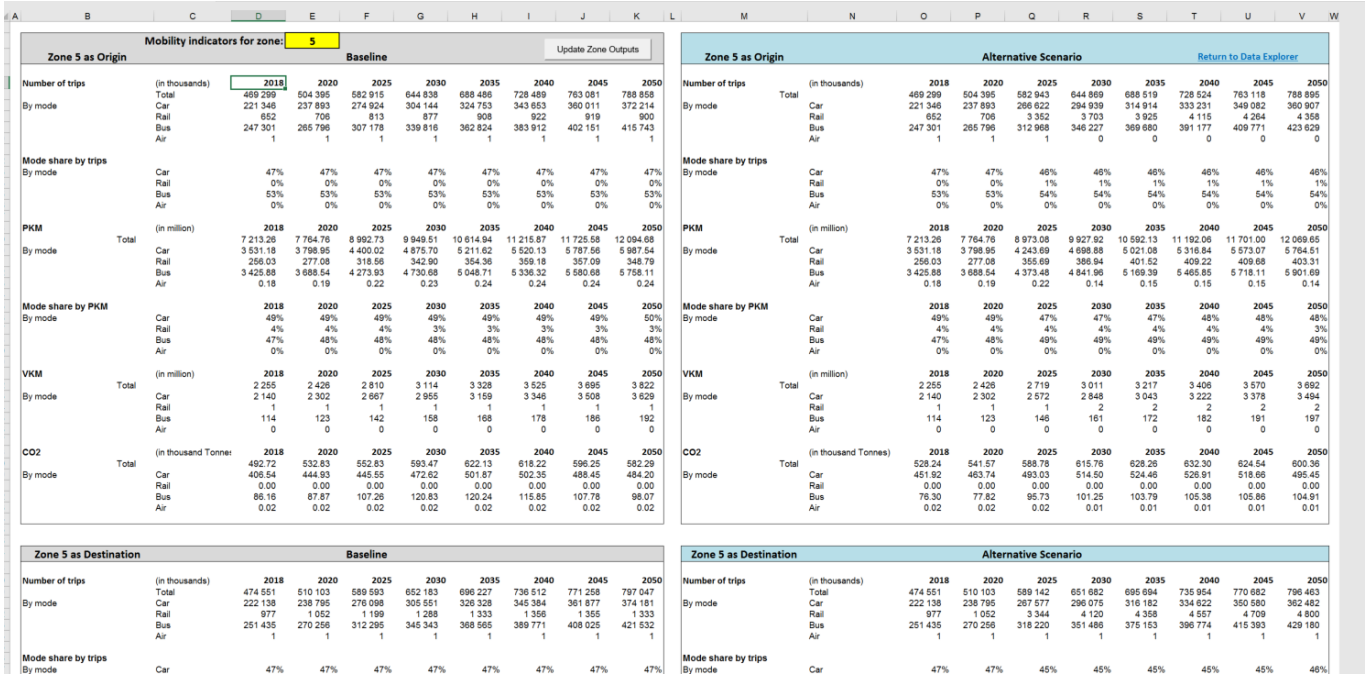
Baseline

Number of trips	(in millions)	**2018**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
For the entire Country		2 047	2 203	2 550	2 825	3 019	3 197	3 351	3 466
By mode	Car	1 018	1 095	1 268	1 404	1 501	1 589	1 666	1 723
	Rail	3	3	4	4	5	5	5	5
	Bus	1 026	1 104	1 278	1 416	1 514	1 603	1 680	1 737
	Air	0	0	0	0	0	0	0	0
Mode share by trips									
By mode	Car	50%	50%	50%	50%	50%	50%	50%	50%
	Rail	0%	0%	0%	0%	0%	0%	0%	0%
	Bus	50%	50%	50%	50%	50%	50%	50%	50%
	Air	0%	0%	0%	0%	0%	0%	0%	0%
PKM	(in billion)	**2018**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
	Total	35.28	38.10	44.36	49.17	52.45	55.34	57.72	59.36
By mode	Car	15.82	17.06	19.83	22.01	23.54	24.93	26.12	27.00
	Rail	1.00	1.09	1.27	1.40	1.47	1.52	1.54	1.54
	Bus	18.40	19.89	23.19	25.70	27.39	28.85	30.02	30.79
	Air	0.07	0.07	0.06	0.05	0.05	0.04	0.03	0.03
Mode share by PKM		**2018**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
By mode	Car	45%	45%	45%	45%	45%	45%	45%	45%
	Rail	3%	3%	3%	3%	3%	3%	3%	3%
	Bus	52%	52%	52%	52%	52%	52%	52%	52%
	Air	0%	0%	0%	0%	0%	0%	0%	0%
VKM	(in million)	**2018**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
For the entire Country		10 105	10 893	12 653	14 029	14 988	15 856	16 597	17 137
By mode	Car	9 487	10 225	11 874	13 165	14 068	14 888	15 589	16 104
	Rail	4	4	5	6	6	6	6	6
	Bus	613	663	773	857	913	962	1 001	1 026
	Air	1	1	1	1	1	1	1	0
CO2	(in Million Tonnes)	**2018**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
For the entire Country		2.22	2.41	2.52	2.70	2.82	2.80	2.70	2.63
By mode	Car	1.80	1.98	1.98	2.11	2.24	2.24	2.17	2.15
	Rail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Bus	0.41	0.42	0.53	0.59	0.58	0.56	0.53	0.48
	Air	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00

Alternative Scenario Return to Data Explorer

Number of trips	(in millions)	**2018**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
For the entire Country		2 047	2 203	2 550	2 825	3 019	3 197	3 351	3 466
By mode	Car	1 018	1 095	1 215	1 345	1 437	1 522	1 596	1 651
	Rail	3	3	6	7	8	8	8	8
	Bus	1 026	1 104	1 330	1 473	1 574	1 667	1 747	1 807
	Air	0	0	0	0	0	0	0	0
Mode share by trips									
By mode	Car	50%	50%	48%	48%	48%	48%	48%	48%
	Rail	0%	0%	0%	0%	0%	0%	0%	0%
	Bus	50%	50%	52%	52%	52%	52%	52%	52%
	Air	0%	0%	0%	0%	0%	0%	0%	0%
PKM	(in billion)	**2018**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
	Total	35.28	38.10	44.15	48.96	52.24	55.14	57.53	59.18
By mode	Car	15.82	17.06	18.90	20.95	22.39	23.70	24.83	25.65
	Rail	1.00	1.09	1.03	1.46	1.53	1.59	1.62	1.61
	Bus	18.40	19.89	24.16	26.50	28.27	29.81	31.06	31.89
	Air	0.07	0.07	0.06	0.05	0.05	0.04	0.03	0.03
Mode share by PKM		**2018**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
By mode	Car	45%	45%	43%	43%	43%	43%	43%	43%
	Rail	3%	3%	2%	3%	3%	3%	3%	3%
	Bus	52%	52%	55%	54%	54%	54%	54%	54%
	Air	0%	0%	0%	0%	0%	0%	0%	0%
VKM	(in million)	**2018**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
For the entire Country		10 105	10 893	12 141	13 441	14 355	15 183	15 887	16 400
By mode	Car	9 487	10 225	11 330	12 551	13 406	14 182	14 845	15 330
	Rail	4	4	4	6	6	6	6	6
	Bus	613	663	805	883	942	994	1 035	1 063
	Air	1	1	1	1	1	1	1	0
CO2	(in Million Tonnes)	**2018**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
For the entire Country		2.38	2.44	2.65	2.77	2.82	2.83	2.80	2.68
By mode	Car	2.00	2.06	2.17	2.27	2.31	2.32	2.28	2.17
	Rail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Bus	0.36	0.37	0.47	0.49	0.51	0.51	0.51	0.51
	Air	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00

Results zone – aggregated results for a zone



Mobility indicators for zone: 5

Update Zone Outputs

Zone 5 as Origin — Baseline

Number of trips		(in thousands)	2018	2020	2025	2030	2035	2040	2045	2050
		Total	469 299	504 395	582 915	644 838	688 486	728 489	763 081	788 858
By mode		Car	221 346	237 893	274 924	304 144	324 753	343 653	360 011	372 214
		Rail	652	706	813	877	908	922	919	900
		Bus	247 301	265 796	307 178	339 816	362 824	383 912	402 151	415 743
		Air	1	1	1	1	1	1	1	1
Mode share by trips										
By mode		Car	47%	47%	47%	47%	47%	47%	47%	47%
		Rail	0%	0%	0%	0%	0%	0%	0%	0%
		Bus	53%	53%	53%	53%	53%	53%	53%	53%
		Air	0%	0%	0%	0%	0%	0%	0%	0%
PKM		(in million)	2018	2020	2025	2030	2035	2040	2045	2050
	Total		7 213.26	7 764.76	8 992.73	9 949.51	10 614.94	11 215.87	11 725.58	12 094.68
By mode		Car	3 531.18	3 798.95	4 400.02	4 875.70	5 211.62	5 520.13	5 787.56	5 987.54
		Rail	256.03	277.08	318.56	342.90	354.36	359.18	357.09	348.79
		Bus	3 425.88	3 688.54	4 273.93	4 730.68	5 048.71	5 336.32	5 580.68	5 758.11
		Air	0.18	0.19	0.22	0.23	0.24	0.24	0.24	0.24
Mode share by PKM			2018	2020	2025	2030	2035	2040	2045	2050
By mode		Car	49%	49%	49%	49%	49%	49%	49%	50%
		Rail	4%	4%	4%	3%	3%	3%	3%	3%
		Bus	47%	48%	48%	48%	48%	48%	48%	48%
		Air	0%	0%	0%	0%	0%	0%	0%	0%
VKM		(in million)	2018	2020	2025	2030	2035	2040	2045	2050
	Total		2 255	2 426	2 810	3 114	3 328	3 525	3 695	3 822
By mode		Car	2 140	2 302	2 667	2 955	3 159	3 346	3 508	3 629
		Rail	1	1	1	1	1	1	1	1
		Bus	114	123	142	158	168	178	186	192
		Air	0	0	0	0	0	0	0	0
CO2		(in thousand Tonnes)	2018	2020	2025	2030	2035	2040	2045	2050
	Total		492.72	532.83	552.83	593.47	622.13	618.22	596.25	582.29
By mode		Car	406.54	444.93	445.55	472.62	501.87	502.35	488.45	484.20
		Rail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Bus	86.16	87.87	107.26	120.83	120.24	115.85	107.78	98.07
		Air	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02

Zone 5 as Origin — Alternative Scenario — Return to Data Explorer

Number of trips		(in thousands)	2018	2020	2025	2030	2035	2040	2045	2050
		Total	469 299	504 395	582 943	644 869	688 519	728 524	763 118	788 895
By mode		Car	221 346	237 893	266 622	294 939	314 914	333 231	349 082	360 907
		Rail	652	706	3 352	3 703	3 925	4 115	4 264	4 358
		Bus	247 301	265 796	312 968	346 227	369 680	391 177	409 771	423 629
		Air	1	1	1	0	0	0	0	0
Mode share by trips										
By mode		Car	47%	47%	46%	46%	46%	46%	46%	46%
		Rail	0%	0%	1%	1%	1%	1%	1%	1%
		Bus	53%	53%	54%	54%	54%	54%	54%	54%
		Air	0%	0%	0%	0%	0%	0%	0%	0%
PKM		(in million)	2018	2020	2025	2030	2035	2040	2045	2050
	Total		7 213.26	7 764.76	8 973.08	9 927.92	10 592.13	11 192.06	11 701.00	12 069.65
By mode		Car	3 531.18	3 798.95	4 243.69	4 698.88	5 021.08	5 316.84	5 573.07	5 764.51
		Rail	256.03	277.08	355.69	386.94	401.52	409.22	409.68	403.31
		Bus	3 425.88	3 688.54	4 373.48	4 841.96	5 169.39	5 465.85	5 718.11	5 901.69
		Air	0.18	0.19	0.22	0.14	0.15	0.15	0.15	0.14
Mode share by PKM			2018	2020	2025	2030	2035	2040	2045	2050
By mode		Car	49%	49%	47%	47%	47%	48%	48%	48%
		Rail	4%	4%	4%	4%	4%	4%	4%	3%
		Bus	47%	48%	49%	49%	49%	49%	49%	49%
		Air	0%	0%	0%	0%	0%	0%	0%	0%
VKM		(in million)	2018	2020	2025	2030	2035	2040	2045	2050
	Total		2 255	2 426	2 719	3 011	3 217	3 406	3 570	3 692
By mode		Car	2 140	2 302	2 572	2 848	3 043	3 222	3 378	3 494
		Rail	1	1	1	2	2	2	2	2
		Bus	114	123	146	161	172	182	191	197
		Air	0	0	0	0	0	0	0	0
CO2		(in thousand Tonnes)	2018	2020	2025	2030	2035	2040	2045	2050
	Total		528.24	541.57	588.78	615.76	628.26	632.30	624.54	600.36
By mode		Car	451.92	463.74	493.03	514.50	524.46	526.91	518.66	495.45
		Rail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Bus	76.30	77.82	95.73	101.25	103.79	105.38	105.86	104.91
		Air	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01

Zone 5 as Destination — Baseline

Number of trips		(in thousands)	2018	2020	2025	2030	2035	2040	2045	2050
		Total	474 551	510 103	589 593	652 183	696 227	736 512	771 258	797 047
By mode		Car	222 138	238 795	276 098	305 551	326 328	345 384	361 877	374 181
		Rail	977	1 052	1 199	1 288	1 333	1 356	1 355	1 333
		Bus	251 435	270 256	312 295	345 343	368 565	389 771	408 025	421 532
		Air	1	1	1	1	1	1	1	1
Mode share by trips										
By mode		Car	47%	47%	47%	47%	47%	47%	47%	47%

Zone 5 as Destination — Alternative Scenario

Number of trips		(in thousands)	2018	2020	2025	2030	2035	2040	2045	2050
		Total	474 551	510 103	589 142	651 682	695 694	735 954	770 682	796 463
By mode		Car	222 138	238 795	267 577	296 075	316 182	334 622	350 580	362 482
		Rail	977	1 052	3 344	4 120	4 358	4 557	4 709	4 800
		Bus	251 435	270 256	318 220	351 486	375 153	396 774	415 393	429 180
		Air	1	1	1	1	1	1	1	1
Mode share by trips										
By mode		Car	47%	47%	45%	45%	45%	45%	45%	46%

Outputs are summarized for the a zone.

They are grouped for the zone as origin, as destination, and for intra-zonal trips

Zone is selected in the scenario built sheet

1. **Introduction**
2. **Model components**
   - Scope
   - Modelling structure
   - Main functions
   - **Model Inputs**
   - Model components

Inputs

Main inputs		
Generation		
Population growth projections		
To change go to:	Baseline	Alternative
GDP annual growth projections		
2018-2020		3.19%
2020-2025		3.24%
2025-2030		2.93%
2030-2035		2.25%
2035-2040		2.35%
2040-2045		2.41%
2045-2050		2.31%
Population evolution by age group throught the study period		
	Baseline	Alternative
Distribution		
Value of time in base year [$US per hour] for intercity trips		
		6.00
Value of time in base year [$US per hour] for urban trips		
		2.00
Average cost per km in base year [$US per km]		
		0.05
Mode Choice		
Fuel cost per litre in $US [2018 values]		
		0.53
Average bus speed [km/hour]		
		60.00
Average car fuel economy in ltr gas/km		
		0.10

Sources	Return to Data Explorer
Based on Azerbaijan's population growth projections byUN DESA	
OECD projections for Azerbaijan adapted by ITF	
Comes from ITF's global models population evolution model component	
ITF estimations based on literature	
ITF estimation based on fuel and operating costs	
Historical prices	
ITF estimation	
IEA Estimates	

Has information about inputs that do not come from ITF calculations or the Azerbaijan statistics

Model parameters

Model Parameters

Return to Data Explorer

Trip Generation

Formula: $T_i = \log(I_i * M) * e^{A+pop\_cat_i+Inc\_cat_i+Age\_group_i+\ln(weighted_{tt_i}*w_{tt})}$

Variable	Coefficient
A	-0.7958
M	0.0015
Population category 1 (<0.5M)	0.2213
Population category 2 (0.5M - 1M)	0.3246
Population category 3 (1M - 2M)	0.4619
Population category 4 (2M+)	1.8333
Income category 1 (<2000 Manat)	0.3354
Income category 2 (2000 - 2100 Manat)	0.8814
Income category 3 (2100 - 2300 Manat)	0.9173
Income category 4 (2300+ Manat)	0.1640
Age group 0-18	0.1361
Age group 19-30	0.2403
Age group 31-50	0.3103
Age group 51-65	0.1839
Age group 66+	0.0003
Weighted average travel time	-0.0059

Trip Distribution

Formula: $f(Gc_{ij}) = Gc_{ij}^{-a}e^{-\beta Gc_{ij}}$

	Coefficient
alpha (interzonal trips)	0.010
beta (interzonal trips)	1.698
alpha (intrazonal trips)	1.403
beta (intrazonal trips)	0.010

Mode Choice

Variable	Coefficient
ASC car	-0.098
ASC rail	-2.960
ASC bus	-1.117
ASC air	0.000
travel time car	-0.083
cost car	-0.133
travel time rail	-0.050
cost rail	-0.113

Utility functions:

ASCcar * one + b_tt_car * tt_car + b_cost_car * cost_car
ASCrail * one + b_tt_rail * tt_rail + b_cost_rail * cost_rail
ASCbus * one + b_tt_bus * tt_bus + b_cost_bus * cost_bus
ASCair * one + b_tt_air * tt_air + b_cost_air * cost_air

Includes coefficients and variables for the various models, as well as the formulas for each one

1. **Introduction**
2. **Model components**
   - Scope
   - Modelling structure
   - Main functions
   - Model Inputs
   - **Model components**

Trip generation

[zone_generation_bl, zone_generation_ScA]

Trip Generation & Attraction

The trip generation module estimates the number of trips an average individual will do based on their zones' population, average income, travel time to other zones, and their own age group.

Trip Generation

Zone	Trips
1	…
2	…
3	…
i	…

Trip generation and attraction

Trip Generation and Attraction, Baseline

Return to Data Explorer

Nb Zones
11

	Generation								Attraction							
Id_Zone	2018	2020	2025	2030	2035	2040	2045	2050	2018	2020	2025	2030	2035	2040	2045	2050
1	**491 294**	528566.0088	612057.0445	677967.7889	724444.3157	767077.9871	803994.5731	831569	**491 294**	528 566	612 057	677 968	724 444	767 078	803 995	831 569
2	**1 107 578**	1194263.236	1388863.699	1542745.172	1651311.341	1751080.433	1837706.752	1902742	**1 107 578**	1 194 263	1 388 864	1 542 745	1 651 311	1 751 080	1 837 707	1 902 742
3	**4 900 647**	5239330.598	5992780.166	6584380.413	7000825.786	7380602.894	7706514.928	7945846	**4 900 647**	5 239 331	5 992 780	6 584 380	7 000 826	7 380 603	7 706 515	7 945 846
4	**248 446**	267163.628	309072.718	342144.6442	365462.274	386843.1283	405345.3072	419149	**248 446**	267 164	309 073	342 145	365 462	386 843	405 345	419 149
5	**1 285 941**	1382258.877	1597822.385	1767876.028	1887761.375	1997650.502	2092693.78	2163532	**1 285 941**	1 382 259	1 597 822	1 767 876	1 887 761	1 997 651	2 092 694	2 163 532
6	**476 108**	511818.3698	591748.1154	654807.9336	699265.2837	740019.1233	775271.6691	801553	**476 108**	511 818	591 748	654 808	699 265	740 019	775 272	801 553
7	**120 891**	129692.3385	149350.3335	164833.3191	175743.031	185725.7301	194336.9662	200723	**120 891**	129 692	149 350	164 833	175 743	185 726	194 337	200 723
8	**817 799**	878925.9197	1015709.152	1123602.173	1199662.384	1269371.859	1329652.219	1374565	**817 799**	878 926	1 015 709	1 123 602	1 199 662	1 269 372	1 329 652	1 374 565
9	**408 618**	437066.6982	500390.5695	550134.0877	585155.0933	617108.18	644550.0128	664731	**408 618**	437 067	500 391	550 134	585 155	617 108	644 550	664 731
10	**304 126**	327472.4644	379813.022	421158.9735	450319.7395	477087.8849	500290.7984	517656	**304 126**	327 472	379 813	421 159	450 320	477 088	500 291	517 656
11	**305 379**	328523.5916	380366.374	421290.7215	450147.771	476617.3024	499535.3431	516651	**305 379**	328 524	380 366	421 291	450 148	476 617	499 535	516 651
Total	**10 466 826**	**11 225 082**	**12 917 974**	**14 250 941**	**15 190 098**	**16 049 185**	**16 789 892**	**17 338 718**								

Id_Zone	Gen_2018	Gen_2020	Gen_2025	Gen_2030	Gen_2035	Gen_2040	Gen_2045	Gen_2050	Pop_2018	Pop_2020	Pop_2025	Pop_2030	Pop_2035	Pop_2040	Pop_2045	Pop_2050
1	491294.3	1.075864327	1.24580531	1.379962667	1.474562842	1.561341117	1.636482608	1.69260923	568000	578064	597657	611287	621629	628956	632417	631834
2	1107577.9	1.078265707	1.253964832	1.39289996	1.490921212	1.580999837	1.659212233	1.71793061	2006000	2041542	2110740	2158875	2195401	2221278	2233499	2231441
3	4900647.3	1.069109904	1.222854811	1.343573608	1.428551233	1.506046527	1.572550402	1.62138711	2262600	2302688	2380738	2435030	2476229	2505416	2519200	2516879
4	248445.59	1.075340609	1.244025795	1.377141166	1.470995237	1.557053737	1.631525492	1.68708687	315300	320886	331763	339329	345070	349137	351058	350735
5	1285940.7	1.074900966	1.242531956	1.374772615	1.468000357	1.553454631	1.627364167	1.68245105	1274800	1297387	1341361	1371951	1395163	1411608	1419374	1418066
6	476107.67	1.075005505	1.242887163	1.375335812	1.468712485	1.554310432	1.628353653	1.68355336	544100	553740	572509	585565	595473	602491	605806	605248
7	120890.67	1.072806884	1.235416585	1.36349087	1.453735322	1.536311582	1.607543187	1.66036997	254100	258602	267367	273465	278091	281369	282917	282657
8	817799.27	1.074745293	1.242003001	1.373933934	1.4669399	1.552180223	1.625890682	1.68080955	927700	944137	976138	998399	1015291	1027258	1032910	1031958
9	408618.24	1.069621128	1.22459187	1.346327793	1.432033722	1.510231619	1.57738925	1.62677772	452800	460823	476442	487307	495552	501393	504152	503687
10	304126.12	1.076765346	1.248866835	1.384816854	1.480700648	1.568717243	1.645010965	1.70211003	616800	627728	649005	663805	675037	682993	686751	686118
11	305378.59	1.075791191	1.245556803	1.379568647	1.47406463	1.560742389	1.635790352	1.69183803	675900	687875	711191	727409	739717	748436	752553	751860
									9898100	10073472	10414912.2	10652420.75	10832654	10960336	11020638	11010483

Trip Distribution

[OD_distribution_bl, OD_distribution_sca]

Trip Distribution

Trip Generation

Zone	Trips
1	…
2	…
3	…
i	…

$$Trips_{i \to j} \propto \frac{1}{impedance_{i \to j}}$$

Trip Distribution across zones

O/D	1	2	3	j
1	…	…	…	…
2	…	…	…	…
3	…	…	…	…
i	…	…	…	Tij

Note: O/D = Origin/Destination

Trip Distribution

Trip Distribution, Baseline

Return to Data Explorer

actual:

Nb Zones: 11 | Nb OD: 121

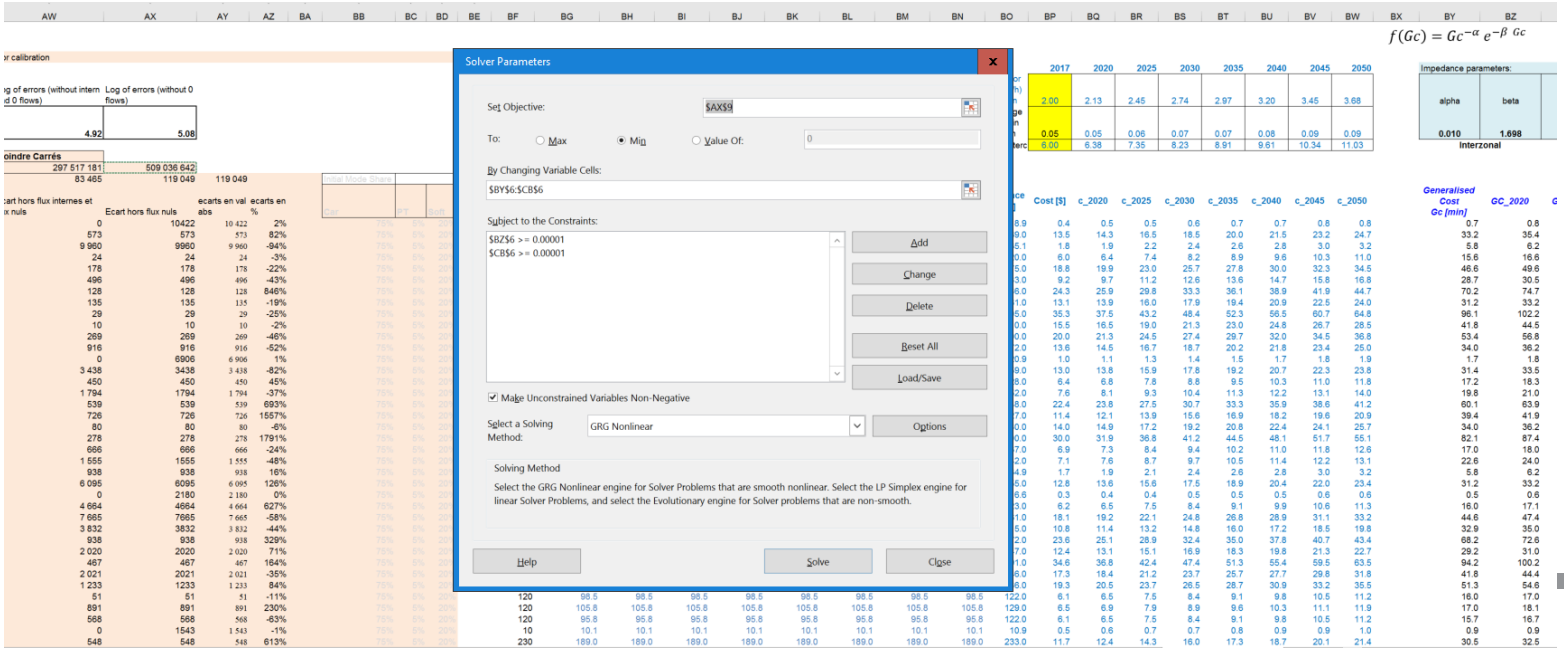
INPUT	2017	
VoT for Gc ($/h) urban	2.00	2
Average cost in $/km	0.05	0
VOT interc	6.00	6

OUTPUTS | INPUTS

ID_OD	Ori_idz	Dest_idz	OD Flow Observed	OD Flow Model	flow_2020	flow_2025	flow_2030	flow_2035	flow_2040	flow_2045	flow_2050	Dist Category	Average travel time 2018 all modes [min]	Travel time 2020	Travel time 2025	Travel time 2030	Travel time 2035	Travel time 2040	Travel time 2045	Travel time 2050	Distance [km]	Cost [$]	c_
1	1	1	475 354	485 776	1.0754	1.2443	1.3774	1.4712	1.5573	1.6317	1.6873	0	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.9	0.4	
2	1	2	700	1 273	1.1107	1.3671	1.5692	1.7059	1.8246	1.9183	1.9779	260	198.0	198.0	198.0	198.0	198.0	198.0	198.0	198.0	269.0	13.5	
3	1	3	10 651	691	1.1724	1.6506	2.1333	2.5357	2.9731	3.4308	3.8646	30	40.5	40.5	40.5	40.5	40.5	40.5	40.5	40.5	35.1	1.8	
4	1	4	700	677	1.1347	1.4778	1.7896	2.0296	2.2715	2.5047	2.7060	120	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	120.0	6.0	
5	1	5	817	639	1.0875	1.2676	1.3829	1.4446	1.4811	1.4898	1.4714	370	278.7	278.7	278.7	278.7	278.7	278.7	278.7	278.7	375.0	18.8	
6	1	6	1 167	671	1.1198	1.4081	1.6483	1.8193	1.9771	2.1131	2.2134	180	195.3	195.3	195.3	195.3	195.3	195.3	195.3	195.3	183.0	9.2	
7	1	7	15	143	1.0432	1.0982	1.0966	1.0718	1.0262	0.9628	0.8896	480	459.5	459.5	459.5	459.5	459.5	459.5	459.5	459.5	486.0	24.3	
8	1	8	700	566	1.1155	1.3870	1.6048	1.7542	1.8862	1.9930	2.0643	260	181.6	181.6	181.6	181.6	181.6	181.6	181.6	181.6	261.0	13.1	
9	1	9	117	88	0.9955	0.9268	0.8245	0.7361	0.6403	0.5439	0.4566	700	608.0	608.0	608.0	608.0	608.0	608.0	608.0	608.0	705.0	35.3	
10	1	10	467	457	1.0917	1.2886	1.4264	1.5091	1.5698	1.6047	1.6110	310	263.1	263.1	263.1	263.1	263.1	263.1	263.1	263.1	310.0	15.5	
11	1	11	584	315	1.0723	1.2083	1.2816	1.3116	1.3173	1.2983	1.2581	400	333.8	333.8	333.8	333.8	333.8	333.8	333.8	333.8	400.0	20.0	
12	2	1	1 756	840	1.0982	1.3078	1.4510	1.5337	1.5908	1.6188	1.6162	270	204.2	204.2	204.2	204.2	204.2	204.2	204.2	204.2	272.0	13.6	
13	2	2	1 087 884	1 094 791	1.0778	1.2522	1.3900	1.4872	1.5766	1.6541	1.7124	20	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	20.9	1.0	
14	2	3	4 177	740	1.1150	1.3783	1.5794	1.7097	1.8166	1.8935	1.9334	250	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	259.0	13.0	
15	2	4	1 003	1 453	1.1270	1.4387	1.7065	1.9027	2.0900	2.2592	2.3936	120	108.1	108.1	108.1	108.1	108.1	108.1	108.1	108.1	128.0	6.4	
16	2	5	4 892	3 098	1.1372	1.4801	1.7799	2.0011	2.2133	2.4050	2.5567	150	121.7	121.7	121.7	121.7	121.7	121.7	121.7	121.7	152.0	7.6	
17	2	6	78	616	1.0540	1.1334	1.1486	1.1336	1.0953	1.0369	0.9662	440	376.6	376.6	376.6	376.6	376.6	376.6	376.6	376.6	448.0	22.4	
18	2	7	47	773	1.0987	1.3155	1.4721	1.5685	1.6416	1.6866	1.6995	220	280.5	280.5	280.5	280.5	280.5	280.5	280.5	280.5	227.0	11.4	
19	2	8	1 254	1 175	1.1056	1.3401	1.5114	1.6180	1.7008	1.7548	1.7754	280	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	280.0	14.0	
20	2	9	16	294	1.0169	0.9963	0.9259	0.8537	0.7674	0.6738	0.5835	600	521.5	521.5	521.5	521.5	521.5	521.5	521.5	521.5	600.0	30.0	
21	2	10	2 760	2 093	1.1375	1.4857	1.7976	2.0339	2.2674	2.4867	2.6697	130	101.1	101.1	101.1	101.1	101.1	101.1	101.1	101.1	137.0	6.9	
22	2	11	3 261	1 706	1.1292	1.4470	1.7196	1.9180	2.1055	2.2720	2.4006	140	154.8	154.8	154.8	154.8	154.8	154.8	154.8	154.8	142.0	7.1	
23	3	1	5 892	6 830	1.1407	1.5079	1.8518	2.1230	2.4027	2.6794	2.9258	30	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	34.9	1.7	
24	3	2	4 824	10 919	1.0963	1.3120	1.4748	1.5811	1.6693	1.7344	1.7700	250	184.6	184.6	184.6	184.6	184.6	184.6	184.6	184.6	255.0	12.8	
25	3	3	4 856 158	4 853 978	1.0689	1.2220	1.3423	1.4270	1.5043	1.5706	1.6194	0	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.6	0.3	
26	3	4	744	5 408	1.1150	1.3960	1.6386	1.8183	1.9924	2.1527	2.2834	120	98.8	98.8	98.8	98.8	98.8	98.8	98.8	98.8	123.0	6.2	
27	3	5	13 143	5 478	1.0735	1.2165	1.2997	1.3389	1.3551	1.3470	1.3168	360	265.3	265.3	265.3	265.3	265.3	265.3	265.3	265.3	361.0	18.1	
28	3	6	8 642	4 810	1.0929	1.2982	1.4500	1.5471	1.6255	1.6804	1.7068	210	221.6	221.6	221.6	221.6	221.6	221.6	221.6	221.6	215.0	10.8	
29	3	7	285	1 223	1.0296	1.0539	1.0306	0.9934	0.9389	0.8705	0.7961	470	446.1	446.1	446.1	446.1	446.1	446.1	446.1	446.1	472.0	23.6	
30	3	8	2 833	4 853	1.1011	1.3311	1.5083	1.6259	1.7257	1.8020	1.8473	240	168.2	168.2	168.2	168.2	168.2	168.2	168.2	168.2	247.0	12.4	
31	3	9	285	752	0.9824	0.8887	0.7737	0.6809	0.5844	0.4904	0.4072	690	596.0	596.0	596.0	596.0	596.0	596.0	596.0	596.0	691.0	34.6	
32	3	10	5 720	3 699	1.0737	1.2210	1.3127	1.3609	1.3883	1.3928	1.3750	340	244.7	244.7	244.7	244.7	244.7	244.7	244.7	244.7	346.0	17.3	
33	3	11	1 465	2 698	1.0584	1.1597	1.2045	1.2157	1.2052	1.1738	1.1258	380	320.4	320.4	320.4	320.4	320.4	320.4	320.4	320.4	386.0	19.3	
34	4	1	447	396	1.1429	1.5056	1.8286	2.0702	2.3051	2.5209	2.6955	120	98.5	98.5	98.5	98.5	98.5	98.5	98.5	98.5	122.0	6.1	
35	4	2	388	1 279	1.1476	1.5300	1.8812	2.1517	2.4230	2.6820	2.9021	120	105.8	105.8	105.8	105.8	105.8	105.8	105.8	105.8	129.0	6.5	
36	4	3	894	326	1.1556	1.5637	1.9427	2.2360	2.5311	2.8133	3.0534	120	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	122.0	6.1	
37	4	4	245 748	244 205	1.0744	1.2405	1.3713	1.4633	1.5476	1.6205	1.6748	10	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.9	0.5	

Trip Distribution - recalibration

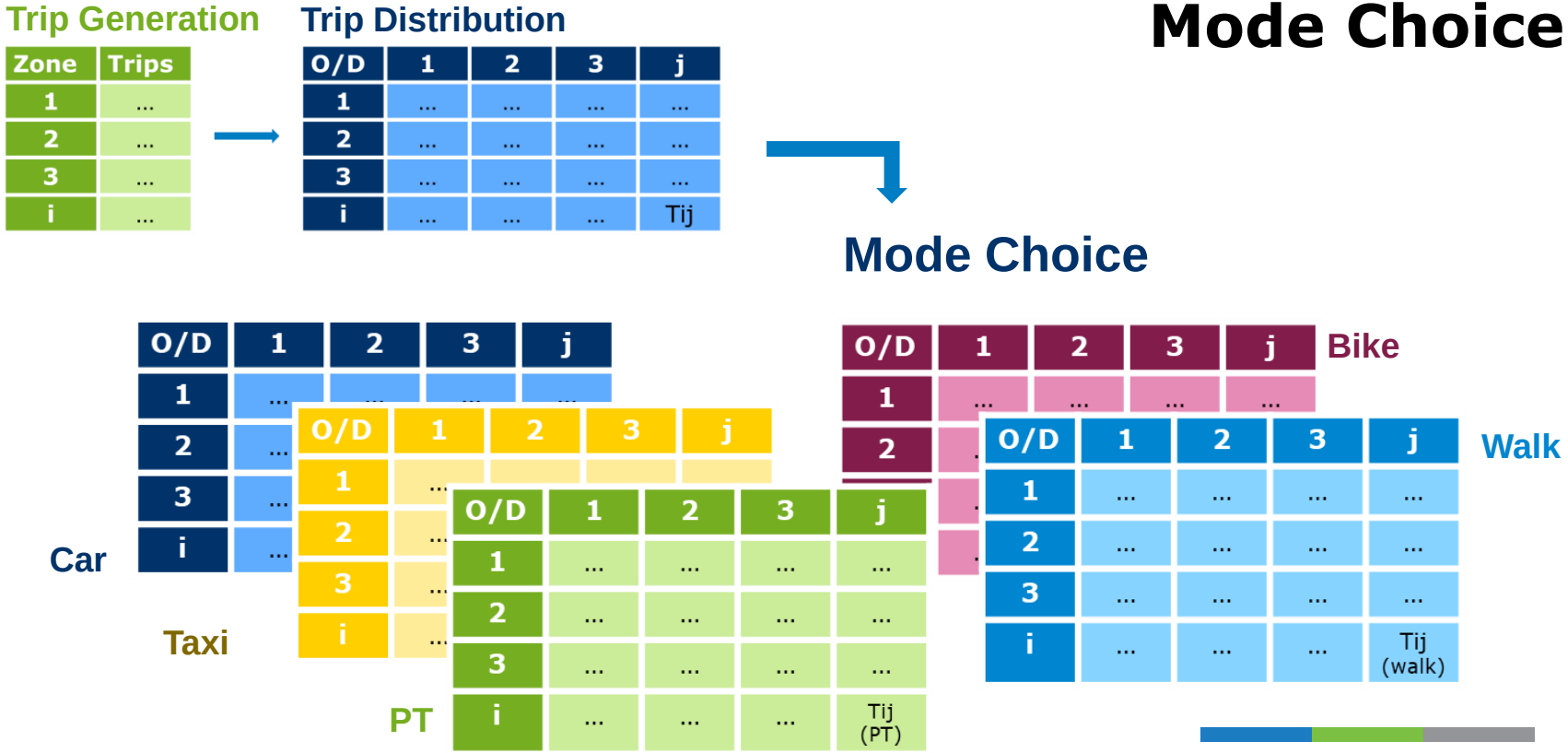
For a change in OD flows, the distribution must be recalibrated using the solver (default add-in in Microsoft Excel, in the data tab). Set solver parameters like the picture below and run it.



Mode Choice

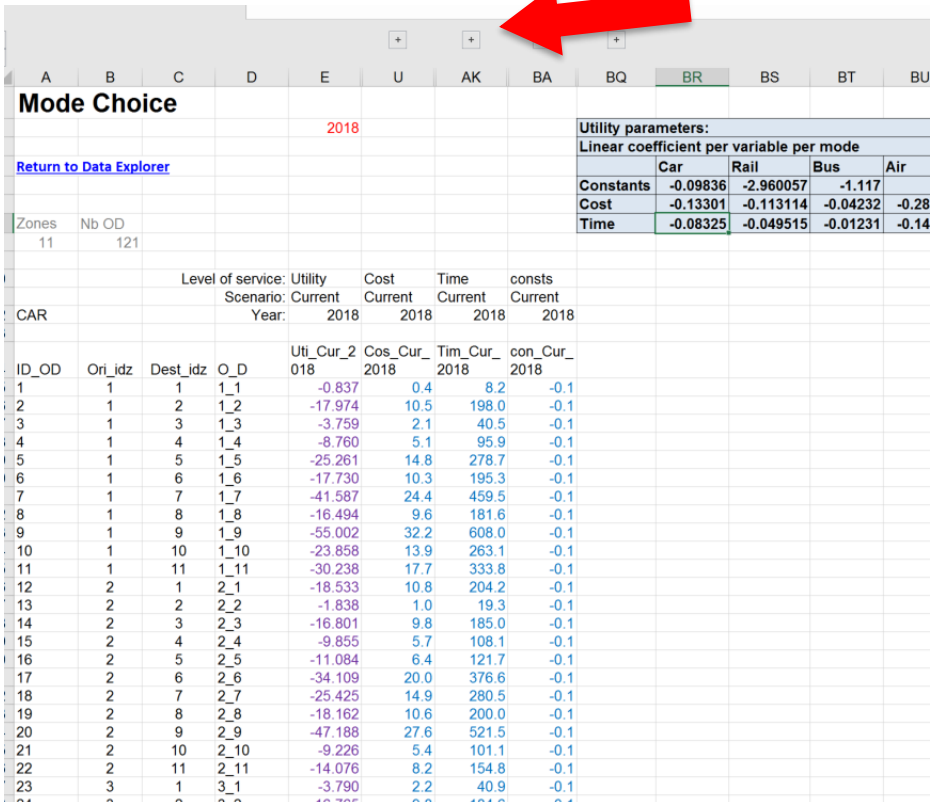
[Mode_choice, Mode_choice1]

Mode Choice



Note: PT = Public Transport

Mode choice1 – utility estimation for all modes



Mode Choice

2018

Return to Data Explorer

Zones	Nb OD
11	121

Utility parameters: Linear coefficient per variable per mode				
	Car	Rail	Bus	Air
Constants	-0.09836	-2.960057	-1.117	
Cost	-0.13301	-0.113114	-0.04232	-0.28
Time	-0.08325	-0.049515	-0.01231	-0.14

				Level of service:	Utility	Cost	Time	consts
				Scenario:	Current	Current	Current	Current
CAR				Year:	2018	2018	2018	2018
ID_OD	Ori_idz	Dest_idz	O_D		Uti_Cur_2018	Cos_Cur_2018	Tim_Cur_2018	con_Cur_2018
1	1	1	1_1		-0.837	0.4	8.2	-0.1
2	1	2	1_2		-17.974	10.5	198.0	-0.1
3	1	3	1_3		-3.759	2.1	40.5	-0.1
4	1	4	1_4		-8.760	5.1	95.9	-0.1
5	1	5	1_5		-25.261	14.8	278.7	-0.1
6	1	6	1_6		-17.730	10.3	195.3	-0.1
7	1	7	1_7		-41.587	24.4	459.5	-0.1
8	1	8	1_8		-16.494	9.6	181.6	-0.1
9	1	9	1_9		-55.002	32.2	608.0	-0.1
10	1	10	1_10		-23.858	13.9	263.1	-0.1
11	1	11	1_11		-30.238	17.7	333.8	-0.1
12	2	1	2_1		-18.533	10.8	204.2	-0.1
13	2	2	2_2		-1.838	1.0	19.3	-0.1
14	2	3	2_3		-16.801	9.8	185.0	-0.1
15	2	4	2_4		-9.855	5.7	108.1	-0.1
16	2	5	2_5		-11.084	6.4	121.7	-0.1
17	2	6	2_6		-34.109	20.0	376.6	-0.1
18	2	7	2_7		-25.425	14.9	280.5	-0.1
19	2	8	2_8		-18.162	10.6	200.0	-0.1
20	2	9	2_9		-47.188	27.6	521.5	-0.1
21	2	10	2_10		-9.226	5.4	101.1	-0.1
22	2	11	2_11		-14.076	8.2	154.8	-0.1
23	3	1	3_1		-3.790	2.2	40.9	-0.1

Click on (+) to see other years

Computes utility for each mode for all the years

Mode choice – all mode summary

Click on (+) to see other years

eturn to Data Explorer

e offset	ID_OD	Ori_idz	Dest_idz	O_D	P_M1_Ref_2017	P_M2_Ref_2017	P_M3_Ref_2017	P_M4_Ref_2017
0	1	1	1	1_1	0.59	0.00	0.41	0.00
1	2	1	2	1_2	0.03	0.00	0.97	0.00
2	3	1	3	1_3	0.45	0.02	0.53	0.00
3	4	1	4	1_4	0.82	0.00	0.18	0.00
4	5	1	5	1_5	0.00	0.00	1.00	0.00
5	6	1	6	1_6	0.00	0.00	0.99	0.00
6	7	1	7	1_7	1.00	0.00	0.00	0.00
7	8	1	8	1_8	0.09	0.00	0.91	0.00
8	9	1	9	1_9	0.00	0.00	1.00	0.00
9	10	1	10	1_10	0.00	0.00	1.00	0.00
10	11	1	11	1_11	0.00	0.00	1.00	0.00
11	12	2	1	2_1	0.02	0.00	0.98	0.00
12	13	2	2	2_2	0.38	0.00	0.62	0.00
13	14	2	3	2_3	0.04	0.36	0.60	0.00
14	15	2	4	2_4	0.66	0.00	0.34	0.00
15	16	2	5	2_5	0.51	0.02	0.47	0.00
16	17	2	6	2_6	1.00	0.00	0.00	0.00
17	18	2	7	2_7	1.00	0.00	0.00	0.00
18	19	2	8	2_8	0.03	0.00	0.97	0.00
19	20	2	9	2_9	1.00	0.00	0.00	0.00
20	21	2	10	2_10	0.81	0.01	0.18	0.00
21	22	2	11	2_11	0.04	0.00	0.96	0.00
22	23	3	1	3_1	0.44	0.02	0.54	0.00
23	24	3	2	3_2	0.04	0.33	0.63	0.00
24	25	3	3	3_3	0.63	0.00	0.37	0.00
25	26	3	4	3_4	0.79	0.00	0.21	0.00
26	27	3	5	3_5	0.00	0.20	0.80	0.00
27	28	3	6	3_6	0.00	0.01	0.99	0.00
28	29	3	7	3_7	1.00	0.00	0.00	0.00

Computes probability of choosing each mode for each OD pair

Load factors[load factors]

Load factors coming from input sheet and changing based on policies

Load Factors

Return to Data Explorer

Data source: IEA Mobility Model (MoMo)	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	ScA	ScA	ScA	ScA	ScA	ScA	ScA	ScA
year	2017	2020	2025	2030	2035	2040	2045	2050	2017	2020	2025	2030	2035	2040	2045	2050
PV_intercity	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.875	2.875	2.875	2.875	2.875
PV	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.90	1.90	1.90	1.90	1.90
Bus	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
rail	250.18	250.18	250.18	250.18	250.18	250.18	250.18	250.18	250.18	250.18	250.18	250.18	250.18	250.18	250.18	250.18
Air	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00

Vehicle stock model & CO2 estimation

[pc_stock_model_bl, pc_stock_model_sca, PT_stocks_emissions]

Car vehicle stock

The two sheets (one for Baseline and one for Alternative) have multiple elements each:

- Total stock by vehicle age (also by fuel type)
- CO2 per VKM (also by fuel type and age)
- Survival curve
- Sales shares based on user input

Total stock by vehicle age

Private vehicle stock - Baseline Return to Data Explorer

Total stock by Vehicle age

Vehicle age		2018	2020	2025	2030	2035	2040	2045	2050
0	5	41 178	234 617	217 335	194 075	179 712	204 280	226 852	230 950
5	10	115 159	40 972	233 443	216 247	193 104	178 813	203 257	225 717
10	15	114 914	111 488	39 666	226 002	209 354	186 949	173 113	196 779
15	20	114 914	101 535	98 509	35 048	199 691	184 981	165 184	152 959
20	25	84 270	78 227	69 120	67 059	23 859	135 938	125 925	112 448
25	50	194 273	51 970	38 347	33 299	32 005	12 941	60 672	59 956
		664 708	**618 810**	**696 419**	**771 731**	**837 725**	**903 902**	**955 004**	**978 809**
Total mileage old vehicles		9 586 205 552	5 645 091 536	7 673 353 532	9 460 243 704	10 672 760 305	11 023 923 554	11 295 043 738	11 745 583 799
Required mileage		9 586 210 031	10 337 435 779	12 020 055 031	13 341 751 545	14 267 005 140	15 109 519 498	15 832 085 720	16 364 584 754
Difference to be covered by new vehicles		4 479	4 692 344 243	4 346 701 499	3 881 507 841	3 594 244 834	4 085 595 944	4 537 041 982	4 619 000 955
Total mileage all vehicles		9 586 210 031	10 337 435 779	12 020 055 031	13 341 751 545	14 267 005 140	15 109 519 498	15 832 085 720	16 364 584 754
Check		-	-	0	0	0	0	0	
Total fleet		664 708	618 810	696 419	771 731	837 725	903 902	955 004	978 809

1

Average annual vkm by age group

Age		Annual km	Fleet average	Target resulting by VKM/total fleet
0	5	20000	14421.68	14421.68
5	10	18342		
10	15	16800		
15	20	15000		
20	25	12500		
25	50	10000		

2

Total stock by fuel type

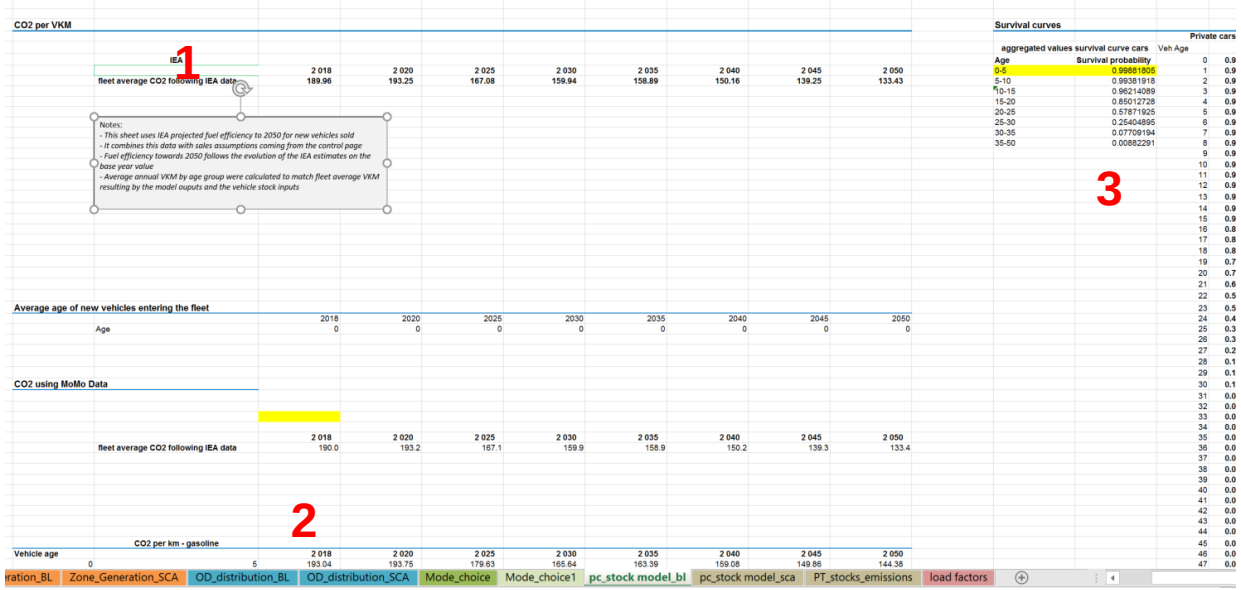
	2018	2020	2025	2030	2035	2040	2045	2050
Total stock	664 708	618 810	696 419	771 731	837 725	903 902	955 004	978 809
Gasoline	622 442	570 012	637 123	697 903	747 324	794 570	820 386	806 326
Gasoline Hybrid	0	0	4 752	12 285	23 921	40 645	60 937	92 905
Diesel	19 873	23 429	29 785	35 569	37 978	37 510	38 544	37 628
Diesel Hybrid	0	0	263	681	1 207	1 994	3 092	4 686
CNG/LPG	22 394	25 369	24 052	24 252	24 422	23 034	21 058	18 018
Hydrogen	0	0	0	0	50	163	389	797
Hydrogen Hybrid	0	0	0	0	0	0	0	0
Electric	0	0	445	1 040	2 873	6 150	10 987	19 246

3

	2018	2020	2025	2030	2035	2040	2045	2050
Total stock	100%	100%	100%	100%	100%	100%	100%	100
Gasoline	94%	92%	91%	90%	89%	88%	86%	82
Gasoline Hybrid	0%	0%	1%	2%	3%	4%	6%	9

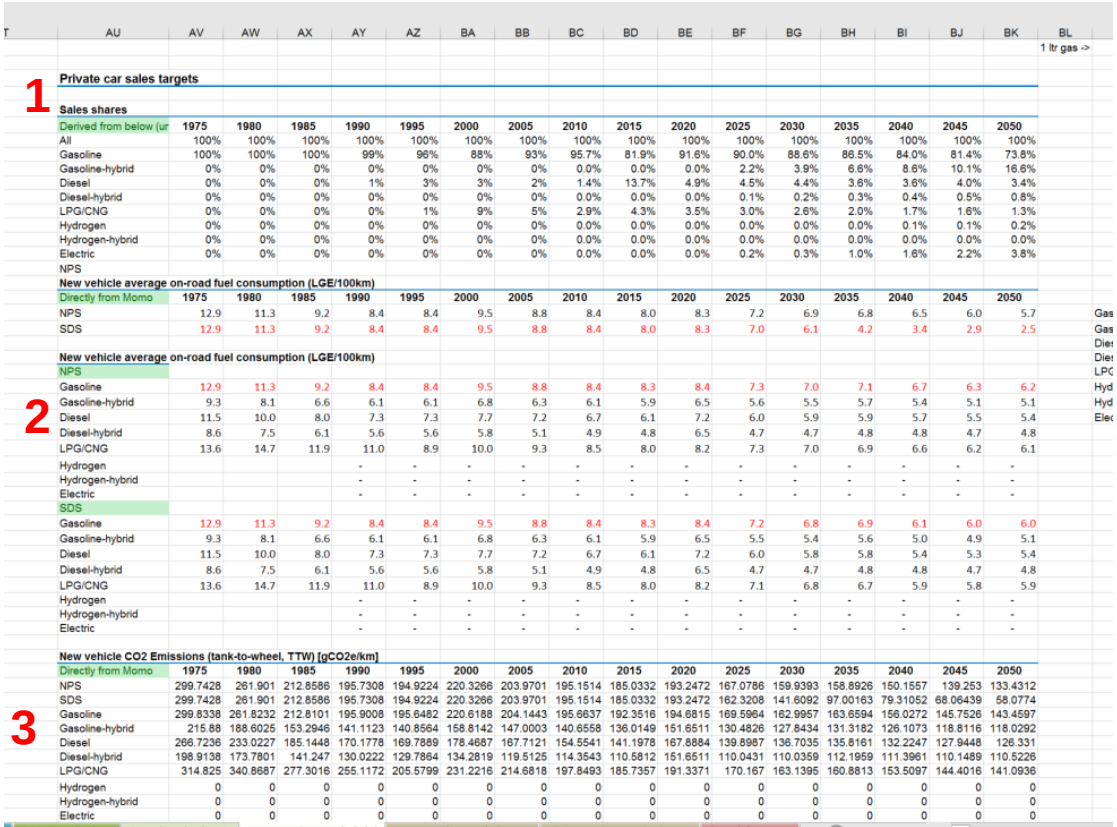
1. Stock by vehicle age
2. Average distance by vehicle in each age category [the two numbers must be equal]
3. Vehicle stock decomposition by fuel type and age (further down on sheet)

Co2 per VKM and survival curve



1. CO2 per VKM
2. Computation for CO2 per VKM using IEA CO2 per VKM by fuel type and age (further down)
3. Survival curve

New vehicle sales



	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL
																		1 ltr gas ->
1	**Private car sales targets**																	
	Sales shares																	
	Derived from below (ur	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	
	All	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
	Gasoline	100%	100%	100%	99%	96%	88%	93%	95.7%	81.9%	91.6%	90.0%	88.6%	86.5%	84.0%	81.4%	73.8%	
	Gasoline-hybrid	0%	0%	0%	0%	0%	0%	0%	0.0%	0.0%	0.0%	2.2%	3.9%	6.6%	8.6%	10.1%	16.6%	
	Diesel	0%	0%	0%	1%	3%	3%	2%	1.4%	13.7%	4.9%	4.5%	4.4%	3.6%	3.6%	4.0%	3.4%	
	Diesel-hybrid	0%	0%	0%	0%	0%	0%	0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.3%	0.4%	0.5%	0.8%	
	LPG/CNG	0%	0%	0%	0%	1%	9%	5%	2.9%	4.3%	3.5%	3.0%	2.6%	2.0%	1.7%	1.6%	1.3%	
	Hydrogen	0%	0%	0%	0%	0%	0%	0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	
	Hydrogen-hybrid	0%	0%	0%	0%	0%	0%	0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Electric	0%	0%	0%	0%	0%	0%	0%	0.0%	0.0%	0.0%	0.2%	0.3%	1.0%	1.6%	2.2%	3.8%	
	NPS																	
	New vehicle average on-road fuel consumption (LGE/100km)																	
	Directly from Momo	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	
	NPS	12.9	11.3	9.2	8.4	8.4	9.5	8.8	8.4	8.0	8.3	7.2	6.9	6.8	6.5	6.0	5.7	Gas
	SDS	12.9	11.3	9.2	8.4	8.4	9.5	8.8	8.4	8.0	8.3	7.0	6.1	4.2	3.4	2.9	2.5	Gas
																		Die
	New vehicle average on-road fuel consumption (LGE/100km)																	Die
	NPS																	LPG
	Gasoline	12.9	11.3	9.2	8.4	8.4	9.5	8.8	8.4	8.3	8.4	7.3	7.0	7.1	6.7	6.3	6.2	Hyd
2	Gasoline-hybrid	9.3	8.1	6.6	6.1	6.1	6.8	6.3	6.1	5.9	6.5	5.6	5.5	5.7	5.4	5.1	5.1	Hyd
	Diesel	11.5	10.0	8.0	7.3	7.3	7.7	7.2	6.7	6.1	7.2	6.0	5.9	5.9	5.7	5.5	5.4	Elec
	Diesel-hybrid	8.6	7.5	6.1	5.6	5.6	5.8	5.1	4.9	4.8	6.5	4.7	4.7	4.8	4.8	4.7	4.8	
	LPG/CNG	13.6	14.7	11.9	11.0	8.9	10.0	9.3	8.5	8.0	8.2	7.3	7.0	6.9	6.6	6.2	6.1	
	Hydrogen				-	-	-	-	-	-	-	-	-	-	-	-	-	
	Hydrogen-hybrid				-	-	-	-	-	-	-	-	-	-	-	-	-	
	Electric				-	-	-	-	-	-	-	-	-	-	-	-	-	
	SDS																	
	Gasoline	12.9	11.3	9.2	8.4	8.4	9.5	8.8	8.4	8.3	8.4	7.2	6.8	6.9	6.1	6.0	6.0	
	Gasoline-hybrid	9.3	8.1	6.6	6.1	6.1	6.8	6.3	6.1	5.9	6.5	5.5	5.4	5.6	5.0	4.9	5.1	
	Diesel	11.5	10.0	8.0	7.3	7.3	7.7	7.2	6.7	6.1	7.2	6.0	5.8	5.8	5.4	5.3	5.4	
	Diesel-hybrid	8.6	7.5	6.1	5.6	5.6	5.8	5.1	4.9	4.8	6.5	4.7	4.7	4.8	4.8	4.7	4.8	
	LPG/CNG	13.6	14.7	11.9	11.0	8.9	10.0	9.3	8.5	8.0	8.2	7.1	6.8	6.7	5.9	5.8	5.9	
	Hydrogen				-	-	-	-	-	-	-	-	-	-	-	-	-	
	Hydrogen-hybrid				-	-	-	-	-	-	-	-	-	-	-	-	-	
	Electric				-	-	-	-	-	-	-	-	-	-	-	-	-	
	New vehicle CO2 Emissions (tank-to-wheel, TTW) [gCO2e/km]																	
	Directly from Momo	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	
	NPS	299.7428	261.901	212.8586	195.7308	194.9224	220.3266	203.9701	195.1514	185.0332	193.2472	167.0786	159.9393	158.8926	150.1557	139.253	133.4312	
	SDS	299.7428	261.901	212.8586	195.7308	194.9224	220.3266	203.9701	195.1514	185.0332	193.2472	162.3208	141.6092	97.00163	79.31052	68.06439	58.0774	
3	Gasoline	299.8338	261.8232	212.8101	195.9008	195.6482	220.6188	204.1443	195.6637	192.3516	194.6815	169.5964	162.9957	163.6594	156.0272	145.7526	143.4597	
	Gasoline-hybrid	215.88	188.6025	153.2946	141.1123	140.8564	158.8142	147.0003	140.6558	136.0149	151.6511	130.4826	127.8434	131.3182	126.1073	118.8116	118.0292	
	Diesel	266.7236	233.0227	185.1448	170.1778	169.7889	178.4687	167.7121	154.5541	141.1978	167.8884	139.8987	136.7035	135.8161	132.2247	127.9448	126.331	
	Diesel-hybrid	198.9138	173.7801	141.247	130.0222	129.7864	134.2819	119.5125	114.3543	110.5812	151.6511	110.0431	110.0359	112.1959	111.3961	110.1489	110.5226	
	LPG/CNG	314.825	340.8687	277.3016	255.1172	205.5799	231.2216	214.6818	197.8493	185.7357	191.3371	170.167	163.1395	160.8813	153.5097	144.4016	141.0936	
	Hydrogen	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Hydrogen-hybrid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Electric	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

1. Sales targets (defined by user or adoption of IEA scenarios)
2. Fuel efficiency of new vehicles (IEA)
3. CO2 emissions of new vehicles (calculated)

Buses and Taxis

CO2 factors for:

1. Buses Intercity ; 2. Buses Urban ; 3. Trains ; 4. Aircrafts

BUS and RAIL emissions

Notes:
- *This sheet estimates public transport & taxi fleets CO2 factors based on IEA data on vehicle fuel efficiency*
- *Targets for the fleet composition in the study period are set by the users*
- *Click on the + signs to see calculations for individual modes*

SUMMARY

1 Bus intercity

	Baseline								ScA							
CO2 per vkm	2018	2020	2025	2030	2035	2040	2045	2050	2018	2020	2025	2030	2035	2040	2045	2050
all	466.88	442.56	502.20	482.25	457.18	423.30	390.11	358.78	413.50	391.98	406.52	387.24	370.60	354.58	339.19	324.38

2 Bus urban

	Baseline								ScA							
CO2 per vkm	2018	2020	2025	2030	2035	2040	2045	2050	2018	2020	2025	2030	2035	2040	2045	2050
all	790.72	749.59	785.89	803.90	748.43	681.13	603.85	530.28	700.24	663.81	690.91	660.51	634.39	609.17	584.82	561.30

3 RAIL

	Baseline								ScA							
CO2 per vkm	2018	2020	2025	2030	2035	2040	2045	2050	2018	2020	2025	2030	2035	2040	2045	2050
Diesel	11303	11185	9747	8494	7401	6449	5620	6203	11303.21	11185.42	9746.99	8493.53	7401.27	6449.48	5620.08	6202.90
Electric	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

4 Air

	Baseline								ScA							
CO2 per pkm	2018	2020	2025	2030	2035	2040	2045	2050	2018	2020	2025	2030	2035	2040	2045	2050
Diesel	124	111.8109	92.61555	83.43592	78.89	73.46577	69.57721	66.17731	123.80	111.81	92.62	83.44	78.89	73.47	69.58	66.18

Buses detailed – similar for other modes in sheet

BUS

1

CO2 per vkm

	2015	2018	2020	2025	2030	2035	2040	2045	2050	2018	2020	2025	2030	2035	2040
all	1392.42	1392.42	1383.74	1061.44	859.57	626.74	422.56	242.93	88.93	1392.42	1383.74	896.45	552.70	386.54	240.94
Gasoline	1309.894	1302.392	1297.39	1123.807	1045.141	974.5937	911.2451	854.2923	846.9454	1302.392	1297.39	1123.807	1045.141	974.5937	911.2451
Gas. Hybri	1047.915	1041.913	1037.912	899.0457	836.1125	779.6749	728.9961	683.4338	677.5563	1041.913	1037.912	899.0457	836.1125	779.6749	728.9961
Diesel	1392.425	1392.425	1387.078	1201.495	1117.391	1041.967	974.239	913.349	905.4942	1392.425	1387.078	1201.495	1117.391	1041.967	974.239
D. Hybrid	1113.94	1113.94	1109.663	961.1963	893.9125	833.5734	779.3912	730.6792	724.3954	1113.94	1109.663	961.1963	893.9125	833.5734	779.3912
CNG/LPG	1375.389	1367.511	1362.26	1179.998	1097.398	1023.323	956.8073	897.0069	889.2926	1367.511	1362.26	1179.998	1097.398	1023.323	956.8073
Hydrogen	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hyd. Hybric	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electric	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

2

Fuel per 100km

	2015	2018	2020	2025	2030	2035	2040	2045	2050	2018	2020	2025	2030	2035	2040
all	60.00	60.00	59.63	45.74	37.04	27.01	18.21	10.47	3.83	60.00	59.63	38.63	23.82	16.66	10.38
Gasoline	56.44347	56.12	55.90469	48.42497	45.03522	41.99534	39.26565	36.81154	36.49496	56.12	55.90469	48.42497	45.03522	41.99534	39.26565
Gas. Hybri	45.15478	44.90	44.72375	38.73998	36.02818	33.59628	31.41252	29.44923	29.19597	44.90	44.72375	38.73998	36.02818	33.59628	31.41252
Diesel	60	60.00	59.76935	51.77256	48.14848	44.89846	41.98006	39.35631	39.01784	60.00	59.76935	51.77256	48.14848	44.89846	41.98006
D. Hybrid	47.99981	47.99981	47.81548	41.41805	38.51879	35.91877	33.58405	31.48504	31.21427	48.00	47.81548	41.41805	38.51879	35.91877	33.58405
CNG/LPG	59.26564	58.93	58.69992	50.84622	47.28698	44.09511	41.22893	38.65212	38.31971	58.93	58.69992	50.84622	47.28698	44.09511	41.22893
Hydrogen	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0	0
Hyd. Hybric	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0	0
Electric	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0	0

3

stock share	2015	2018	2020	2025	2030	2035	2040	2045	2050	2018	2020	2025	2030	2035	2040
all	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Gasoline	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Gas. Hybri	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Diesel	100%	100%	99%	54%	10%	8%	5%	3%	0%	100%	99%	59%	20%	15%	10%
D. Hybrid	0%	0%	1%	5.6%	10%	7.50%	5%	3%	0%	0%	1%	0.6%	0%	0.00%	0%
CNG/LPG	0%	0%	0%	30.0%	60%	47.50%	35%	23%	10%	0%	0%	15.0%	30%	22.50%	15%

1. CO2 per vkm resulting from below
2. Fuel per 100km (IEA)
3. Target based fleet (user input)

Developer related sheets

[hidden sheets]

Inputs_aze

This sheet includes data that were created by the ITF to compute the mode choice model.

- It serves as the basis for the variables in the mode choice sheets
- The data come from ITF estimations and were combined with data from Azerbaijan statistics and other sources to estimate the mode choice model parameters
- If you want to change/update this data please get in touch with ITF

Control_2

This sheet works as the sheet where the measures, the scenario built, and the models interface

- The different measures affect this sheet and create multipliers or additions/subtractions that affect parameters in the models
- It primarily affects mode choice sheets but also distribution (directly and indirectly)

Control_2

- These interfaces are included in the OD matrices by mode [the right part of control_2] through long IF statements and links to other sheets.
- Please do not change them directly unless you understand how they work as they might render the model non-functional
- They often link to another sheet, OD_zone_measures

OD_zone_measures

This sheet identifies which OD pairs are affected when a new infrastructure is put in place between two zones.

- For example if a new rail line is done between zones 1 and 3 would affect all zone pairs that would use that line.

Adding a policy measure

- Need to understand the impacts of this new policy (e.g. will it affect travel time, cost, people perception)
- Measures are basically added via IF statements, where the first part has a lot of conditions and safeguards. Then there is the impact in absolute or relative terms
- Whole country measures are easiest to add, zone measures are less easy, OD measures are the hardest