

Extended Snapshot Tool [Demo]

Version 2.2

Users' Manual

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Table of contents

1	Overview of ExSS Demo Version.....	1
1.1	What is ExSS Demo Version?.....	1
1.2	System requirements	1
1.3	Four Steps using ExSS Demo Version.....	2
1.4	Components of Excel worksheets	2
1.5	Necessary information of the base year.....	3
1.6	Calculation structure in future estimation	3
1.7	Cell property.....	4
2	Setting Framework	5
2.1	Area	5
2.2	Base year and target year.....	5
2.3	Scenario name	5
2.4	LCS target	5
2.5	Unit.....	5
2.6	Classification	5
3	Input base year information.....	6
3.1	Demography	6
3.2	Economy	6
3.3	Passenger transport.....	6
3.4	Freight transport	6
3.5	Building.....	7
3.6	Energy demand.....	7
3.7	Energy efficiency	8
3.8	Power supply	8
3.9	Emission factor.....	9
4	Estimate future socio-economic scenario and “BaU” emissions.....	10
4.1	Demography	10
4.2	Economy	10
4.3	Transport demand.....	11
4.4	Check the result of socio-economic indicators and BaU emissions	11
4.5	Iterating simulations.....	12
5	Setting low-carbon measures and analyzing the result.....	13
5.1	Power supply (CPG).....	13
5.2	Residential and commercial sectors	13

5.3	Industry	14
5.4	Passenger and freight Transport	14
5.5	Carbon sink	15
5.6	Iterating simulations for “The most suitable portfolio”	15
5.7	Analyzing the result	16

1 Overview of ExSS Demo Version

1.1 What is ExSS Demo Version?

ExSS Demo Version is a simplified version of ExSS (extend snapshot tool) for demonstration and training. ExSS is an estimation tool used for low-carbon society (LCS) study based on the idea of “back casting”. In order to contribute decision making towards LCS, it estimates future society as a social goal. It is a static, accounting type model which describes consistent future state of demography, economy, transport, energy use, low-carbon measures and CO₂ emissions. So far ExSS Demo Version focus on CO₂ emissions from fossil fuel use only, however, it is possible to extend ExSS (not Demo Version) to land use, forestry, agriculture, water and air pollution, waste emission and disposal, etc.

Figure 1.1 shows overall idea of ExSS. Users assume future societies and low-carbon measures, comparing them to the present socio-economic conditions, energy consumptions and environmental load emissions. Based on the assumptions, users estimate future environmental load emissions and the scale of low-carbon measures. in order to achieve the environmental target. This tool can make the discussion effective when people discuss the environmental project in their regions.

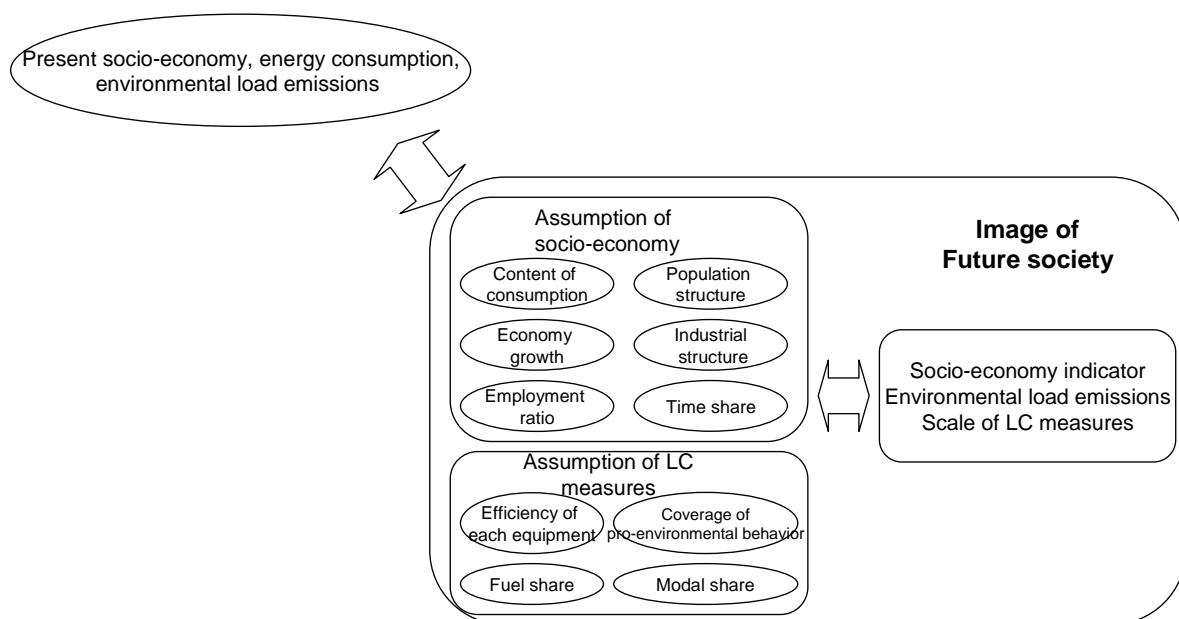


Figure 1.1 Overview of a study using ExSS. LC: Low-carbon

1.2 System requirements

Microsoft Excel needs to be installed. Requirement of software versions has not been checked, though there's no problem if you use EXCEL 2000 or later.

1.3 Four Steps using ExSS Demo Version

Figure 1.2 shows general procedure of a scenario exercise using ExSS Demo Version. It consists of four steps. Each step is described in more detail in Chapter 2.

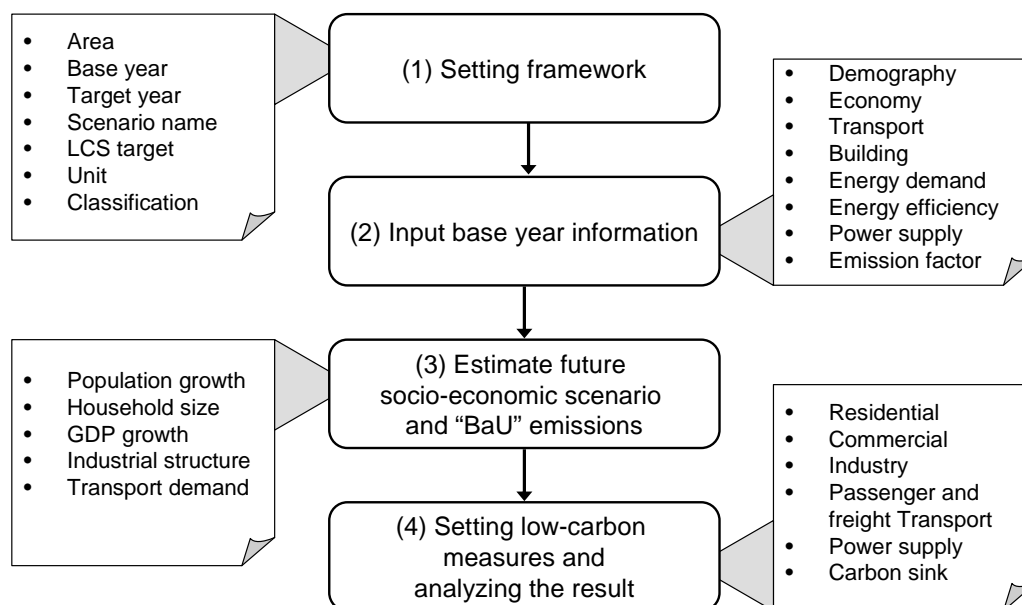


Figure 1.2 Four steps using ExSS Demo Version

1.4 Components of Excel worksheets

ExSS Demo Version is developed as an Excel tool named "ExSS Demo Version.xls". The file contains the worksheets as shown in Table 1.1.

Table 1.1 Worksheets of ExSS Demo Version

Sheet name	Contents
Setting	Setting framework & unit
Driving force	Setting socioeconomic scenarios
Energy	Calculation of energy demand
Power supply	Setting of power generation sector
LCM(RES)	Setting of Low Carbon measures of residential sector
LCM(COM)	Setting of Low Carbon measures of commercial sector
LCM(IND)	Setting of Low Carbon measures of industrial sector
LCM(PT)	Setting of Low Carbon measures of passenger transport sector
LCM(FT)	Setting of Low Carbon measures of freight transport sector
Factor	Calculation of emission reduction by each measure
Result	Main results
Graph	Graphs of main results

1.5 Necessary information of the base year

Table 1.2 shows required information for the base year. When the information of the area is not available, it should be estimated by using indirect information.

Table 1.2 Necessary information for ExSS Demo Version

Data	Classification
Population	-
Number of Household	-
Gross value added (GDP)	by industry
Floor area of commercial buildings	-
Final energy demand	by sector, by service, by fuel
Energy efficiency	by sector, by service, by fuel
Power supply	supply, fuel demand, own use, transmission loss

1.6 Calculation structure for future estimation

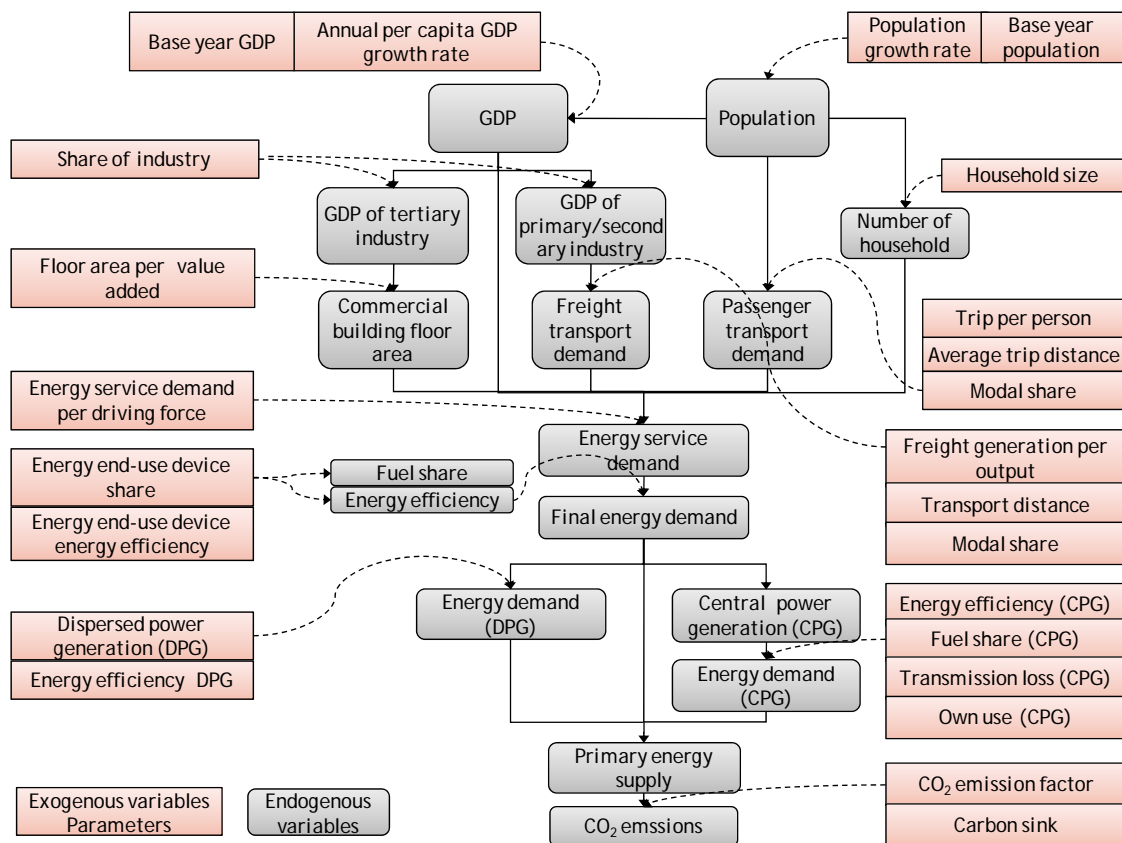


Figure 1.3 Calculation flow of ExSS Demo Version

Figure 1.3 shows calculation flow, main variables and parameters in future estimation by ExSS Demo Version. It starts with the estimation of population, and then, GDP, industrial structure, transport demand, energy demand and CO2 emissions are calculated. Users should input parameters in the figure for future estimation.

1.7 Cell property

As shown [Setting] worksheet, there are four kinds of cells in ExSS Demo Version.

- Green cell: it is frame of the table. The cell must not be changed.
- Yellow cell: it contains a formula, and automatically calculated. The cell must not be changed.
- White cell with BLACK rule: it is to be input base year data.
- White cell with BLUE rule: it is to be input target year assumption.

2 Setting Framework

First, users should determine overall framework of the scenario study. In the practice it must be decided among stakeholders considering the context of scenario development.

2.1 Area

Determine the area which is object of the exercise. Input the name of the area (likely a country, province, city, etc.) into [Area] table of [Setting] worksheet.

2.2 Base year and target year

Determine the base year and target year of the exercise. Normally BASE year is the latest year in which important information is available. TARGET year should be determined according to the objective of the exercise, though, it is recommended to choose more than ten years because a low-carbon society needs time for significant change. Input the base year and target year into [Year] table in [Setting] worksheet.

2.3 Scenario name

Determine scenario name WITH and WITHOUT low-carbon measures. For example “BaU” for without measures and “CM” for with measures. (BaU: business as usual, CM: countermeasure). Input the name into [Scenario name] table in [Setting] worksheet.

2.4 LCS target

Determine the emission target of CO₂ from fossil fuel use. In step 4, LCS measures should be introduced to achieve this target.

2.5 Unit

Unit for currency, energy, trip distance of transport, weight of freight, floor area and CO₂ should be decided. The unit determined here must be used throughout the exercise, i.e. the unit must be common for all input. Input the unit in [Unit] table in [Setting] worksheet. The units input appear in the other sheets.

2.6 Classification

It is possible to change the classification of industry, fuel, energy service, transport mode, etc. When this Demo Version is applied for a particular area and it is necessary to change those classifications, users can change them. However, it is strongly recommended to contact developers before changing.

3 Input base year information

The second step is input of base year information. In many case of modeling work, much of the effort will be devoted in this step.

3.1 Demography

Input population and number of household in the base year into [Population] table in [Driving Force] worksheet.

3.2 Economy

Input gross value added of each industry in [Industrial structure] table in [Driving Force] worksheet. The sum of gross value added of all industry is GDP, as automatically shown in [Economy (GDP)] table.

3.3 Passenger transport

Three parameters should be prepared of passenger transport. Input following parameters in [Passenger Transport] table in [Driving Force] sheet. Passenger transport demand is calculated by multiplying following parameters and population.

(1) Trip generation

Number of trips of one person in a day. Normally the number is between 2 and 4.

(2) Modal share

Modal share refers shares in total trip by transport mode such as Bicycle and walk, vehicle, bus and rail. So far ExSS Demo Version does not include water and air transport. The sum of all modal shares must be 1.

(3) Average trip distance

Average trip distance is average length of one trip. It should be different mode by mode, e.g. normally bicycle and walk have shorter average distance than vehicle or bus.

3.4 Freight transport

Structure of freight transport model is similar to passenger transport. Freight transport demand is calculated by multiplying following three parameters and gross value added of industry. Input the parameters into [Freight Transport] table in [Driving Force] worksheet.

(1) Freight generation per industrial output

Weight of freight per value added of industry: In ExSS Demo Version, this parameter should be given

respectively for “Agriculture, Forestry, Fisheries” and “Other industry”.

(2) Modal share

Modal share refers to shares in freight transport service by transport mode such as vehicle, rail and ship. The sum of all modal shares must be 1.

(3) Average distance

Average distance is average transported length of freight.

3.5 Building

Floor area of commercial building should be input into [Floor area of commercial buildings] table in [Driving Force] worksheet. If information of building is not available, use gross value added of tertiary industry (in default setting, sum of “whole sale and retail” and “Services”) instead.

3.6 Energy demand

Final energy demand is crucial information for LCS scenario study as well as ExSS modeling. ExSS Demo Version demands final energy demand by sector, by energy service and by fuel. Input into [Final Energy Demand] table in [Energy] worksheet.

Note: What’s final energy demand?

Here, “final energy demand” means energy consumption of end-use sectors. Energy demand of power supply sector is not included, while electricity demand of energy demand sectors should be input. If the area has an “energy balance table”, demand side of that table can be used as input data. Though, the data should be given by “energy service”, such as air conditioning, hot water, industry, transport mode, and so on. Normally an energy balance table does not show such a detail of energy service. In that case, users need to use other information source to divide energy demand to the services, such as SAGE*.

* U.S. Department of Energy (2003): Model Documentation Report: System for the Analysis of Global Energy Markets (SAGE), Washington, DC. Available on: [http://tonto.eia.doe.gov/FTPROOT/modeldoc/m072\(2003\)1.pdf](http://tonto.eia.doe.gov/FTPROOT/modeldoc/m072(2003)1.pdf)

3.7 Energy efficiency

In ExSS Demo Version, energy efficiency is defined as “energy service demand per energy demand”. Thus, greater number means better efficiency. The units of energy efficiency differ by energy service, though; the energy unit must be same for all energy services and all fuels. It should be given in the same classification with energy demand, and if energy demand exists in a fuel of a service in a sector, energy efficiency also must be input for that fuel of the service of the sector. Input into [Energy Efficiency] table in [Energy] worksheet.

Note: What’s energy service demand?

The idea of “energy service” is essential for a low-carbon society study using ExSS. “Energy service” means utility gained by energy consumption. For example, effective heat supply for heating or cooling, one km of passenger trip, one ton of steel production, and one hour of watching TV. In a formulation, it can be defined as: Energy service demand = Energy efficiency / Energy demand. Therefore, if energy efficiency is improved (greater value), a society can enjoy more energy service with same amount of energy consumption. What a society directly needs is energy service, not energy. A low-carbon society must supply sufficient energy service, while consuming less energy and emitting less GHG.

3.8 Power supply

In ExSS, there are two kinds of power (electricity) supply, central power generation (DPG) and dispersed power generation (DPG). CPG includes large-scale power plants which provide electricity to the consumers. DPG is power generation at the energy demand sectors, including industry, household, and commercial sectors. The definitions are so rough that the users should define what exactly each of DPG and CPG means in the study.

(1) Central power supply (CPG)

Base year information of CPG should be input to [Power generation] and [Energy demand & CO2 emission in power generation sector] tables in [Power supply] worksheet. Four kinds of information are needed.

- Power supply at generation end: “Supply (@gen.)”
- Energy demand at generation end: “Energy demand (@gen.)”
- Transmission loss rate
- Own use rate

The information above can be found in an energy balance table of the region or other energy supply statistics.

(2) Dispersed power generation (DPG)

Base year information of DPG should be input to [Dispersed power generation (DPG)] table in [Energy] worksheet. Two kinds of information are needed.

- Power supply by fuel by sector: “Power generation”
- Efficiency of power generation: “Efficiency”

3.9 Emission factor

CO₂ emission factor of each fuel is input into [Fuel] table in [Setting] worksheet.

4 Estimate future socio-economic scenario and “BaU” emissions

The third step of the exercise is estimation of future socio-economic indicators and CO₂ emissions without low-carbon measures (here after “BaU emissions”). Since energy demand is strongly dependent on population, GDP and industrial structure, it is crucial to determine those variables. In ExSS Demo Version, future estimation of demography and economy is done by giving changes from base year rather than inputting absolute value directly.

4.1 Demography

(1) Population growth rate

Input annual population growth rate in [Population] table in [Driving Force] worksheet. Then, population in the target year is automatically calculated from that growth rate, population in base year, and years between base year and target year. In order to simplify the exercise, composition of the population such as share of age group or urban/rural ratio is not considered here. Since population drives overall economy and energy demand, this setting affects the result (e.g. CO₂ emissions) significantly.

(2) Household size

Input average number of people per household in [Population] table in [Driving Force] worksheet. Then, number of household is automatically calculated. It tends to be smaller with economic growth and urbanization.

4.2 Economy

(1) GDP growth

In ExSS Demo Version, future economy size in terms of GDP is calculated by future population, per capita GDP in base year, and annual per capita GDP growth rate towards target year. Input annual per capita GDP growth rate into [Economy (GDP)] table in [Driving Force] worksheet. Then, future GDP is automatically calculated and distributed to each industry. This parameter, as well as population growth rate, is a basic driver of energy demand and CO₂ emissions. In addition, for growth rate, REAL GDP growth rate is recommended because real GDP is more relevant to energy consumption than nominal.

(2) Industrial structure

Normally the share of each industry in GDP changes according to economic growth. It is said that the industrial structure of a country shifts from primary industry to secondary, secondary to tertiary. On the other hand, if the area is small enough (e.g. a town), changes to any direction may occur, e.g. if huge manufacturing factory is constructed in a town and it employs tens of thousands of people, the town’s industrial structure may significantly change to secondary industry. Or, the central government may have strong will to facilitate

particular industry. Consider these factors and determine which industry will grow more than others. The parameter for this assumption is “Share change” in table [Industrial structure] in [Driving Force] worksheet. Input change of the share of each industry in terms of percent-point. E.g. if one industry increase its share from 12% to 26%, input “14%”. If one industry increased its share, some other should decrease its share (= input negative value in the table). Thus, some of “share change” must be zero (0).

4.3 Transport demand

(1) Passenger transport

Here, only BaU case is assumed. Input three parameters, “Trip generation”, “Modal share” and “Average trip distance” in the second column (the name of the column, “target year”+”scenario name WITHOUT low-carbon measures” will appear as input in [Setting] worksheet) of table [Passenger Transport] in [Driving Force] worksheet. When economy grows, in many cases, share of vehicle is thought increase while bicycle and work are decreasing.

(2) Freight transport

BaU setting of freight transport is, in many cases, not necessary to change from base year unless there is some evident reason of changes in logistics system.

4.4 Check the result of socio-economic indicators and BaU emissions

(1) “T/B”

Many tables in ExSS Demo Version has column “(T/B)”. It means “target year per base year”. Users can find changes of each variable from base year to target year.

(2) CO₂ emissions

Most of the worksheets have a table named “CO₂ emissions”. It shows total CO₂ emissions in base year and both scenarios in target year. Users can check how much the setting affects total CO₂ emissions immediately while setting future assumptions.

(3) Summary of the results

Summary tables of the calculation results are shown in [Result] worksheet.

(4) Graphs

[Graph] worksheet contains bar chart of main results. Also users can add any graphs in ExSS Demo Version.

4.5 Iterating simulations

It is not necessary to fix input value at once. It is strongly recommended to try a range of input value. Then it will be easier to understand how socio-economic development affects CO₂ emissions. Especially, population growth rate, per capita annual GDP growth rate, and industrial structure are worth to try many times and check the result. Also it is often conducted to develop multiple scenarios such as “high growth” and “low growth” to investigate wide range of possible social development. In that case, using ExSS Demo Version, users can rename the excel file and produce a lot of scenarios after inputting base year data.

5 Setting low-carbon measures and analyzing the result

ExSS Demo Version does not introduce low-carbon measures automatically. So the measures should be set one by one by the users.

5.1 Power supply (CPG)

(1) Share of fuels in CPG

At the right-hand-side of the table [Power generation] in [Power supply] worksheet, there are columns of the target year WITH low-carbon measures (name of the column is “target year”+”scenario name WITHOUT low-carbon measures” as input in [Setting] worksheet).

Setting “Share (@end user)”, users can change the share of fuels in power generation. As a low-carbon measure, it is necessary to increase share of fuels with less CO₂ emission factor, such as natural gas, nuclear or renewable energies. Sum of the share must be one.

(2) Efficiency in CPG

In the table [Energy demand & CO₂ emission in power generation sector] in [Power supply] worksheet, there is a row “Energy efficiency”. In the base year, it is calculated automatically from input data, and in BaU, it is same as base year. As a low-carbon measure, it is necessary to increase energy efficiency of power generation.

5.2 Residential and commercial sectors

In the worksheets [LCM(RES)] and [LCM(COM)], there are tables for low-carbon measures in residential and commercial sector, respectively.

(1) Energy efficient devices

The upper part of the table shows diffusion of devices. Users should input the share of each device in target year. If available, efficiency of “High efficiency” device also can be changed in column “Performance”. Sum of the share in one service must be 1.

Solar water heater also should be introduced as one type of “Device” for “Hot water”.

(2) Building (solar power generation and insulation)

In ExSS Demo Version, two kinds of low-carbon measures for buildings are prepared: solar power generation (or, photovoltaic power generation, PV) and insulation. For solar power generation, two figures are required: potential and diffusion. Potential means maximum power supplied by PV in respective sector, and diffusion means how much percent of the potential was actually generated. Thus, users need potential of PV generation

in the area in the target year.

On the other hand, insulation can increase efficiency of air conditioner. Like energy efficient devices, performance and diffusion should be input.

(3) Behavior change

In ExSS Demo Version, “Behavior change” means any kind of actions which can reduce ENERGY SERVICE DEMAND per driving force. One typical example are turning off lightings when not necessary and air-conditioning mildly. Also “Home energy management system (HEMS)” or “Business (Building) Energy Management System” can reduce energy service demand per driving force. Here, “performance” means reduction rate of energy service when implemented, and “diffusion” means” people or buildings which are implementing that action.

5.3 Industry

(1) Energy efficiency improvement

In ExSS Demo Version, energy efficiency improvement is set in much aggregated form. There is a table for energy efficiency improvement in [LCM(IND)] worksheet. Unlike other sectors, only aggregated energy efficiency improvement of industrial devices of each fuel is assumed.

(2) Fuel switch

Fuel share of industry in target year can be changed as a low-carbon measure in table [Fuel share] in worksheet [LCM(IND)]. In general, if efficiency is similar, emission of the fuels are, coal > oil > gas. Thus, using more gas and less coal leads less emission. However, users should be careful for some industries when try to switch fuels. For example, iron & steel industry needs a lot of coal and it cannot be replaced with gas.

5.4 Passenger and freight Transport

Passenger and freight transport employs similar measures and they are set in worksheet [LCM(PT)] and [LCM(FT)].

(1) Energy efficient vehicles and other transport mode

Like device share in residential and commercial sector, energy efficiency improvement is assumed by setting “performance” and “diffusion” of each type of vehicle or other transport mode. By setting the diffusion of vehicles using different fuels, users can set introduction of bio fuel for electric vehicles.

Note: Vehicles using more than two kinds of fuels

Currently, biofuel and gasoline is mixed and used at once in some countries. In such case, for example “E10” fuel which consists of 10% of bio ethanol and 90% of gasoline, users should set share of the vehicles using each fuel according to the composition.

For example, when all vehicles are using E10 and 40% are conventional and 60% are hybrid (but not plug-in hybrid) vehicles, their share should be like as follows.

- Conventional, Oil: 36%
- Conventional, Biomass: 4%
- Hybrid, Oil: 54%
- Hybrid, Biomass: 6%

(2) Transport structure reform

“Transport structure reform” refers to actions which changes transport demand in order to reduce energy demand. There are two types: modal shift and demand reduction. Modal shift as low-carbon measure normally means reducing share of vehicles and increasing mass-transport (bus or train) or bicycle and walking. In ExSS Demo Version, it can be introduced in table [Transportation structure] in worksheets [LCM(PT)] and [LCM(FT)].

Another type of transport structure reform, demand reduction, is related to “compact city” for passenger transport and “logistics improvement” in freight transport. Compact city structure makes average trip distance shorter, while logistics improvement reduces freight transport demand using efficient arrangement of freight transport.

5.5 Carbon sink

In ExSS Demo Version, “carbon sink” means any kinds of NET carbon removal from atmosphere. Typical example is tree planting. However accurate estimation of carbon sink requires a lot of data and complicated calculation, here just the amount to be sink should be input directly in [LCM(Sink)] worksheet.

5.6 Iterating simulations for “The most suitable portfolio”

Since ExSS Demo Version does not introduce low-carbon measures automatically, users need to find a combination of the measures through try and error process. Normally, there can be infinite number of combination which can achieve same LCS target. One prominent candidate to determine the “portfolio” is minimizing cost. However, considering difficulty of defining cost of many number of the measures, the fact that cost minimization is not always achieved in the real world, and objective of “Demo Version” as a training tool, it is not always necessary to find cost-minimized, “optimal” solution. Instead, its flexible “try and error” process enable to enhance discussion among stakeholders. For example, in a meeting with various stakeholders,

users can input a set of measures which can achieve the low-carbon target and show the result to the participants. It is very likely that some of the members have opinions about feasibility of the measures. If, for example, a person suggested your setting of photovoltaic power generation (PV) is too large and therefore not realistic, you can change the number and calculate again immediately. Since PV is reduced, the emission will exceed the target level. Then you can ask the participants other measures to compensate the emission increase. Iterate this process until the stakeholders agree the result. Since ExSS need not so much time to calculate one case, such an interactive communication is possible, and the process of scenario and policy making will be more efficient and effective.

5.7 Analyzing the result

Users can find the results in [CO₂ emission] table in each worksheet, summary table in [Result] worksheet and graphs in [Graph] worksheet.

(1) Decomposition analysis

The worksheet [Factor] is operating “decomposition analysis” which analyzes contribution of each factor to overall CO₂ emission reduction. In ExSS Demo Version, CO₂ reduction from BaU emission is decomposed to following five factors.

- Driving force change
- Service intensity change
- Energy intensity change
- CO₂ intensity change (demand)
- CO₂ intensity change (supply)

Since it decompose “reduction”, negative value means the factor is working as increasing factor of emissions.

Note: Decomposition analysis against base year

Same technique of decomposition can be used between base year and target year, however, to date, that analysis is not installed into ExSS Demo Version. Normal version of ExSS (a GAMS program) has that function.

(2) Contribution of the measures

Contribution of each low-carbon measure to overall emission reduction from BaU is calculated from decomposition analysis, and shown in each table of low-carbon measures.

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