ExSS is an “input-output” type static model consists of simultaneous equations with around 6000 variables.

ExSS describes Socio-economic activity, Energy consumption, Power generation, Technology diffusion and GHG emissions in a particular future year.

ExSS is based on the idea of “back-casting” approach and used to “Design” a future society as a LCD in a consistent and quantitative manner.

ExSS has been used for development of low-carbon scenarios in several nations and cities in Asia.
PROCEDURE

- Area
- Base year
- Target year
- Scenario name
- LCS target
- Unit
- Classification

Setting framework

Information collection

Estimate future socio-economic variables and “BaU” emissions

Setting low-carbon measures and analyzing the result

- Demography
  - Economy
  - Transport
  - Building
  - Energy demand
  - Energy efficiency
  - Power supply
  - Emission factor

- Population growth
- Household size
- GDP growth
- Industrial structure
- Transport demand

- Residential
  - Commercial
  - Industry
  - Passenger and freight Transport
  - Power supply
  - Carbon sink
Supply-demand Energy and Driver of Energy Growth

Population

Transportation

Industrial Production and Commercial

Demand

Residential

Flow of Commodity

Supply

Supply-demand

Energy and Driver of Energy Growth

Fossil

Biomas

Renewable

GHG Emission

Coal, Oil, Gas, Biofuel, Biomass

Electric Supply

Power Plant

Hydro, Geothermal, Wind, Solar, Ocean

Supply

Demand of Energy
BASICS OF ENERGY DATA

Driving Forces

GDP, Population…

Services

Technology producing the demanded services

Total Final Energy Consumption

Transformation Technologies

Total Primary Energy Supply

Production

Loss

Import/Export

Energy stock
TECHNOLOGIES

• Technology database
  • 200 - 400 (or more) options
    • Currently existing technologies
    • Future innovative technologies

Notes:
• Effects of mitigation measures such as additional policies promoting modal shift, public-enlightenment actions are not considered in the model.
• Such effects are taken into account as changes of service demand outside the model, and given to the model as service demand change.

Technology database shall be arranged to match each country’s situation.
CHARACTERISTICS OF ENDUSE

- What is AIM/Enduse?
  - Bottom-up model with detail technology selection framework
  - Individual technologies
    - air conditioner
    - vehicles
    - machinery, etc.

- What can be assessed?
  - Technological transition over time
  - Energy consumption
  - GHG emissions
  - Cost of mitigation actions
Key concept of AIM/End-use

Energy
- Coal
- Oil
- Gas
- Renewables
- Electricity

Energy Technology
- Blast furnace
- Power plant
- Air conditioner
- Boiler
- Car

Energy Service
- Iron
- Cement
- Space heating and cooling
- Hot water
- Passenger, freight transport

Energy Consumption
- CO2 emission

Energy Database
- Energy type
- Energy price
- Energy constraints
- CO2 emission factor

Technology Database
- Technology cost (Fixed cost, running cost)
- Energy consumption
- Service supply
- Diffusion rate
- Lifetime

Socio-economic scenarios
- Population growth
- Economic growth
- Industrial structure
- Number of Employees
- Lifestyle
## DATA SOURCES

<table>
<thead>
<tr>
<th>Category</th>
<th>Data</th>
<th>Information source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demography</td>
<td>Population and number of household</td>
<td>Indonesian population census, BPS-Indonesia</td>
</tr>
<tr>
<td>Economy</td>
<td>Input-output table</td>
<td>Indonesian Input-Output table, BPS-Indonesia</td>
</tr>
<tr>
<td>Transport</td>
<td>Passenger transport volume</td>
<td>Transportation statistics, Ministry of transportation</td>
</tr>
<tr>
<td></td>
<td>Freight transport volume</td>
<td>AIM database</td>
</tr>
<tr>
<td>Energy</td>
<td>Energy demand and supply</td>
<td>National energy balance, Pusdatin-MEMR</td>
</tr>
<tr>
<td></td>
<td>Energy demand by industry</td>
<td>AIM database</td>
</tr>
</tbody>
</table>
## ASSUMPTIONS

<table>
<thead>
<tr>
<th>Category</th>
<th>Assumption</th>
<th>Reference</th>
</tr>
</thead>
</table>
| Population                | 220 million (2005)  
                            256 million (2020)                                                      | United Nation Statistics  
                            Second National Communications      |
| Household size            | 3.68 persons/household                                                     | -                                        |
| GDP growth rate           | 6.6 %/year (2011-2015)  
                            7.2 %/year (2016-2020)                                                   | Second National Communications         |
| Industrial structure      | More share of  
                            -Agriculture  
                            -Food and Beverage  
                            -Tertiary Industries will increase.                                         | -                                        |
| Transport                 | The share of motorcycle and car will slight increase in Baseline scenario. | -                                        |
## END-USER ENERGY EFFICIENCY MEASURES

<table>
<thead>
<tr>
<th>Sector</th>
<th>Penetration share of BAT</th>
<th>Efficiency improvement of BAT compared to existing device</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>30%</td>
<td>10 – 30%</td>
<td>In the model this efficiency improvement varies, depend on the type of device (not sectoral aggregate)</td>
</tr>
<tr>
<td>Commercial</td>
<td>15%</td>
<td>20 - 30%</td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>10%</td>
<td>10 - 20%</td>
<td></td>
</tr>
</tbody>
</table>

Note: Penetration share of BAT in industry sector 30% means that in 2020 the technology used in industries will comprise 30% BAT and 70% existing technology (less efficient).
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>Million</td>
<td>219</td>
<td>261</td>
<td>261</td>
<td>1.19</td>
<td>1.19</td>
</tr>
<tr>
<td>Household</td>
<td>Million household</td>
<td>60</td>
<td>71</td>
<td>71</td>
<td>1.19</td>
<td>1.19</td>
</tr>
<tr>
<td>GDP</td>
<td>Trillion Rupiah</td>
<td>1,758</td>
<td>4,440</td>
<td>4,440</td>
<td>2.53</td>
<td>2.53</td>
</tr>
<tr>
<td>Per capita GDP</td>
<td>Million Rupiah</td>
<td>8,019</td>
<td>17,010</td>
<td>17,010</td>
<td>2.12</td>
<td>2.12</td>
</tr>
<tr>
<td>Gross Output</td>
<td>Trillion Rupiah</td>
<td>3,533</td>
<td>8,983</td>
<td>8,983</td>
<td>2.54</td>
<td>2.54</td>
</tr>
<tr>
<td>Primary</td>
<td>Million</td>
<td>570</td>
<td>1,406</td>
<td>1,406</td>
<td>2.47</td>
<td>2.47</td>
</tr>
<tr>
<td>Secondary</td>
<td>Million</td>
<td>1,713</td>
<td>4,501</td>
<td>4,501</td>
<td>2.63</td>
<td>2.63</td>
</tr>
<tr>
<td>Tertiary</td>
<td>Million</td>
<td>1,251</td>
<td>3,077</td>
<td>3,077</td>
<td>2.46</td>
<td>2.46</td>
</tr>
<tr>
<td>Passenger Transport</td>
<td>Million Passenger-km</td>
<td>929,107</td>
<td>1,491,934</td>
<td>1,691,866</td>
<td>1.61</td>
<td>1.82</td>
</tr>
<tr>
<td>Freight Transport</td>
<td>Million t-km</td>
<td>273,575</td>
<td>708,017</td>
<td>705,432</td>
<td>2.59</td>
<td>2.58</td>
</tr>
</tbody>
</table>
GROSS OUTPUT

• Gross output will become 2.5 times from 2005.
• The highest increase is Secondary industries. It will be 2.6 times, or 2,788 Trillion Rupiah growth in 2020.
Both modal share and transport volume of private vehicle increase in 2020 Baseline.

In 2020 CM, it is assumed that share of train increase, the volume of train become larger.

Freight transport volume increases proportionally with growth of secondary industries.
Energy Efficiency Improvement (EEI): No change in Baseline scenario

Diffusion rate:
• The share of Biomass use seems too large in 2005 result. In that case, it is assumed to be more less in 2020 Baseline and is shifted to other fuels.
• Also the share of oil seems to be too high in some places, is shifted to other fuels.

Power supply

<table>
<thead>
<tr>
<th></th>
<th>Coal</th>
<th>Oil</th>
<th>Natural Gas</th>
<th>Hydropower</th>
<th>Biomass</th>
<th>Geothermal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>28%</td>
<td>33%</td>
<td>38%</td>
<td>18%</td>
<td>29%</td>
<td>16%</td>
</tr>
<tr>
<td>Transportation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss</td>
<td>12.1%</td>
<td>12.1%</td>
<td>12.1%</td>
<td>12.1%</td>
<td>12.1%</td>
<td>12.1%</td>
</tr>
<tr>
<td>Share</td>
<td>53.0%</td>
<td>4.0%</td>
<td>26.0%</td>
<td>9.7%</td>
<td>0.3%</td>
<td>7.0%</td>
</tr>
</tbody>
</table>
PROJECTED ENERGY MIX OF POWER SUPPLY

- **2020 CM(41%)**
  - Coal: 52%
  - Oil: 4%
  - Gas: 26%
  - Hydropower: 11%
  - Biomass: 7%
  - Geothermal: 0.4%
  - Solar & Wind: 0.1%

- **2020 CM(26%)**
  - Coal: 52%
  - Oil: 4%
  - Gas: 26%
  - Hydropower: 11%
  - Biomass: 7%
  - Geothermal: 0.3%
  - Solar & Wind: 0.1%

- **2020 BaU**
  - Coal: 53%
  - Oil: 4%
  - Gas: 26%
  - Hydropower: 10%
  - Biomass: 7%
  - Geothermal: 0.3%

- **2005**
  - Coal: 41%
  - Oil: 31%
  - Gas: 15%
  - Hydropower: 8%
  - Biomass: 5%
  - Geothermal: 0.02%
  - Solar & Wind: 0.4%
PROJECTED MODAL SHARE OF PASSENGER TRANSPORT

- **2020 CM**
  - Car: 14%
  - Bus: 19%
  - Train: 28%
  - Motorcycle: 15%
  - Ship: 4%
  - Airplane: 5%
  - Walk: 5%
  - Bike: 10%

- **2020 BaU**
  - Car: 29%
  - Bus: 15%
  - Train: 2%
  - Motorcycle: 30%
  - Ship: 4%
  - Airplane: 5%
  - Walk: 5%
  - Bike: 10%

- **2005**
  - Car: 19%
  - Bus: 11%
  - Train: 25%
  - Motorcycle: 5%
  - Ship: 3%
  - Airplane: 29%
  - Walk: 29%
  - Bike: 7%
PROJECTED FINAL ENERGY DEMAND BY FUEL

Million toe

<table>
<thead>
<tr>
<th>Year</th>
<th>Biofuel</th>
<th>Electricity</th>
<th>Biomass</th>
<th>Gas</th>
<th>Oil</th>
<th>Coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>115</td>
</tr>
<tr>
<td>2020 Ba U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>266</td>
</tr>
<tr>
<td>2020 CM (26%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>253</td>
</tr>
<tr>
<td>2020 CM (41%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>251</td>
</tr>
</tbody>
</table>

2005: Biofuel = 50, Electricity = 50, Biomass = 25, Gas = 15, Oil = 15, Coal = 115
2020 Ba U: Biofuel = 30, Electricity = 70, Biomass = 60, Gas = 55, Oil = 55, Coal = 266
2020 CM (26%): Biofuel = 30, Electricity = 70, Biomass = 60, Gas = 55, Oil = 55, Coal = 253
2020 CM (41%): Biofuel = 30, Electricity = 70, Biomass = 60, Gas = 55, Oil = 55, Coal = 251
PROJECTED FINAL ENERGY DEMAND

By Fuel

By Sector
FINAL ENERGY DEMAND BY SECTORS

- **2005**:
  - Tertiary Industries: 114 Mtoe
  - Cement: 25 Mtoe
  - Iron & Steel: 32 Mtoe
  - Other Industries: 66 Mtoe
  - Construction: 100 Mtoe
  - Chemical Industry: 7 Mtoe
  - Textile: 5 Mtoe
  - Food & Beverage: 10 Mtoe
  - Mining: 20 Mtoe
  - Agriculture: 5 Mtoe
  - Residential: 30 Mtoe
  - Freight Transport: 10 Mtoe
  - Passenger Transport: 5 Mtoe

- **2020 Baseline**:
  - Tertiary Industries: 266 Mtoe
  - Cement: 25 Mtoe
  - Iron & Steel: 32 Mtoe
  - Other Industries: 66 Mtoe
  - Construction: 100 Mtoe
  - Chemical Industry: 7 Mtoe
  - Textile: 5 Mtoe
  - Food & Beverage: 10 Mtoe
  - Mining: 20 Mtoe
  - Agriculture: 5 Mtoe
  - Residential: 30 Mtoe
  - Freight Transport: 10 Mtoe
  - Passenger Transport: 5 Mtoe

- **2020 CM**:
  - Tertiary Industries: 253 Mtoe
  - Cement: 25 Mtoe
  - Iron & Steel: 32 Mtoe
  - Other Industries: 66 Mtoe
  - Construction: 100 Mtoe
  - Chemical Industry: 7 Mtoe
  - Textile: 5 Mtoe
  - Food & Beverage: 10 Mtoe
  - Mining: 20 Mtoe
  - Agriculture: 5 Mtoe
  - Residential: 30 Mtoe
  - Freight Transport: 10 Mtoe
  - Passenger Transport: 5 Mtoe
FINAL ENERGY DEMAND BY SECTOR

- Commercial
- Industry
- Residential
- Passenger Transport
- Freight Transport

<table>
<thead>
<tr>
<th>Year</th>
<th>Comm</th>
<th>Industry</th>
<th>Residential</th>
<th>Passenger</th>
<th>Freight</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>115</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020 Ba U</td>
<td>266</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020 CM (26%)</td>
<td>253</td>
<td>100</td>
<td>150</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>2020 CM (41%)</td>
<td>251</td>
<td>100</td>
<td>150</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>
PROJECTED PRIMARY ENERGY DEMAND

- Million toe

- 2005: 145
- 2020 BaU: 378
- 2020 CM (26%): 364
- 2020 CM (41%): 360

Legend:
- Biofuel
- Solar & Wind
- Geothermal
- Biomass
- Hydropower
- Gas
- Oil
- Coal
In 2020, CO₂ emission is almost tripled from 2005.

In CM scenario, it was reduced about 39.0 MtCO₂ from Baseline scenario. It shows that we can achieve the national target by introducing the measures.
• In 2020, CO₂ intensity is 2.6 times from 2005.
• In CM scenario, it was slightly reduced about 0.1 tCO₂.
CO₂ REDUCTION BY MEASURES

- Road construction / improvement and preservation: 1.1 MtCO₂
- Construction of double-e-double track (including electrification): 7.0 MtCO₂
- Development of Bandung’s city railways: 4.5 MtCO₂
- Building of Non-Motorized (Pedestrian and bicycle) lines: 0.209 MtCO₂
- Smart driving (eco-driving) training and socialization: 0.002 MtCO₂
- Installation of Converter Kit (public transport gasification): 0.03 MtCO₂
- Rejuvenation of public transport fleets: 0.9 MtCO₂
- Reformulation of transit system - Bus Rapid Transit (BRT) & Semi BRT: 1.3 MtCO₂
- Application of parking management: 0.3 MtCO₂
- Application of a Traffic Impact Control (TIC): 1.9 MtCO₂
- Development of Intelligent Transport System (ITS): 0.002 MtCO₂
- Construction of Liquid Petroleum Gas (LPG) mini plants: 0.3 MtCO₂
- Enhancement of the pipe connection of natural gas to houses: 2.8 MtCO₂
- Use of natural gas as city public transportation fuel: 0.2 MtCO₂
- Biogas utilization: 4.4 MtCO₂
- Supply and management of new renewable energy and energy conservation: 0.8 MtCO₂
- Enhancement of household utensils efficiency: 2.1 MtCO₂
- Implementation of energy conservation partnership program: 10.2 MtCO₂
- Mandatory application of energy management for energy-intensive users: -1 MtCO₂

MtCO₂
CO₂ REDUCTION BY MEASURES

- Road construction / improvement and preservation
- Construction of double/e-double track (including electrification)
- Development of Bandung’s city railways
- Building of Non-Motorized (Pedestrian and bicycle) lines
- Smart driving (eco-driving) training and socialization
- Installation of Converter Kit (public transport gasification)
- Rejuvenation of public transport fleets
- Reformation of transit system - Bus Rapid Transit (BRT) I semi BRT
- Application of parking management
- Application of a Traffic Impact Control (TIC)
- Development of Intelligent Transport System (ITS)
- Construction of Liquid Petroleum Gas (LPG) mini plants
- Enhancement of the pipe connection of natural gas to houses
- Use of natural gas as city public transportation fuel
- Biogas Utilization
- Supply and management of new renewable energy and energy conservation
- Enhancement of household utensils efficiency
- Implementation of energy conservation partnership program
- Mandatory application of energy management for energy-intensive users

MtCO₂
CO₂ REDUCTION BY MEASURES

MtCO₂

KU  RAN-GRK  ITB

38.5  55.9  38.5

A26  A20
A19  A18
A17  A16
A15  A14
A13  A12
A11  A10
A8   A7
A6   A5
A4   A3
A2   A1