

Data Protocols and Management

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with contributions from many other people

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Why is this a priority?

- Modeling comparison exercises and scenario reviews have expanded over the past years
- Handling the data requests has become a pain for the modeling teams
- Manual data processing due to varying templates is error-prone
- Incorporate quality control mechanisms
- Data availability improves transparency and credibility
- Easy data access can foster interesting analysis of scenario data (follow the example of the climate modeling community)

What happened so far?

- September 2009: Initial Discussions at the IAMC Annual Meeting 2009, Tsukuba
- October/November 2009: Series of Conference Calls with interested people from PNNL, PBL, NIES, IIASA
- December 2009: 1st AME data template
- May 2010: 2nd AME data template
- July 2010: database prototype shown at Snowmass
- August 2010: 1st EMF24 data template
- September 2010: Launch of EMF24 online database based on the 1st EMF24 data template

The Data Template

- People involved:
Kate Calvin (PNNL), Leon Clarke (PNNL), Tatsuya Hanaoka (NIES), Mikiko Kainuma (NIES), Peter Kolp (IIASA), Volker Krey (IIASA), Keywan Riahi (IIASA), Bas van Ruijven (PBL)
- Objectives in designing the template:
 - Prescribe a structure that can easily be parsed
 - Format should be adaptable to future needs
 - Keep the barrier low: format should be manageable manually as well as in an automated fashion
- Results: Data container (spreadsheet) and sets of variables (core and extended)

The Data Template – Time Series

EMF24_template_05Sep2010.xls [Compatibility Mode] - Microsoft Excel

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Model	Scenario	Region	Variable	Unit	2005	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
2				Population Total	million											
3				Population Urban	million											
4				Population Rural	million											
5				GDP Total MER	billion US\$2005/yr											
6				GDP Total PPP	billion US\$2005/yr											
7				GDP Industry MER	billion US\$2005/yr											
8				GDP Services MER	billion US\$2005/yr											
9				GDP Agriculture MER	billion US\$2005/yr											
10				Primary Energy Total	EJ/yr											
11				Primary Energy Fossil Total	EJ/yr											
12				Primary Energy Fossil w/ CCS	EJ/yr											
13				Primary Energy Fossil w/o CCS	EJ/yr											
14				Primary Energy Coal Total	EJ/yr											
15				Primary Energy Coal w/ CCS	EJ/yr											
16				Primary Energy Coal w/o CCS	EJ/yr											
17				Primary Energy Oil Total	EJ/yr											
18				Primary Energy Oil w/ CCS	EJ/yr											
19				Primary Energy Oil w/o CCS	EJ/yr											
20				Primary Energy Gas Total	EJ/yr											
21				Primary Energy Gas w/ CCS	EJ/yr											
22				Primary Energy Gas w/o CCS	EJ/yr											
23				Primary Energy Biomass Total	EJ/yr											
24				Primary Energy Biomass w/ CCS	EJ/yr											
25				Primary Energy Biomass w/o CCS	EJ/yr											
26				Primary Energy Nuclear Total	EJ/yr											
27				Primary Energy Non-Biomass Renewables	EJ/yr											
28				Primary Energy Hydro Total	EJ/yr											
29				Primary Energy Wind Total	EJ/yr											
30				Primary Energy Solar Total	EJ/yr											
31				Primary Energy Geothermal Total	EJ/yr											
32				Primary Energy Ocean Total	EJ/yr											
33				Primary Energy Secondary Energy Trade Total	EJ/yr											
34				Primary Energy Other	EJ/yr											
35				Secondary Energy Electricity Total	EJ/yr											
36				Secondary Energy Electricity Coal Total	EJ/yr											
37				Secondary Energy Electricity Coal w/ CCS	EJ/yr											
38				Secondary Energy Electricity Coal w/o CCS	EJ/yr											
39				Secondary Energy Electricity Oil Total	EJ/yr											
40				Secondary Energy Electricity Oil w/ CCS	EJ/yr											
41				Secondary Energy Electricity Oil w/o CCS	EJ/yr											
42				Secondary Energy Electricity Gas Total	EJ/yr											
43				Secondary Energy Electricity Gas w/ CCS	EJ/yr											
44				Secondary Energy Electricity Gas w/o CCS	EJ/yr											
45				Secondary Energy Electricity Biomass Total	EJ/yr											
46				Secondary Energy Electricity Biomass w/ CCS	EJ/yr											
47				Secondary Energy Electricity Biomass w/o CCS	EJ/yr											

instructions meta US scenarios int scenario description int scenario names data variable definitions tech availability

The Data Template – Variables

Variable	Unit	Definition
Population Total	million	total population
Population Urban	million	urban population
Population Rural	million	rural population
GDP Total MER	billion US\$2005/yr	GDP at market exchange rate
GDP Total PPP	billion US\$2005/yr	GDP converted to US \$ using purchasing power parity
GDP Industry MER	billion US\$2005/yr	GDP at market exchange rate
GDP Services MER	billion US\$2005/yr	GDP at market exchange rate
GDP Agriculture MER	billion US\$2005/yr	GDP at market exchange rate. Includes agriculture, forestry, and fisheries
Primary Energy Total	EJ/yr	total primary energy consumption (direct equivalent)
Primary Energy Fossil Total	EJ/yr	coal, gas, conventional and unconventional oil primary energy consumption
Primary Energy Fossil w/ CCS	EJ/yr	coal, gas, conventional and unconventional oil primary energy consumption used in combination with CCS
Primary Energy Fossil w/o CCS	EJ/yr	coal, gas, conventional and unconventional oil primary energy consumption without CCS
Primary Energy Coal Total	EJ/yr	coal primary energy consumption
Primary Energy Coal w/ CCS	EJ/yr	coal primary energy consumption used in combination with CCS
Primary Energy Coal w/o CCS	EJ/yr	coal primary energy consumption without CCS
Primary Energy Oil Total	EJ/yr	conventional & unconventional oil primary energy consumption
Primary Energy Oil w/ CCS	EJ/yr	conventional & unconventional oil primary energy consumption used in combination with CCS
Primary Energy Oil w/o CCS	EJ/yr	conventional & unconventional oil primary energy consumption without CCS
Primary Energy Gas Total	EJ/yr	gas primary energy consumption
Primary Energy Gas w/ CCS	EJ/yr	gas primary energy consumption used in combination with CCS
Primary Energy Gas w/o CCS	EJ/yr	gas primary energy consumption without CCS
Primary Energy Biomass Total	EJ/yr	purpose-grown bioenergy crops, crop and forestry residue bioenergy, municipal solid waste bioenergy, traditional biomass primary energy consumption
Primary Energy Biomass w/ CCS	EJ/yr	purpose-grown bioenergy crops, crop and forestry residue bioenergy, municipal solid waste bioenergy, traditional biomass primary energy consumption used in combination with CCS
Primary Energy Biomass w/o CCS	EJ/yr	purpose-grown bioenergy crops, crop and forestry residue bioenergy, municipal solid waste bioenergy, traditional biomass primary energy consumption without CCS
Primary Energy Nuclear Total	EJ/yr	nuclear primary energy consumption (direct equivalent, includes electricity, heat and hydrogen production from nuclear energy)
Primary Energy Non-Biomass Renewables	EJ/yr	non-biomass renewable energy consumption (direct equivalent, includes hydro electricity, wind electricity, geothermal electricity and heat, solar electricity, heat and
Primary Energy Hydro Total	EJ/yr	total hydro primary energy consumption
Primary Energy Wind Total	EJ/yr	total wind primary energy consumption
Primary Energy Solar Total	EJ/yr	total solar primary energy consumption
Primary Energy Geothermal Total	EJ/yr	total geothermal primary energy consumption
Primary Energy Ocean Total	EJ/yr	total ocean primary energy consumption
Primary Energy Secondary Energy Trade Total	EJ/yr	trade in secondary energy carriers (e.g. electricity, hydrogen, fossil syngas, negative means net exports)
Primary Energy Other	EJ/yr	primary energy consumption from sources that do not fit to any other category (direct equivalent, please provide a definition of the sources in this category in the 'comments' column)
Secondary Energy Electricity Total	EJ/yr	total net electricity production
Secondary Energy Electricity Coal Total	EJ/yr	net electricity production from coal
Secondary Energy Electricity Coal w/ CCS	EJ/yr	net electricity production from coal with a CO2 capture component
Secondary Energy Electricity Coal w/o CCS	EJ/yr	net electricity production from coal with freely vented CO2 emissions
Secondary Energy Electricity Oil Total	EJ/yr	net electricity production from refined liquids
Secondary Energy Electricity Oil w/ CCS	EJ/yr	net electricity production from refined liquids with a CO2 capture component
Secondary Energy Electricity Oil w/o CCS	EJ/yr	net electricity production from refined liquids with freely vented CO2 emissions
Secondary Energy Electricity Gas Total	EJ/yr	net electricity production from natural gas
Secondary Energy Electricity Gas w/ CCS	EJ/yr	net electricity production from natural gas with a CO2 capture component
Secondary Energy Electricity Gas w/o CCS	EJ/yr	net electricity production from natural gas with freely vented CO2 emissions
Secondary Energy Electricity Biomass Total	EJ/yr	net electricity production from municipal solid waste, purpose-grown biomass, crop residues, forest industry waste, biogas
Secondary Energy Electricity Biomass w/ CCS	EJ/yr	net electricity production from municipal solid waste, purpose-grown biomass, crop residues, forest industry waste with a CO2 capture component
Secondary Energy Electricity Biomass w/o CCS	EJ/yr	net electricity production from municipal solid waste, purpose-grown biomass, crop residues, forest industry waste with freely vented CO2 emissions

The Database

- RCP database served as a starting point
- Added functionality
 - User/group management
 - Interactive scenario uploads
 - Automated aggregation to “standard regions”
 - Some initial quality checks (model, variable and region names)
- First prototype presented at Snowmass 2010
- First application in EMF24

Select region(s), scenario(s), and variable to define your query

(1.) Regions:

- Compare
- World
- OECD 90
- Reforming Ecor
- Asia
- Middle East an
- Latin America
- European Unic
- Federative Rej
- People's Repu
- Republic of In
- Russian Feder
- State of Japan

(2.) Scenarios:

- MESSAGE
- Scenario 1
- Scenario 11
- Scenario 12
- Scenario 13
- Scenario 14
- Scenario 15
- Scenario 16
- Scenario 18
- Scenario 2
- Scenario 20
- Scenario 3
- Scenario 4
- Scenario 5
- Scenario 6

(3.) Variables:

- Population
- GDP
- Primary Energy
- Secondary Energy
- Final Energy
- Energy Service
- Emissions
 - CO2
 - Total
 - Fossil fuels and Industry
 - Power Plants, Energy Conve
 - Industry (combustion & proc
 - Residential and Commercial

Query Results - Chart Preview:

© EMF24 Scenario database (Version 0.9) generated: 2010-10-26 22:51:30

Query Results:

Region	Scenario	Variable	Unit	2005	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
World	MESSAGE - Scenario 1	Emissions CO2 Total	Mt CO2/yr	33861.663	35579.086	42634.145	48850.509	56790.239	63855.484	70334.598	73888.742	73768.039	72384.506	69346.816
World	MESSAGE - Scenario 5	Emissions CO2 Total	Mt CO2/yr	33861.370	35578.734	34845.169	31256.584	25619.334	17817.796	9323.739	1324.759	-5634.343	-11681.439	-16523.126
World	MESSAGE - Scenario 6	Emissions CO2 Total	Mt CO2/yr	33861.586	35578.917	37820.097	37386.921	33813.102	26069.483	17695.737	9340.624	11861.487	7678.352	-1329.086

© EMF24 Scenario database (Version 0.9) generated: 2010-10-26 22:51:30

Output Options:

Microsoft Excel

Portable Network Graphics

Notes:

Scenario upload

Model	Scenario	Action
History	IEA	<input type="button" value="Delete scenario"/>
MESSAGE	Scenario 1	<input type="button" value="Delete scenario"/>
MESSAGE	Scenario 11	<input type="button" value="Delete scenario"/>
MESSAGE	Scenario 12	<input type="button" value="Delete scenario"/>
MESSAGE	Scenario 13	<input type="button" value="Delete scenario"/>
MESSAGE	Scenario 14	<input type="button" value="Delete scenario"/>
MESSAGE	Scenario 15	<input type="button" value="Delete scenario"/>
MESSAGE	Scenario 16	<input type="button" value="Delete scenario"/>
MESSAGE	Scenario 18	<input type="button" value="Delete scenario"/>
MESSAGE	Scenario 2	<input type="button" value="Delete scenario"/>
MESSAGE	Scenario 20	<input type="button" value="Delete scenario"/>

Improvements in EMF24 Submission

- Stability
 - Servlet and importer decoupled
 - More resistant against changes in original template
- Performance
 - Imports ~50 times faster than initially
 - Rule of thumb: ~1 second per scenario and region
- Some Checks
 - Region submission check
(similar to variables – spelling differences, etc.)
- Improved communication
 - Messages upon queuing and completion of import

Plans for the EMF24 Database

EMF24 Scenario database - Mozilla Firefox

http://www.iiasa.ac.at/web-apps/ene/EMF24DB/dsd?Action=htmlpage&page=series

EMF24 Scenario database

Science for Global Insight

About Regions Sectors Series Manage

EMF24 Scenario database Version 0.9

Select region(s), scenario(s), and variable to define your query

(1.) Regions:

- Compare
- World
- OECD 90
- Reforming Economies
- Asia
- Middle East and North Af
- Latin America
- European Union (27 mem
- Federative Republic of Br
- People's Republic of Chin.
- Republic of India
- Russian Federation
- State of Japan
- United States of America
- MESSAGE
- Centrally Planned Asia ar
- Eastern Europe
- Former Soviet Union

(2.) Scenarios:

- MESSAGE
- Scenario 1
- Scenario 11
- Scenario 12
- Scenario 13
- Scenario 14
- Scenario 15
- Scenario 16
- Scenario 18
- Scenario 2
- Scenario 20
- Scenario 3
- Scenario 3

(3.) Variables:

- Population
- GDP
- Primary Energy
 - Total
 - Fossil
 - Coal
 - Oil
 - Gas
 - Biomass
 - Nuclear
 - Non-Biomass Renewables
 - Hydro
 - Wind
 - Solar
 - Geothermal
 - Ocean
 - Secondary Energy
- Secondary Energy

Query Results - Chart Preview:

Primary Energy|Total

Legend: World - MESSAGE - Scenario 1, World - MESSAGE - Scenario 5

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History

Region	Scenario	Unit	2005	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
World	MESSAGE - Scenario 1	EJ/yr	447.102	471.809	569.267	666.977	789.636	917.033	1051.128	1162.431	1231.953	1313.537	1354.481
World	MESSAGE - Scenario 5	EJ/yr	447.098	471.807	480.432	488.665	516.751	555.240	575.340	584.538	584.332	602.228	621.995
Region	Scenario (History)	Unit	1971	1980	1990	2000	2005	2007					
World	History - IEA	Primary Energy, Total	230.666	296.857	350.367	397.624	455.244	480.599					

© EMF24 Scenario database (Version 0.9)
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Output Options:

- Microsoft Excel (XLS)
- Portable Network Graphics (PNG)
- Scalable Vector Graphics (SVG)

Notes:

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current user: krey logout My account

The Way Forward: Issues and Ideas (1)

- Finalizing a „standard IAMC template“ and an extended list of variables including documentation
- Establish process for updating the template
 - collect proposals for new variables continuously
 - revisit regularly (e.g. once a year)
- Extension to spatial data sets
 - building on initial work done in the RCP process
- Look at examples in other communities, for example the climate modeling community's Program for Climate Model Diagnosis and Intercomparison (PCMDI)

The Way Forward: Issues and Ideas (2)

- Developing a community database beyond specific applications such as EMF24 or AME
 - Useful region definitions for public data
 - develop criteria for submission (e.g. peer-reviewed publication)
 - include references to underlying publications
 - suggested citation for database
- Other applications of the database platform
 - collect input data sets (e.g. technology database) as a community resource
- Explore potential links to other research priorities
 - Storylines and RCP replication
 - Model validation

Access and Legal Issues

- Who should be able to access data?
 - Internal data access in specific applications (e.g. EMF24)
 - Public access to finalized/published data
- Agreement between modeling groups, database host and data users
 - Disclaimer
 - Terms of use
 - Licensing (e.g. Creative/Scientific Commons License)
- Build on experience of climate modeling community
 - CMIP5 website, etc.

Feedback...

...is most welcome!

Thank You!