Package: mrindustry (via r-universe)

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Type Package

Title input data generation for the REMIND industry module

Version 0.1.0

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Description The mrindustry packages contains data preprocessing for the REMIND model.

License LGPL-3

URL https://github.com/pik-piam/mrindustry

Depends R (>= 2.10.0), madrat (>= 3.7.1), magclass (>= 6.16.1), GDPuc (>= 1.3.0), mrremind (>= 0.180.0), mrdrivers (>= 2.0.0)

Imports assertr, broom, car, countrycode, data.table, dplyr, ggplot2, Hmisc, magrittr, purrr, quitte (>= 0.3105.0), readODS, readr, readxl, reshape2, rlang, tibble, tidyr, tidyselect, zoo

Suggests testthat

Encoding UTF-8

RoxygenNote 7.3.2

Repository https://pik-piam.r-universe.dev

RemoteUrl https://github.com/pik-piam/mrindustry

RemoteRef HEAD

RemoteSha b4b6288c90ec27cf57fd6a8b186ddb02ad7d3607

Contents

`calcCement` *Calculate Historic Cement Production*

Description

Combines cement production data from `readvanRuijven2016()` and `readUSGS(cement)` into a single data set, using USGS data from 2005 on.

Usage

```
calcCement()
```

Value

A list with a `magpie` object `x` with country-level cement production in tonnes, `weight`, `unit`, `description`, and `min` fields.

Author(s)

Michaja Pehl

See Also

calcOutput

calcCementShare *Calculate Cement Share in NONMET FE Use*

Description

Estimated shares of cement in NONMET final energy use based on OECD and Non-OECD figures from IEA 2017 Energy Technology Perspectives. Shares are weighted by GDP for aggregation and converge towards global values by 2100.

Usage

```
calcCementShare()
```

Value

A list with a magpie object x, weight, unit, description, min, and max.

Author(s)

Michaja Pehl

See Also

calcOutput()

calcChemicalFeedstocksShare *Calculate Chemical Feedstock share projections*

Description

Calculates the share of CHEMICAL in CHEMICAL = NECHEM and converges it towards the maximum value of either OECD or non-OECD countries by 2050.

Usage

```
calcChemicalFeedstocksShare()
```

Value

A list with a magpie object x, weight, unit, description, min, and max.

Author(s)

Michaja Pehl

See Also

calcOutput()

---

calcClinker_to_cement_ratio

Calculate Clinker-to-Cement Ratio

Description

Calculate Clinker-to-Cement Ratio

Usage

```
calcClinker_to_cement_ratio()
```

Value

A list with a magpie object x, weight, unit, and description.

Author(s)

Michaja Pehl

See Also

calcOutput(), readADVANCE_WP2(), convertADVANCE_WP2()

---

calcEmissionFactorsFeedstocks

Calculate emission factors for feedstocks in the chemicals industry using emissions from UNFCCC and energy demands from IEA Energy Balances

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Description

Calculate emission factors for feedstocks in the chemicals industry using emissions from UNFCCC and energy demands from IEA Energy Balances

Usage

```
calcEmissionFactorsFeedstocks()
```

Value

A list with a magpie object x, weight, unit, description.

Author(s)

Falk Benke, Renato Rodrigues, Simón Moreno Leiva

See Also

calcOutput()

---

calcFeDemandIndustry *Calculates FE demand in industry as REMIND variables*

Description

Calculates FE demand in industry as REMIND variables

Usage

```
calcFeDemandIndustry(use_ODYM_RECC = FALSE)
```

Arguments

use_ODYM_RECC	per-capita pathways for 'SDP_xx' scenarios? (Defaults to 'FALSE'.)

Author(s)

Michaja Pehl

---

calcIndustry_CCS_limits *Calculate Limits on Industry CCS Capacities*

Description

Calculate Limits on Industry CCS Capacities

Usage

```
calcIndustry_CCS_limits(
  a1 = 0.3,
  a2 = 0.15,
  installation_minimum = 1,
 stage_weight = c(Operational = 1, `In construction` = 1, `Advanced development` = 0.5,
    `Early development` = 0.2),
  facility_subsector = c(Cement = "cement", Chemical = "chemicals",
    `Hydrogen / Ammonia / Fertiliser` = "chemicals", Ethan = "chemicals",
    `Iron and Steel Production` = "steel"),
  region_mapping = NULL
)
```

Arguments

a1, a2	Annual growth factors of CCS capacity limits, for the first ten years and thereafter, default to 0.7 and 0.2 (70 % and 20 %, respectively).
installation_minimum	Minimum emission capacity (in MtCO~2~/year) capacities are rounded up to. Defaults to 0.5 (500 ktCO~2~/year).
stage_weight	A named vector of weight factors for different lifecycle stages. See Details.
facility_subsector	A named vector mapping the "Facility Industry" of CCS projects to REMIND industry subsectors. See Details.
region_mapping	A data frame with columns iso3c and region detailing the regional resolution on which data should be extrapolated. If NULL (the default), extrapolation is done at the country level.

Details

The limits on industry CCS capacities are calculated from data of the Global Status of CCS 2023 report (through readGlobalCCSinstitute(). CCS projects are

- filtered for valid (i.e. not "Under Evaluation") data for "Operation date" and "CO~2~ capture capacity"
- assigned to REMIND industry subsectors according to facility_subsector, which defaults to

Facility Industry	subsector
Cement	cement
Chemical	chemicals
Hydrogen / Ammonia / Fertiliser	chemicals
Ethan	chemicals
Iron and Steel Production	steel

- weighted by lifecycle stage according to stage_weight, which defaults to

Lifecycle stage	weight
Operational	100 %
In construction	100 %
Advanced development	50 %
Early development	20 %

The resulting project capacities constitute the limits on industry subsector CCS capacity for 2025. The limit on CCS capacities for regions (or countries if region_mapping is NULL) is set to a value of total 2025 subsector CCS capacity, times the regions share in subsector activity (e.g. cement production) of the SSP2EU scenario

- in 2030 if the region as some CCS capacity in 2025 in a different industry subsector, or

- in 2035 if the region has no industry CCS capacity in 2030 at all.

CCS capacities are increased by the annual growth factor `a1` for the ten first years, and by the annual growth factor `a2` afterwards (defaulting to 70 % and 20 %, respectively).

Value

A list with a `magpie` object `x`, `weight`, `unit`, `description`, and `min`.

Author(s)

Michaja Pehl

`calcIndustry_EEK` *Industry Energy Efficiency Capital*

Description

Industry Energy Efficiency Capital

Usage

```
calcIndustry_EEK(kap)
```

Arguments

`kap`	General internal capital stock, as calculated internally by ‘calcCapital()‘.

Value

A list with a [‘magpie‘][magclass::magclass] object ‘x‘, ‘weight‘, ‘unit‘, and ‘description‘ fields.

`calcindustry_max_secondary_steel_share`
Calculate Maximum Secondary Steel Production Share

Description

Reads ExpertGuess/industry_max_secondary_steel_share and expands to all ‘scenarios‘/‘regions‘ using default data. See [‘tool_expand_tibble()‘] for details.

Usage

```
calcindustry_max_secondary_steel_share(scenarios = NULL, regions = NULL)
```

Arguments

scenarios	A character vector of scenarios to expand data to.
regions	A character vector of regions to expand data to.

Value

A list with a [‘magpie‘][magclass::magclass] object ‘x‘.

---

calcindustry_specific_FE_limits *Thermodynamic Limits for Industry Specific FE Demand*

Description

Return `readindustry_subsectors_specific('industry_specific_FE_limits')` in a format usable as a REMIND input.

Usage

```
calcindustry_specific_FE_limits()
```

Value

A magpie object.

Author(s)

Michaja Pehl

---

calcnonEnergyIndFE *Final energy demand for feedstocks (non-energy use)*

Description

Final energy demand for feedstocks (non-energy use)

Usage

```
calcnonEnergyIndFE()
```

Value

A magpie object.

Author(s)

Renato Rodrigues

See Also

calcOutput().

---

calcShareIndFE *Share of Industry Subsectors in FE Use*

Description

Calculates industry subsector shares in final energy carrier use for the fixed_shares realisation of the industry module.

Usage

```
calcShareIndFE()
```

Details

For the region mapping regionmapping_21_EU11.csv, these are based on IEA data from calcOutput(type = 'FEdemand'), for all other region mappings on vintage data which is ultimately based on Enerdata data.

Value

A magpie object.

Note

There is a discrepancy between the shares calculated from these two sources, that will affect REMIND emission reporting.

Author(s)

Lavinia Baumstark

Michaja Pehl

See Also

calcOutput().

calcSteelStock *Calculate Steel Stock from Mueller steel stock per capita and WDI population*

Description

Calculate Steel Stock from Mueller steel stock per capita and WDI population

Usage

```
calcSteelStock()
```

Value

A magpie object.

Author(s)

Falk Benke

calcSteel_Projections *EDGE-Industry*

Description

Functions for calculating industry activity trajectories.

Usage

```
calcSteel_Projections(
  subtype = "production",
  match.steel.historic.values = TRUE,
  match.steel.estimates = "none",
  save.plots = NULL,
  China_Production = NULL
)

calcIndustry_Value_Added(
  subtype = "physical",
  match.steel.historic.values = TRUE,
  match.steel.estimates = "none",
  save.plots = NULL,
  China_Production = NULL
)
```

Arguments

`subtype` One of

- `production` Returns trajectories of primary and secondary steel production (`calcSteel_Projections()`).
- `secondary.steel.max.share` Returns the maximum share of secondary steel in total steel production (`calcSteel_Projections()`).
- `physical` Returns physical production trajectories for cement (`calcIndustry_Value_Added()`).
- `economic` Returns value added trajectories for all subsectors (`calcIndustry_Value_Added()`).

`match.steel.historic.values`
Should steel production trajectories match historic values?

`match.steel.estimates`
Should steel production trajectories match exogenous estimates? `NULL` or one of

- `IEA_ETP` IEA 2017 Energy Transition Pathways steel production totals for OECD and Non-OECD countries from the *Reference Technologies Scenario* until 2060, and original growth rates after that.

`save.plots` `NULL` (default) if no plots are saved, or the path to save directories to.

`China_Production`
A data frame with columns `period` and `total.production` prescribing total production for China to have, disregarding results from the stock saturation model.

Value

A list with a `magpie` object `x`, `weight`, `unit`, `description`, `min`, and `max`.

Author(s)

Michaja Pehl

See Also

`calcOutput()`

---

convertADVANCE_WP2 *Convert ADVANCE WP2 Data*

Description

Convert ADVANCE WP2 Data

Usage

```
convertADVANCE_WP2(x, subtype)
```

Arguments

x	A magpie object returned by readADVANCE_WP2().
subtype	One of • clinker-to-cement-ratio for the clinker-to-cement ratios from figure 21 of Edelenbosch, O. *Enhancing the representation of energy demand developments in IAM models - A Modeling Guide for the Cement Industry* (2015) zotero://select/items/JP8X2QFK, which is extended from H12 regions to country level.

Value

A magpie object.

Author(s)

Michaja Pehl

See Also

readSource(), readADVANCE_WP2()

---

convertMueller *Convert Mueller data*

Description

Convert Mueller data

Usage

```
convertMueller(x, subtype)
```

Arguments

x	A magpie object returned from readMueller().
subtype	One of: • countries: read table mapping country names use by Müller et al. 2013 to ISO 3166-1 alpha-3 codes. • stocks: read low/medium/high estimates of per-capita steel stocks from Müller et al. 2013 SI2

Value

A magpie object.

Author(s)

Falk Benke

convertStegmann2022 *convertStegmann2022*

Description

Converts data from Stegmann2022

Usage

```
convertStegmann2022(x)
```

Arguments

x	unconverted magpie object from read-script

Value

magpie object with a completed dataset.

readADVANCE_WP2 *Read ADVANCE WP2 Data*

Description

Read ADVANCE WP2 Data

Usage

```
readADVANCE_WP2(subtype)
```

Arguments

subtype	One of • `clinker-to-cement-ratio` for the clinker-to-cement ratios from figure 21 of Edelenbosch, O. *Enhancing the representation of energy demand developments in IAM models - A Modeling Guide for the Cement Industry* (2015) zotero://select/items/JP8X2QFK

Value

A magpie object.

Author(s)

Michaja Pehl

See Also

readSource(), convertADVANCE_WP2()

---

readindustry_subsectors_specific
industry/subsector change factors

Description

Change factors of specific FE and material demand for the industry/subsector realisation of REMIND.

Usage

```
readindustry_subsectors_specific(subtype = NULL)

calcindustry_subsectors_specific(
  subtype = NULL,
  scenarios = NULL,
  regions = NULL,
  direct = NULL
)
```

Arguments

subtype	One of • FE for specific final energy demand change factors • material_alpha for alpha factors and convergence time of specific material demand decreases relative to the SSP2EU scenario • material_relative for scaling factors of specific material demand relative to baseline scenarios • material_relative_change for scaling factors of specific material demand *change* relative to baseline scenarios
scenarios	A vector of scenarios for which factors are to be returned.
regions	A vector of regions for which factors are to be returned.
direct	A data frame as returned by readindustry_subsectors_specific() to load debugging/developing data directly instead of from file.

Details

Factors are read from the files specific_FE.csv, specific_material_alpha.csv, specific_material_relative.csv, and specific_material_relative_change.csv, respectively. NA is used to mark defaults for the scenario and region columns, and specified values will overwrite these defaults.

So

- NA,NA,cement,1 will be extended to all scenarios and regions
- scen1,NA,cement,2 will overwrite this default for all regions in scen1
- NA,regi1,cement,3 will overwrite this again for all scenarios (including scen1) for regi1
- scen1,regi1,cement,4 will lastly overwrite the value for the scen1, regi1 combination

Replacements occure in this fixed order (NA/NA, scenario/NA, NA/region, scenario/region).

Lastly, output is filtered for scenarios and regions.

For debugging and development, instead of modifying the .csv files in sources/industry_subsectors_specific/ and interfering with production runs, modify the calling code (e.g. calcFEdemand.R) to use direct data (entered verbatim or loaded from somewhere else.)

Value

A magpie object.

Author(s)

Michaja Pehl

---

readMueller *Read Müller et al. 2013 data.*

Description

Read data from Müller et al. 2013 (http://dx.doi.org/10.1021/es402618m).

Usage

```
readMueller(subtype)
```

Arguments

subtype	One of: • countries: read table mapping country names use by Müller et al. 2013 to ISO 3166-1 alpha-3 codes. • stocks: read low/medium/high estimates of per-capita steel stocks from Müller et al. 2013 SI2

Value

A magpie object.

Author(s)

Michaja Pehl

See Also

readSource()

readnonEnergyDemand *Read Final energy demand for feedstocks (non-energy use)*

Description

Read Final energy demand for feedstocks (non-energy use)

Usage

```
readnonEnergyDemand()
```

Value

magpie object of region dependent data

Author(s)

Renato Rodrigues

See Also

readSource

Examples

```
## Not run:
a <- readSource(type = "nonEnergyDemand")

## End(Not run)
```

readODYM_RECC *Read ODYM_RECC data from the SHAPE Project*

Description

Read ODYM_RECC data from the SHAPE Project

Usage

```
readODYM_RECC(subtype, smooth = TRUE)

calcODYM_RECC(subtype, smooth = TRUE)
```

Arguments

subtype	One of • 'REMIND_industry_trends': Trends in per-capita production of industry subsectors cement, chemicals, steel_primary, steel_secondary, and otherInd. Trends for chemicals and otherInd are averages of the other three trends, which are provided by NTNU.
smooth	Smooth REMIND_industry_trends (default) or not.

Value

A magpie object.

Author(s)

Michaja Pehl

---

readPauliuk *Read Pauliuk et al. 2013 data*

Description

Read data from Pauliuk et al. 2013 (https://dx.doi.org/10.1016/j.resconrec.2012.11.008).

Usage

```
readPauliuk(subtype = "lifetime")
```

Arguments

subtype	One of: • lifetime: Read estimated lifetime of overall steel stocks (approach b) in years.

Value

A magpie object.

Author(s)

Michaja Pehl

See Also

readSource()

readStegmann2022 *Read PlasticsEoL*

Description

Read-in data for the End-of-Life fate of plastics from 1.Stegmann, P., Daioglou, V., Londo, M., van Vuuren, D. P. & Junginger, M. Plastic futures and their CO2 emissions. Nature 612, 272–276 (2022). https://www.nature.com/articles/s41586-022-05422-5 Link to SI: https://static-content.springer.com/esm/art%3A10.1
022-05422-5/MediaObjects/41586_2022_5422_MOESM1_ESM.xlsx #nolint

Usage

```
readStegmann2022()
```

Value

magpie object of the data

Author(s)

Falk Benke, Simón Moreno

See Also

readSource

Examples

```
## Not run:
a <- readSource(type = "Stegmann2022")

## End(Not run)
```

readUNIDO *UNIDO data*

Description

Read and convert data from United Nations Industrial Organisation.

Usage

```
readUNIDO(subtype = "INDSTAT2")

convertUNIDO(x, subtype = "INDSTAT2")

calcUNIDO(subtype = "INDSTAT2")
```

Arguments

subtype	one of - INDSTAT2: read INDSTAT2 data
x	result from readUNIDO() as passed to convertUNIDO()

Value

A magpie object.

readUNIDO returns raw INDSTAT2 data. convertUNIDO converts to iso3c country codes, selects industry subsectors value added data according to this table

subsector	ISIC	ctable	utable
manufacturing	D	20	17–20
cement	20	20	17–20
chemicals	24	20	17–20
steel	27	20	17–20

and filters data that is either unreasonable or would unduly bias regional regressions according to this table

subsector	iso3c	years
manufacturing	BIH	1990–91
manufacturing	CHN	1963–97
manufacturing	HKG	1963–2015
manufacturing	IRQ	1994–98
manufacturing	MAC	1963–2015
manufacturing	MDV	1963–2015
cement	BDI	1980–2010
cement	CIV	1990–93
cement	HKG	1973–79
cement	IRQ	1992–97
cement	NAM	2007–10
cement	RUS	1970–90
chemicals	CIV	1989
chemicals	HKG	1973–79, 2008–15
chemicals	MAC	1978–79
chemicals	NER	1999–2002
steel	BGD	2011
steel	CHE	1995–96
steel	CHL	2008
steel	HKG	1973–79
steel	HRV	2012
steel	IRL	1980
steel	LKA	2006
steel	MAR	1989–2004
steel	MKD	1996
steel	PAK	1981–82

steel TUN 2003–06

`calcUNIDO()` calculates `otherInd` subsector values as the difference between `manufacturing` and `cement`, `chemicals`, and `steel` values and is intended to be called through `calcOutput()`, which will aggregate regions.

Author(s)

Michaja Pehl

See Also

`readSource()`, `calcOutput()`

`readUSGS` *Read U.S. Geological Survey data*

Description

Read U.S. Geological Survey data

Usage

```
readUSGS(subtype = "cement")

convertUSGS(x, subtype = "cement")
```

Arguments

`subtype`	One of • 'cement': read cement production data from U.S. Geological Survey Minerals Yearbook (unit: tonnes per year)
`x`	Data returned by `readUSGS()`.

Value

A `magpie` object.

Author(s)

Michaja Pehl

readvanRuijven2016 *Read van Ruijven et al. (2016) data.*

Description

Read data from van Ruijven et al. 2016, (http://dx.doi.org/10.1016/j.resconrec.2016.04.016, https://www.zotero.org/groups/5
obtained through personal communication (e-mail to Michaja Pehl). Units are tonnes per year.

Usage

```
readvanRuijven2016()
```

Value

A magpie object.

Author(s)

Michaja Pehl

See Also

readSource()

readworldsteel *Read World Steel Statistical Yearbook Data*

Description

Read combined data of World Steel Association statistical yearbooks (https://www.worldsteel.org/steel-by-topic/statistics/steel-statistical-yearbook.html).

Usage

```
readworldsteel(subtype = "detailed")
```

Arguments

subtype	One of - 'detailed' returning data for the worksheets - 'Pig Iron Production' - 'DRI Production' - 'Total Production of Crude Steel' - 'Production in Oxygen-Blown Converters' - 'Production in Open Hearth Furnaces' - 'Production in Electric Arc Furnaces' - 'Apparent Steel Use (Crude Steel Equivalent)' from 1991 on or - 'long' returning total production data from 1967 on

Value

A ['magpie'][magclass::magclass] object.

Author(s)

Michaja Pehl

See Also

[‘readSource()‘]

`tool_expand_tibble` *Expand tibble across scenarios and regions with default values*

Description

The data.frame ‘d‘ is expanded in such a manner that all rows with ‘NA‘ in either the ‘scenario‘ or ‘region‘ columns are extended to repeat for all scenarios and regions listed in ‘scenarios‘ and ‘regions‘. Rows with specified scenarios and/or regions will overwrite extended ones. Regions are expanded before scenarios.

Usage

```
tool_expand_tibble(d, scenarios, regions, structure.columns = NULL)
```

Arguments

`d`	A data.frame with columns ‘scenario‘ and ‘region‘.
`scenarios`	A character vector of scenario names.
`regions`	A character vector of region names.
`structure.columns`	A character vector of column names to be carried along.

Value

A ‘tibble‘.

Examples

```
## Not run:
tribble(
  ~scenario,   ~region,   ~value,
  NA,          NA,        0,
  NA,          'CHA',     1,
  'SSP1',      NA,        2,
  'SSP2EU',    'DEU',     3) %>%
  tool_expand_tibble(scenarios = c('SSP1', 'SSP2EU', 'SSP5'),
                     regions = c('CHA', 'DEU', 'USA')) %>%
  pivot_wider(names_from = 'region')

tribble(
```

```
  ~scenario,   ~region,   ~name,   ~value,
  NA,          NA,        'A',     0,
  NA,          'CHA',     'B',     1,
  'SSP1',      NA,        'A',     2,
  'SSP2EU',    'DEU',     'B',     3) %>%
  tool_expand_tibble(scenarios = c('SSP1', 'SSP2EU', 'SSP5'),
                     regions = c('CHA', 'DEU', 'USA'),
                     structure.columns = 'name')

## End(Not run)
```

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