**Assessing the Sustainability of Passenger Fleet Transition: A System Dynamics Analysis of Behavior, Policy, and Environmental Outcomes.**

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## Model Source code and instructions

### Instructions

1. **Building the model**

The paper and this supplementary material provides the full model description. The source code below allows replicating the exact formulations. The model is built in the Vensim PLE simulation environment (<http://vensim.com>), but the source code can be developed in any other environment. The provided equations are self-explanatory, but users can download supportive documentation from <https://github.com/abamichael/SD-Model-Norway> to find explanation.

1. **Model Source Code**

"1 dollar" = 1

Units: Dollars/Year

"1 Yr" = 1

Units: Year

"Annual ICV R & D Expenditure" = 5e+08

Units: Dollars/Year

"Annual R & D Expenditure" = 1e+09

Units: Dollars/Year

"Annual R&D Investment" = 1e+06

Units: Dollars/Year

Available Charging stations = INTEG( Charging stations deployed - Charging stations scrappage

, "INITIAL NO. OF CHARGING STATIONS" )

Units: Stations

Available refuel stations = INTEG( refuel stations deployed - Refuel stations scrappage

, INITIAL REFUEL STATIONS )

Units: Stations

Average Annual emissions limit = AVKT \* Emissions target \* "1 Yr"

Units: kgCO2/Car

AVERAGE ELECTRICITY SUPPLY EMISSIONS = 0.016

Units: kgCO2/kWh

Average electricity supply emissions per km = ZIDZ ( AVERAGE ELECTRICITY SUPPLY EMISSIONS

, 1 / EV FUEL ECONOMY )

Units: kgCO2/km

Average Emissions per EV = EV emissions / EV Stocks

Units: kgCO2/Car

Average ICV emissions = ICV emissions / ICV Stocks

Units: kgCO2/Car

Average petrol fuel emissions per km = ZIDZ ( PETROL FUEL SUPPLY EMISSION FACTOR, 1/ ICV FUEL ECONOMY )

Units: kgCO2/km

AVKT = 13621

Units: km/(Car\*Year)

Base cost = Base cost Experience factor \* INITIAL BASE COST

Units: USD

Base cost Experience factor = ( Cumulative ICV Engine production 0 /

Reference Base cost Experience level

) ^ - Strength of Base cost learning curve

Units: Dmnl

Base costs learning rate = 0.05

Units: Dmnl

Battery Capacity = IF THEN ELSE ( Time < 2019, 24, 37)

Units: kWh

BATTERY COST LR = 0.25

Units: Dmnl

Battery Exp Factor = ( "Cumulative Battery R&D Investment" / "REFERENCE BATTERY R&D INVESTMENT"

) ^ - Strength of Battery learning curve

Units: Dmnl

"Battery R&D Investment" = "Annual R&D Investment"

Units: Dollars/Year

Change in Charger to EV ratio = ( CHARGER TO EVE RATION LIMIT - charger to EV ratio

)

/ TIME TO CHANGE CHARGER TO EV RATIO

Units: Stations/Car/Year

Change in GDP = ( GDP PER CAPITA GROWTH RATE \* Gross Domestic Product per capita

)

Units: Dollars/(Year\*Year)

Change in station to ICV ratio = ( STATION TO ICV RATION LIMIT - refuel station to ICV ratio

) / TIME TO CHANGE REFUEL STATIONS TO ICV RATIO

Units: Stations/Car/Year

charger to EV ratio = INTEG( Change in Charger to EV ratio , INITIAL CHARGER TO EV RATIO

)

Units: Stations/Car

CHARGER TO EVE RATION LIMIT = 0.04

Units: Stations/Car

Charging station coverage = Available Charging stations / Total stations

Units: Dmnl

Charging station deficit = MAX ( 0, Optimal charger required - Total Chargers

)

Units: Stations

CHARGING STATION LIFESPAN = 20

Units: Year

Charging stations deployed = ZIDZ ( Charging stations under construction

, Time to Deploy Charging station

)

Units: Stations/Year

CHARGING STATIONS IN PLANNING = Charging station deficit / CHARGING STATIONS IN PLANNING APPROVAL RATE

Units: Stations/Year

CHARGING STATIONS IN PLANNING APPROVAL RATE = 1

Units: Year

Charging stations scrappage = ZIDZ ( Available Charging stations , CHARGING STATION LIFESPAN

)

Units: Stations/Year

Charging stations under construction = INTEG( CHARGING STATIONS IN PLANNING

- Charging stations deployed

, 0)

Units: Stations

Constant = -2.07666

Units: Dmnl

"Cumulative Battery R&D Investment" = INTEG( "Battery R&D Investment"

, "REFERENCE BATTERY R&D INVESTMENT"

)

Units: USD

Cumulative Electric Vehicle production = INTEG( Electric Vehicle production

, 100000)

Units: Car

Cumulative ICV Engine production = INTEG( ICV Engine production , Reference ICV Engine Production level

)

Units: Car

Cumulative ICV Engine production 0 = INTEG( ICV Engine production 0 ,

100000)

Units: Car

"Cumulative ICV R & D Expenditure" = INTEG( "ICV R & D Expenditure" ,

"INITIAL ICV R & D INVESTMENT"

)

Units: USD

"Cumulative R & D Expenditure" = INTEG( "R & D Expenditure" , "INITIAL R & D INVESTMENT"

)

Units: USD

DIRECT CONTACT EFFECT = 0.25

Units: Dmnl/Year

Discards = Total Vehicle Discards

Units: Car/Year

Effect of Charging station coverage = ( Refuel stations coverage / Reference EV CHARGING STATION COVERAGE

) \* Sensitivity of ICV Sensitivity station coverage

Units: Dmnl

Effect of Culture = ( PFAD INDEX / reference of culture effect ) \* Sensitivity of National Cultural Index

Units: Dmnl

Effect of EV Affordability = Sensitivity of Affordability \* ( EV Affordability Utility

/ Reference Affordability )

Units: Dmnl

Effect of EV O M cost = ( EV Maintenance cost + Effective EV FE \* EV Fuel Cost

) \* "EV O&M cost Sensitivity"

Units: Dmnl

Effect of EV Range = EV Relative Range Index \* Sensitivity of Range

Units: Dmnl

Effect of EV station Coverage = Sensitivity of EV Charging stations \*

( Charging station coverage

/ Reference EV CHARGING STATION COVERAGE )

Units: Dmnl

Effect of HDI on EV adoption = Sensitivity of HDI \* ( Human Development Index

/ Ref HDI Index

)

Units: Dmnl

effect of ICV affordability = ( ICV Affordability Utility / Reference Affordability

)

\* Sensitivity of ICV affordability

Units: Dmnl

Effect of ICV emissions = ( Average ICV emissions / Average Annual emissions limit

)

\* Sensitivity of ICV emissions

Units: Dmnl

"Effect of ICV O & M cost" = ( ICV Maintenance cost + effective ICV FE

\* ICV Fuel Cost

) \* "ICV O&M Sensitivity"

Units: Dmnl

Effect of Range = ICV Relative Range Index \* Sensitivity of ICV Range

Units: Dmnl

Effect of social exposure on forgetfulness = EXP ( -4 \* epsilon \* ( Total network effect

- REFERENCE SOCIAL EXPOSURE ) ) / ( 1 + EXP ( -4 \* epsilon

\* ( Total network effect

- REFERENCE SOCIAL EXPOSURE ) ) )

Units: Dmnl

Effective EV FE = EV FUEL ECONOMY \* "R & D Factor"

Units: kWh/km

effective ICV FE = ICV FUEL ECONOMY \* "ICV R & D Factor"

Units: L/km

"Elect-BBL converter" = 0.000588441

Units: BBL/kWh

Electric Vehicle production = EV New Sales

Units: Car/Year

EMBODIED EMISSIONS = 0.016

Units: kgCO2/km

Emissions per car = Total emissions / total vehicle market

Units: TCO2/Car

Emissions target = 0.085

Units: kgCO2/km

epsilon = 1 / REFERENCE SOCIAL EXPOSURE

Units: Year

EV Affordability Utility = ( ( "EV Price + tax" / one thousand dollars

) / LN GDP )

Units: Dmnl

EV Attractiveness = EV Network effect \* EV Utility

Units: Dmnl

EV Discards = EV Stocks / EV LIFETIME

Units: Car/Year

EV Electricity demand = AVKT \* EV Stocks \* Effective EV FE

Units: kWh/Year

EV emissions = INTEG( "EV emissions flow-in" - EV Emissions outflow ,

0)

Units: kgCO2

"EV emissions flow-in" = ( Average electricity supply emissions per km

+ EMBODIED EMISSIONS

+ EV TAIL PIPE EMISSION ) \* EV Stocks \* AVKT

Units: kgCO2/Year

EV Emissions outflow = EV emissions / "1 Yr"

Units: kgCO2/Year

EV environmental Impact = ( Average Emissions per EV / Average Annual emissions limit

) \* Sensitivity to environmental impact

Units: Dmnl

EV Experience factor = ( Cumulative Electric Vehicle production / Reference Electric Vehicle Production level

) ^ - Strength of EV Production Strength curve

Units: Dmnl

EV Fuel Cost = WITH LOOKUP( Time , ([(0.3,0.3)-(2050,0.02)],(2008,0.02

),(2009,0.01),(2010,0.02)

,(2011,0.02),(2012,0.01),(2013,0.01),(2014,0.01),(2015,0.01),(

2016,0.01),

(2018,0.01),(2019,0.01),(2020,0.01),(2021,0.01),(2022,0.02),(2023

,0.04),(2023,0.02)

,(2050,0.03) ) )

Units: USD/kWh

EV FUEL ECONOMY = 0.2

Units: kWh/km

EV LIFETIME = 16

Units: Year

EV Maintenance cost = 0.052

Units: USD/km

EV MARKET ADJUST FACTOR = 0.01277

Units: Dmnl

EV Market Share = EV Stocks / total vehicle market

Units: Dmnl

EV MSRP = EV Total cost \* ( 1 + Markup )

Units: USD

EV Network effect = INTEG( Network effect gain - Network effect loss

, INITIAL NETWORK EFFECT

)

Units: Dmnl

EV New Sales = Sales \* Share of EV sales

Units: Car/Year

"EV O&M cost Sensitivity" = -0.00109

Units: Dmnl/USD\*km

"EV Price + tax" = IF THEN ELSE ( Time <= POLICY END DATE , EV MSRP ,

EV MSRP \* ( 1 +

VEHICLE PURCHASE TAX ) \* ( 1 + VAT ) )

Units: USD

EV Production costs learning rate = 0.7

Units: Dmnl

EV Range = Battery Capacity / Effective EV FE

Units: km

EV Relative Range Index = EV Range / Reference Desirable Range

Units: Dmnl

EV Stocks = INTEG( EV New Sales - EV Discards , INITIAL EV STOCK )

Units: Car

EV TAIL PIPE EMISSION = 0

Units: kgCO2/km

EV Total cost = Base cost + ( Battery Capacity \* Unit Battery Cost )

Units: USD

EV Utility = EXP ( Effect of EV Affordability ) \* EXP ( Effect of EV station Coverage

) \* EXP ( Effect of EV Range ) \* EXP ( Effect of Culture

) \* EXP (

Effect of HDI on EV adoption ) \* EXP ( Effect of EV O M cost

) \* EXP (

EV environmental Impact )

Units: Dmnl

EXP(Effect of EV Affordability+Effect of EV

stationCoverage+Effect of EV Range+Effect of Culture +Effect of

HDI on EV adoption+Effect of EV O & M cost+EV environmental Impact)

EVA INDEX = ( ( 1 - INDIVIDUALISM ) + ( 1 - INDULGENCE INDEX ) + ( 1

- LONG-TERM MINDSET

) + ( MASCULINITY INDEX ) + ( POWER DISTANCE INDEX ) + (

UNCERTAINTY AVOIDANCE

) ) / 10

Units: Dmnl

FINAL TIME = 2050

Units: Year

The final time for the simulation.

FORGETTING RATE = 0.05

Units: 1/Year [0,?,1]

Fuel Demand per car = ZIDZ ( Total fuel demand , total vehicle market

)

Units: BBL/Year/Car

FX RATE = WITH LOOKUP( Time , ([(5.6361,5.6361)-(2050,10.8)],(2008,5.6361

),(2009,6.2817)

,(2010,6.0453),(2011,5.6074),(2012,5.821),(2013,5.8768),(2014,

6.3019),(2015,8.0739)

,(2016,8.3987),(2017,8.263),(2018,8.1338),(2019,8.8037),(2020,

9.4004),(2021,8.5991)

,(2022,9.6245),(2023,10.5647),(2024,10.7433),(2050,10.8) ) )

Units: NOK/Dollars

GDP PER CAPITA GROWTH RATE = WITH LOOKUP( Time , ([(-0.4,-0.4)-(2100,

0.05)],(2008,0),

(2009,0),(2010,0),(2011,0.15),(2012,0.01),(2012,0.01),(2013,-0.06

),(2014,-0.23)

,(2015,-0.05),(2016,0.08),(2017,0.09),(2018,-0.08),(2019,-0.11

),(2020,0.36)

,(2021,0.17),(2022,-0.19),(2023,0),(2024,0.022),(2025,0.019),(

2050,0.015)

,(2100,0.015) ) )

Units: 1/Year

Gross Domestic Product per capita = INTEG( Change in GDP , INITIAL GROSS DOMESTIC PRODUCT per capita

)

Units: Dollars/Year

HDI change = ( HDI MAXIMUM LIMIT - Human Development Index ) / TIME TO CHANGE HDI

Units: Dmnl/Year

HDI MAXIMUM LIMIT = 1

Units: Dmnl

HEAT RATE = 0

Units: btu/kWh

Human Development Index = INTEG( HDI change , INITIAL HDI )

Units: Dmnl

IC Engine cost = ICV Engine Experience factor \* INITIAL IC ENGINE COST

Units: USD

ICE TANK CAPACITY = 30

Units: L

ICV Affordability Utility = ( ( "ICV Price + Tax" / one thousand dollars

) / LN GDP )

Units: Dmnl

ICV Attractiveness = ICV Network effect \* ICV Utility

Units: Dmnl

ICV DIRECT CONTACT EFFECT = 0.0475

Units: Dmnl/Year

ICV Discards = ICV Stocks / ICV LIFETIME

Units: Car/Year

ICV Effect of social exposure on forgetfulness = EXP ( -4 \* ICV epsilon

\* ( ICV Total network effect

- ICV REFERENCE SOCIAL EXPOSURE ) ) / ( 1 + EXP ( -4 \* ICV epsilon

\* ( ICV Total network effect - ICV REFERENCE SOCIAL EXPOSURE

) ) )

Units: Dmnl

ICV EMBODIED EMISSIONS = 0.016

Units: kgCO2/km

ICV emissions = INTEG( "ICV emissions flow-in" - ICV Emissions outflow

, 0)

Units: kgCO2

"ICV emissions flow-in" = ( Average petrol fuel emissions per km + ICV EMBODIED EMISSIONS

+ ICV TAIL PIPE EMISSION ) \* ICV Stocks \* AVKT

Units: kgCO2/Year

ICV Emissions outflow = ICV emissions / "1 Yr"

Units: kgCO2/Year

ICV Engine Experience factor = ( Cumulative ICV Engine production / Reference ICV Engine Production level

) ^ - Strength of ICV Engine Production Strength curve

Units: Dmnl

ICV Engine production = ICV New Sales

Units: Car/Year

ICV Engine production 0 = ICV New Sales

Units: Car/Year

ICV Engine Production costs learning rate = 0.1

Units: Dmnl

ICV epsilon = 1 / ICV REFERENCE SOCIAL EXPOSURE

Units: Year

ICV FORGETTING RATE = 0.558775

Units: 1/Year [0,?,1]

ICV Fuel Cost = WITH LOOKUP( Time , ([(0.18,0.18)-(2050,0.25)],(2008,

0.18),(2009,0.16)

,(2010,0.17),(2011,0.21),(2012,0.21),(2013,0.21),(2014,0.2),(2015

,0.14),(2016,0.13)

,(2017,0.15),(2018,0.16),(2019,0.15),(2020,0.13),(2021,0.16),(

2022,0.19),

(2023,0.17),(2050,0.25) ) )

Units: USD/L

ICV FUEL ECONOMY = 0.0836

Units: L/km

ICV INDIRECT CONTACT EFFECT = 0.0016

Units: Dmnl/Year

ICV INITIAL NETWORK EFFECT = 1

Units: Dmnl

ICV LIFETIME = 20

Units: Year

ICV Maintenance cost = 0.077

Units: USD/km

ICV Market share = ICV Stocks / total vehicle market

Units: Dmnl

ICV MARKETING EFFECTIVENESS = 0

Units: Dmnl/Year

ICV MSRP = ICV Total cost \* ( 1 + Markup )

Units: USD

ICV Network effect = INTEG( ICV Network effect gain - ICV Network effect loss

, ICV INITIAL NETWORK EFFECT

)

Units: Dmnl

ICV Network effect gain = ICV Total network effect \* ( 1 - ICV Network effect

)

Units: Dmnl/Year

ICV Network effect loss = ICV Effect of social exposure on forgetfulness

\* ICV FORGETTING RATE

\* ICV Network effect

Units: Dmnl/Year

ICV New Sales = Sales \* Share of ICV Sales

Units: Car/Year

"ICV O&M Sensitivity" = -0.07722

Units: Dmnl/USD\*km

"ICV Price + Tax" = ICV MSRP \* ( 1 + VEHICLE PURCHASE TAX ) \* ( 1 + VAT

)

Units: USD

"ICV R & D Expenditure" = "Annual ICV R & D Expenditure"

Units: Dollars/Year

"ICV R & D Factor" = ( "Cumulative ICV R & D Expenditure" / "Reference ICV R & D Investment"

) ^ - "Strength of ICV R & D Learning curve"

Units: Dmnl

"ICV R&D Learning rate" = 0.1

Units: Dmnl

ICV Range = ICE TANK CAPACITY / effective ICV FE

Units: km

ICV REFERENCE SOCIAL EXPOSURE = 0.05

Units: 1/Year

ICV REFUELING STATIONS IN PLANNING APPROVAL RATE = 5

Units: Year

ICV Relative Range Index = ICV Range / Reference Desirable Range

Units: Dmnl

ICV Stocks = INTEG( ICV New Sales - ICV Discards , INITIAL ICV STOCK

)

Units: Car

ICV TAIL PIPE EMISSION = 0.012

Units: kgCO2/km

ICV Total cost = Base cost + IC Engine cost

Units: USD

ICV Total network effect = ICV DIRECT CONTACT EFFECT \* ICV Market share

+ ICV INDIRECT CONTACT EFFECT

\* ICV Market share + ICV MARKETING EFFECTIVENESS

Units: Dmnl/Year

ICV Utility = EXP ( Effect of Charging station coverage ) \* EXP ( effect of ICV affordability

) \* EXP ( Effect of Range + "Effect of ICV O & M cost" )

\* EXP ( Effect of ICV emissions

) \* EXP ( Constant )

Units: Dmnl

INDIRECT CONTACT EFFECT = 0.15

Units: Dmnl/Year

INDIVIDUALISM = 0.81

Units: Dmnl

INDULGENCE INDEX = 0.55

Units: Dmnl

INITIAL BASE COST = 15000

Units: USD

INITIAL BIOENERGY CAPACITY = 100

Units: MW

INITIAL CHARGER TO EV RATIO = "INITIAL NO. OF CHARGING STATIONS" / INITIAL EV STOCK

Units: Stations/Car

INITIAL EV STOCK = 1693

Units: Car

INITIAL GROSS DOMESTIC PRODUCT per capita = 87823.8

Units: Dollars/Year

INITIAL HDI = 0.94

Units: Dmnl

INITIAL HYDRO CAPACITY = 2080

Units: MW

INITIAL IC ENGINE COST = 3000

Units: USD

"INITIAL ICV R & D INVESTMENT" = 5e+08

Units: USD

INITIAL ICV STOCK = 2.1955e+06

Units: Car

INITIAL NETWORK EFFECT = 0.0001

Units: Dmnl

INITIAL NG CCGT CAPACITY = 6140

Units: MW

"INITIAL NO. OF CHARGING STATIONS" = 2800

Units: Stations

"INITIAL R & D INVESTMENT" = 5e+10

Units: USD

INITIAL REFUEL STATION TO ICV RATIO = INITIAL REFUEL STATIONS / INITIAL ICV STOCK

Units: Stations/Car

INITIAL REFUEL STATIONS = 1799

Units: Stations

INITIAL TIME = 2008

Units: Year

The initial time for the simulation.

INITIAL UNIT BATTERY COST = 1400

Units: USD/kWh

INITIAL VEHICLE STOCK = 2.19719e+06

Units: Car

kg to Tons converter = 1000

Units: kgCO2/TCO2

LN GDP = LN ( Gross Domestic Product per capita / "1 dollar" )

Units: Dmnl

MARKET GROWTH RATE = 0.022

Units: Dmnl/Year

MARKETING EFFECTIVENESS = IF THEN ELSE ( Time >= "MARKETING POLICY ADJUST. DATE"

, EV MARKET ADJUST FACTOR

\* 0.5 / "1 Yr" , EV MARKET ADJUST FACTOR / "1 Yr" )

Units: Dmnl/Year

"MARKETING POLICY ADJUST. DATE" = 2030

Units: Year

Markup = 0.1

Units: Dmnl

MASCULINITY INDEX = 0.08

Units: Dmnl

Network effect gain = Total network effect \* ( 1 - EV Network effect

)

Units: Dmnl/Year

Network effect loss = Effect of social exposure on forgetfulness \* FORGETTING RATE

\*

EV Network effect

Units: Dmnl/Year

one thousand dollars = 1000

Units: USD

Optimal charger required = charger to EV ratio \* EV Stocks

Units: Stations

optimal refuel stations = ICV Stocks \* refuel station to ICV ratio

Units: Stations

Passenger transport demand = Petrol Fuel Demand \* "Petrol Fuel-BBL Converter"

Units: BBL/Year

Petrol Fuel Demand = AVKT \* effective ICV FE \* ICV Stocks

Units: L/Year

PETROL FUEL SUPPLY EMISSION FACTOR = 0.5519

Units: kgCO2/L

"Petrol Fuel-BBL Converter" = 1 / 159

Units: BBL/L

PFAD INDEX = 1 - ( EVA INDEX )

Units: Dmnl

POLICY END DATE = 2050

Units: Year

POWER DISTANCE INDEX = 0.31

Units: Dmnl

"R & D Expenditure" = "Annual R & D Expenditure"

Units: Dollars/Year

"R & D Factor" = ( "Cumulative R & D Expenditure" / "Reference R & D Investment"

) ^

- "Strength of R & D Learning curve"

Units: Dmnl

"R&D Learning rate" = 0.2

Units: Dmnl

Ref HDI Index = 0.8

Units: Dmnl

Reference Affordability = 1

Units: Dmnl

Reference Base cost Experience level = 100000

Units: Car

"REFERENCE BATTERY R&D INVESTMENT" = 1e+07

Units: USD

Reference Desirable Range = 500

Units: km

Reference Electric Vehicle Production level = 100000

Units: Car

Reference EV CHARGING STATION COVERAGE = 0.2

Units: Dmnl

Reference ICV Engine Production level = 100000

Units: Car

"Reference ICV R & D Investment" = 5e+08

Units: USD

reference of culture effect = 0.7

Units: Dmnl

"Reference R & D Investment" = 5e+10

Units: USD

REFERENCE SOCIAL EXPOSURE = 0.05

Units: 1/Year

REFUEL STATION COMMISSIONING TIME = 1

Units: Year

Refuel station deficit = MAX ( 0, optimal refuel stations - Total Refuel stations

)

Units: Stations

REFUEL STATION LIFESPAN = 25

Units: Year

refuel station to ICV ratio = INTEG( Change in station to ICV ratio ,

INITIAL REFUEL STATION TO ICV RATIO

)

Units: Stations/Car

Refuel stations coverage = Available refuel stations / Total stations

Units: Dmnl

refuel stations deployed = ZIDZ ( Refuel stations under construction

, REFUEL STATION COMMISSIONING TIME

)

Units: Stations/Year

Refuel stations in planning = Refuel station deficit / ICV REFUELING STATIONS IN PLANNING APPROVAL RATE

Units: Stations/Year

Refuel stations scrappage = ZIDZ ( Available refuel stations , REFUEL STATION LIFESPAN

)

Units: Stations/Year

Refuel stations under construction = INTEG( Refuel stations in planning

- refuel stations deployed

, 0)

Units: Stations

Sales = MARKET GROWTH RATE \* total vehicle market + Discards

Units: Car/Year

SAVEPER = TIME STEP

Units: Year [0,?]

The frequency with which output is stored.

Sensitivity of Affordability = -2.45698

Units: Dmnl

Sensitivity of EV Charging stations = 0.1

Units: Dmnl

Sensitivity of HDI = 0.1037

Units: Dmnl

Sensitivity of ICV affordability = -0.0716

Units: Dmnl

Sensitivity of ICV emissions = -0.0158

Units: Dmnl

Sensitivity of ICV Range = 0.00011

Units: Dmnl

Sensitivity of ICV Sensitivity station coverage = 0.001

Units: Dmnl

Sensitivity of National Cultural Index = 0.0001

Units: Dmnl

Sensitivity of Range = 8

Units: Dmnl

Sensitivity to environmental impact = -0.0001

Units: Dmnl

Share of EV sales = EV Attractiveness / Total Attractiveness

Units: Dmnl

Share of ICV Sales = ICV Attractiveness / Total Attractiveness

Units: Dmnl

STATION TO ICV RATIO LIMIT = 0.0008329

Units: Stations/Car

Strength of Base cost learning curve = - LOG ( 1 - Base costs learning rate

, 2)

Units: Dmnl

Strength of Battery learning curve = - LOG ( BATTERY COST LR , 2)

Units: Dmnl

Strength of EV Production Strength curve = - LOG ( 1 - EV Production costs learning rate

, 2)

Units: Dmnl

Strength of ICV Engine Production Strength curve = - LOG ( 1 - ICV Engine Production costs learning rate

, 2)

Units: Dmnl

"Strength of ICV R & D Learning curve" = - LOG ( 1 - "ICV R&D Learning rate"

, 2)

Units: Dmnl

"Strength of R & D Learning curve" = - LOG ( 1 - "R&D Learning rate"

, 2)

Units: Dmnl

TIME STEP = 0.125

Units: Year [0,?]

The time step for the simulation.

TIME TO CHANGE CHARGER TO EV RATIO = 3

Units: Year

TIME TO CHANGE HDI = 30

Units: Year

TIME TO CHANGE REFUEL STATIONS TO ICV RATIO = 12

Units: Year

Time to Deploy Charging station = 1

Units: Year

Total Attractiveness = EV Attractiveness + ICV Attractiveness

Units: Dmnl

Total Chargers = Available Charging stations + Charging stations under construction

Units: Stations

Total emissions = ( EV emissions + ICV emissions ) / kg to Tons converter

Units: TCO2

Total fuel demand = ( "Elect-BBL converter" \* EV Electricity demand )

+ ( Petrol Fuel Demand

\* "Petrol Fuel-BBL Converter" )

Units: BBL/Year

Total network effect = DIRECT CONTACT EFFECT \* EV Market Share + INDIRECT CONTACT EFFECT

\* EV Market Share + MARKETING EFFECTIVENESS

Units: Dmnl/Year

Total Refuel stations = Available refuel stations + Refuel stations under construction

Units: Stations

Total stations = Available Charging stations + Available refuel stations

Units: Stations

Total Vehicle Discards = EV Discards + ICV Discards

Units: Car/Year

total vehicle market = INTEG( Sales - Discards , INITIAL VEHICLE STOCK

)

Units: Car

UNCERTAINTY AVOIDANCE = 0.5

Units: Dmnl

Unit Battery Cost = Battery Exp Factor \* INITIAL UNIT BATTERY COST

Units: USD/kWh

VAT = 0.25

Units: Dmnl

VEHICLE PURCHASE TAX = 0.45

Units: Dmnl