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WORKSHOP ON DESIGNING SUSTAINABLE ENERGY SYSTEMS
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NOTES TO INPUT DATA FORM FOR MESSAGE

Duy-Thanh BUI
I.A.E.A.,
Planning and Economic Studies Section, Dept. of Nuclear Energy
A-1400 Vienna, Austria

These are preliminary lecture notes, intended only for distribution to participants.

strada costiera, 11 - 34014 trieste italy - tel. +39 040 2240111 fax +39 040 224163 - sci_info@ictp.trieste.it - www.ictp.trieste.it

This workbook is prepared to demonstrate the input data format to use in MESSAGE model

The data format is shown in 4 separate worksheets:

- General data
- Demand data
- Technology data
- Resource data

Each has two part: first part, in blue color, gives the format of typical data; second part, in black color, gives some examples

MESSAGE DATA ENTRY FORM

Typical general data

Data Item	Parameter in MESSAGE	Unit	Time Series Value						Explanatory Note
			Year1	Year2	Year3	. . . .	YearN-1	YearN	
Study period and its division into time steps	timesteps	-							Time step can have equal or different length. Time step data entered in one line with blank space in between
Discount rate	drate	-							

Example

Data Item	Parameter in MESSAGE	Unit	Time Series Value						Explanatory Note
			Year1	Year2	Year3	. . . .	YearN-1	YearN	
Study period and its division into time steps	timesteps	-	2000	2001	2002		2040	2050	Time step can have equal or different length. Time step data entered in one line with blank space in between
Discount rate	drate	-	8						4 percent is used throughout the study period

MESSAGE DATA ENTRY FORM

Typical demand data

Data Item	Parameter in MESSAGE	Unit	Time Series Value						Explanatory Note
			Year1	Year2	Year3	. . . .	YearN-1	YearN	
Fuel 1	-	MWyear							M is the total number of fuels considered
Fuel 2	-	MWyear							in the study
Fuel 3	-	MWyear							For each fuel data of projected future
. . . . .	-	MWyear							demand is needed
Fuel M-1	-	MWyear							
Fuel M-1	-	MWyear							

NOTE: IN ORDER TO PREPARE LOAD CURVE FOR A GIVEN ENERGY DEMAND A FULL SET OF 8760 HOURLY DATA OF A TYPICAL YEAR IS NEEDED LOAD CURVE CAN BE APPLIED TO ANY DEMAND WITH SIGNIFICANT SEASONAL OR DIURNAL VARIATION (E.G., GAS, ELECTRICITY, HEAT)

Example

Data Item	Parameter in MESSAGE	Unit	Time Series Value						Explanatory Note
			Year1	Year2	Year3	. . . .	YearN-1	YearN	
Electricity	-	MWyear	1485	1574	1624	. . .	2879	5698	
Gasoline	-	MWyear	5624	5869	6024	. . .	8796	1896	
Coal	-	MWyear	235	258	365	. . .	689	1254	
. . . . .	-	MWyear	. . .	. . .	. . .	. . .	. . .	. . .	
Biomass	-	MWyear	16	16	16	. . .	16	16	Constant demand
Heat	-	MWyear	2547	2687	2875	. . . .	3687	7598	

Typical data for a technology

Data Item	Parameter in MESSAGE	Unit	Time Series Value		Explanatory Note
			Year1	YearN	
Technical and economic data:					
First year	fyear	year			The year, before that new capacity of the technology cannot be built
Last year	lyear	year			The year, after that new capacity of the technology cannot be built
Plant factor	plf	fraction			Ratio of maximum available capacity over installed capacity
Plant life	pll	year			Life time without rehabilitation, modernization, etc.
Operation time	optm	fraction			Maximum number of hours in a year the technology can be in operation
Minimum utilization	minutil	fraction			Minimum number of hours in a year the technology must be used if at all
Investment cost	inv	$/kW			Overnight cost per unit of capacity producing main output
Fixed O&M cost	fom	$/kW-year			Cost payable per unit of capacity producing main output, independent to production
Variable O&M cost	vom	$/kWyear			Cost payable per unit of main output
Unit size	cmix	MW			Size of incremental capacity addition
Construction time	ctime	year			Number of years to build one block specified in unit size
Historical capacity	hisc	year MW			Start-up year and corresponding MW installed
Minimum power	pmin	MW			Minimum level of operating capacity
Maximum power	pmax	MW			Maximum level of operating capacity
Main output	moutp				Main fuel produced by the technology (e.g., electricity)
Other output	outp				Used when more then one fuel is produced by the technology (e.g., heat)
Main input	minp				Main fuel fed into the technology (e.g., fuel oil)
Other input	inp				Used when more then one fuel enter the technology (e.g., gas)
Thermal efficiency	-	%			
Other data:					
Annual bound on production	abda	MWyear			Optional, used to specify production pattern with seasonal variation
Bound on production	bda	MWyear			Optional, used to specify bound on annual production of technology
Lag parameter for output	alags	year			Optional, used to specify the time lag of output in relation to input
Annual bound on capacity addition	bdc	MW			Optional, used to specify bound on annual addition of new capacity
Bound on total capacity addition	bdi	MW			Optional, used to specify bound on total capacity
Initial core	corin	MWyear/MW			Optional, used to specify initial core of nuclear reactor
Final core	corout	MWyear/MW			Optional, used to specify the energy left out after the close of technology
Emission factor (e.g., CO2)	con1a	kg/MWyear			Relative to input or output fuel

Note:
Year1, YearN denote the data fields for the first and last year of the study period. User should provide as many data as the number of predefined time steps (See general data)

MESSAGE DATA ENTRY FORM

Example 1: **Pulverized Coal - existing, producing electricity and heat from coal**

Data Item	Parameter in MESSAGE	Unit	Time Series Value		Explanatory Note
			Year1	YearN	
Technical and economic data:					
Plant factor	plf	fraction	0.75		
Plant life	pll	year	40		
Operation time	optm	fraction	0.9		
Minimum utilization	minutil	fraction	0.2		
Investment cost	inv	$/kW	-		For existing facilities investment cost is not considered (sunk cost)
Fixed O&M cost	fom	$/kW-year	52.9		
Variable O&M cost	vom	$/kWyear	45.8		
Unit size	cmix	MW	400		
Construction time	ctime	year	5		
Historical capacity	hisc	year MW	1980 2000		2000 MW was commissioned in the year 1980
Minimum power	pmin	MW	400		The power plant, once in operation, must operate at least at 400 MW
Maximum power	pmax	MW	1950		And cannot operate more than 1950 MW
Main output	moutp		electricity		This is a cogeneration unit. Once electricity is specified as main output, all costs
Other output	outp		heat		should be re-calculated to this output. Secondary output does not bear any cost
Main input	minp		coal		
Other input	inp				not used in this example
Thermal efficiency	eff	%	33		
Other data:					
Annual bound on production	bda	MWyear	-		not used in this example
Annual bound on capacity addition	bdc	MW			not used in this example
Bound on total capacity addition	bdi	MW			not used in this example
Nox emission	con1a	kg/MWyear			not used in this example

Note:
Year1, YearN denote the data fields for the first and last year of the study period. User should provide as many data as the number of predefined time steps (See general data)

MESSAGE DATA ENTRY FORM

Example 2: **Cogeneration plant - existing, producing electricity and heat from oil and orimulsion**

Data Item	Parameter in MESSAGE	Unit	Time Series Value		Explanatory Note
			Year1	YearN	
Technical and economic data:					
Plant factor	plf	fraction	0.9		
Plant life	pll	year	25		
Operation time	optm	fraction	0.82		
Minimum utilization	minutil	fraction			not used in this example
Investment cost	inv	$/kW	36		Small cost reflecting the cost of modernization of the existing technology
Fixed O&M cost	fom	$/kW-year	8.77		
Variable O&M cost	vom	$/kWyear	21.1		
Unit size	cmix	MW	-		not used in this example
Construction time	ctime	year	1		time for modernization
Historical capacity	hisc	year MW	1975 320		320 MW was commissioned in the year 1975
Minimum power	pmin	MW	-		not used in this example
Maximum power	pmax	MW	-		not used in this example
Main output	moutp		electricity		This is a cogeneration unit. Once electricity is specified as main output, all costs
Other output	outp		heat		should be re-calculated to this output. Secondary output does not bear any cost
Main input	minp		oil		
Other input	inp		orimulsion		
Thermal efficiency	eff	%	30		to produce electricity (efficiency can vary in accordance with fuel input)
Thermal efficiency	eff	%	32.7		to produce heat
Other data:					
Annual bound on capacity addition	bdc	MW			not used in this example
Bound on total capacity addition	bdi	MW	320		No more new addition is allowed in this example

Note:
Year1, YearN denote the data fields for the first and last year of the study period. User should provide as many data as the number of predefined time steps (See general data)

MESSAGE DATA ENTRY FORM

Example 3: **Bi-fuel CCGT, new**

Data Item	Parameter in MESSAGE	Unit	Time Series Value		Explanatory Note
			Year1	YearN	
Technical and economic data:					
Plant factor	plf	fraction	0.9		
Plant life	pll	year	25		
Operation time	optm	fraction	0.9		
Minimum utilization	minutil	fraction	-		not used in this example
Investment cost	inv	$/KW	450		
Fixed O&M cost	fom	$/KW-year	14.59		
Variable O&M cost	vom	$/kWyear	4.64		
Unit size	cmix	MW	300		
Construction time	ctime	year	2		
Historical capacity	hisc	MW	-		not applicable
Minimum power	pmin	MW	-		not used in this example
Maximum power	pmax	MW	-		not used in this example
Main output	moutp				Electricity
Other output	outp		-		not applicable
Main input	minp				Gas
Other input	inp				Diesel
Losses	-	%	60		Efficiency 40 % = ratio between output and input
Other data:					
Annual bound on production	bda	MWyear	-		not used in this example
Bound on total capacity addition	bdi	MW	600		Equivalent to 2 units
Nox emission	con1a	kg/MWyear	4.73		Relative to output

Note:
Year1, YearN denote the data fields for the first and last year of the study period. User should provide as many data as the number of predefined time steps (See general data)

MESSAGE DATA ENTRY FORM

Example 4: **Atmospheric distillation of crude oil, refinery**

Data Item	Parameter in MESSAGE	Unit	Time Series Value		Explanatory Note
			Year1	YearN	
Technical and economic data:					
Plant factor	plf	fraction	1		
Plant life	pll	year	30		
Operation time	optm	fraction	0.9		
Minimum utilization	minutil	fraction	-		not used in this example
Investment cost	inv	$/MW	2581		Calculated based on main output (e.g., gasoline)
Fixed O&M cost	fom	$/kW-year	0.01		
Variable O&M cost	vom	$/kWyear	336	323	Variable cost includes fuel price
Unit size	cmix	MW	-		not used in this example
Construction time	ctime	year	4		
Main input	minp	MWyear			Crude
Other input	inp	MWyear			Ancillary input such as electricity, steam
Main output	moutp	MWyear			Gasoline (defined by user)
Other output	outp	MWyear			Fuel oil (defined by user)
Other output	outp	MWyear			Diesel (defined by user)
Other output	outp	MWyear			LPG (defined by user)
Other output	outp	MWyear			Naphtha (defined by user)
Other data:					
Annual bound on production	bda	MWyear	222		
Annual bound on capacity addition	bdc	MW	-		not used in this example
Bound on total capacity addition	bdi	MW	-		not used in this example
SO2 emission	con1a	kg/MWyear	-		not used in this example

Note:
Year1, YearN denote the data fields for the first and last year of the study period. User should provide as many data as the number of predefined time steps (See general data)

MESSAGE DATA ENTRY FORM

Example 5: **Gas pipeline, new**

Data Item	Parameter in MESSAGE	Unit	Time Series Value		Explanatory Note
			Year1	YearN	
Technical and economic data:					
Plant factor	plf	fraction	1		
Plant life	pll	year	30		
Operation time	optm	fraction	1		
Investment cost	inv	$/MW	41.7		
Fixed O&M cost	fom	$/kW-year	0.001		
Variable O&M cost	vom	$/kWyear	0.001		
Construction time	ctime	year	1		
Main input	minp	MWyear			Gas
Main output	moutp	MWyear			Gas
Other data:					
Annual bound on production	bda	MWyear	-		not used in this example
Annual bound on capacity addition	bdc	MW	60		

Example 5: **Electricity transmission line, existing**

Data Item	Parameter in MESSAGE	Unit	Time Series Value		Explanatory Note
			Year1	YearN	
Technical and economic data:					
Main input	minp	MWyear			Electricity
Main output	moutp	MWyear			Electricity
Variable O&M cost	vom	$/kWyear	65.7		Including actual fixed and variable O&M costs
Transmission loss	-	%	12.5		Used to calculate technology efficiency

Note:
Year1, YearN denote the data fields for the first and last year of the study period. User should provide as many data as the number of predefined time steps (See general data)

MESSAGE DATA ENTRY FORM

Example 6: **Crude oil extraction, existing**

Data Item	Parameter in MESSAGE	Unit	Time Series Value		Explanatory Note
			Year1	YearN	
Technical and economic data:					
Main input	minp	MWyear			Oil from resource
Main output	moutp	MWyear			Produced crude
Variable O&M cost	vom	$/kWyear	158.7		levelized production costs
Production losses	-	%	0.1		Used to calculate technology efficiency
Other data:					
Annual bound on production	bda	MWyear	174.3		
CO2 emission	con1a	kg/MWyear	2.29		

Example 7: **Import of crude oil**

Data Item	Parameter in MESSAGE	Unit	Time Series Value		Explanatory Note
			Year1	YearN	
Technical and economic data:					
Main input	-	-			Import technology has no input
Main output	moutp	MWyear			Crude oil
Variable O&M cost	vom	$/kWyear	146		Import price and operational expenses
Transportation loss	-	%	1		Used to calculate technology efficiency

Example 8: **Fuel oil export**

Data Item	Parameter in MESSAGE	Unit	Time Series Value		Explanatory Note
			Year1	YearN	
Technical and economic data:					
Main input	minp	-			Fuel oil
Main output	moutp	MWyear			Fuel oil
Variable O&M cost	vom	$/kWyear	-86.2		Export price, negative in relation to the model
Transportation loss	-	%	-		not used in this example

Note:
Year1, YearN denote the data fields for the first and last year of the study period. User should provide as many data as the number of predefined time steps (See general data)

MESSAGE DATA ENTRY FORM

Typical data for a resource

Data Item	Parameter in MESSAGE	Unit	Time Series Value		Explanatory Note
			Year1	YearN	
Resource level:					
Upper limit	uplim	MWyear			Upper limit on extraction of total resource including all grades
Grade level:					
Total volume of a grade	volume	MWyear			Total volume of this particular grade of this resource
Initial value	intval	MWyear			Value of the resource of this grade at the beginning of the base year
Remaining reserve	resrem	MWyear			Remaining resource available for extraction at the beginning of the next time step
Limit on extraction	uplim	MWyear			Upper limit on annual extraction within a given time step
Cost of resource	cost	$/MWyear			a) Value of resource; b) extraction cost (then should not enter again in extraction technology)

Example **Crude oil resource**

Data Item	Parameter in MESSAGE	Unit	Time Series Value		Explanatory Note
			Year1	YearN	
Resource level:					
Upper limit	uplim	MWyear	2995		One data value applied for the study, time series data is not applicable
Grade level:					
Total volume of a grade	volume	MWyear	1897		One data value applied for the study, time series data is not applicable
Initial value	intval	MWyear	-		not used in this example
Remaining reserve	resrem	MWyear	-		not used in this example
Limit on extraction	uplim	MWyear	234		
Cost of resource	cost	$/MWyear	0.1		Assumed value of resource