energyRt
energy systems modeling R-toolbox

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Outline

• Demand for reproducible research

• The concept of object oriented programming (OOP)

• energyRt
  • language
  • main objects
  • main methods
  • Main features
Motivation

• minimize **time** of development and application of RES/BottomUp models,

• boost **learning curve** in energy modeling,

• improve **transparency** and understanding of energy models,

• use power of **open-source** to improve energy models and their application,

• making **reproducible research** accessible in RES-modeling,

• **integration** with other models and software.
General modeling workflow

• Model development
  • Design model structure
  • Data collection, processing
  • Model implementation (software)
  • Calibration of the model

• Model application
  • Design scenarios
  • Adjust, update model
  • Running the model
  • Processing results
  • Analysis of the results
  • Conclusions
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Demand for reproducible research in energy modeling: an example

• How many model runs have your team done to reach “reasonable” results?
• How much time have you and your team spent for processing your model results and finding inconsistencies?
• How much time will it take to reproduce your own results?
• Will be able other people (new team members) reproduce your research?
energyRt: workflow

Data
- TXT
- SQL

Reports
- PDF
- Excel
- Word

GAMS
GLPK
ГЛПК

RStudio
energyRt
R

Flowchart showing the workflow of energyRt with data inputs and outputs in various formats.
General modeling workflow with energyRt

- Model development
  - Design model structure
  - Data collection, processing (R, energyRt classes: commodity, technology, repository)
  - Model implementation (energyRt classes: model; code: GAMS or GLPK)
  - Calibration of the model (energyRt methods: draw, levcost, compare, ...)

- Model application
  - Design scenarios (energRt classes: constrain, scenario)
  - Adjust, update model (R, energyRt)
  - Running the model (energyRt methods: solve)
  - Processing results (energyRt methods: report, getData, ...)
  - Analysis of the results (R graphs; energyRt methods: plot, report, ...)
  - Conclusions
R + RStudio + energyRt
Classes: custom data structure
Classes: custom data structure (1/2)

Design your own data class
Classes: custom data structure (2/2)

An object/class

slot 1
slot 2
...
slot n

Nestable
energyRt: main classes

- **technology** – stores technology parameters
- **commodity** – stores commodity information
- **supply** – stores info on resources supply
- **demand** – stores info about final demand
- **constrain** – constrain on endogenous variables
- **repository** – stores commodities, technologies, supply, demand
- **model** – stores main model parameters and all info above
- **scenario** – stores all info above and results from the model run
Adding data to “technology” object, final code

```r
ECOA <- newTechnology(
  name = "ECOA",
  description = "Coal-fired power plant",
  input = list(comm = "COA",
                unit = "PJ",
                combustion = 1),
  output = list(comm = "ELC",
                unit = "PJ"),
  units = list(capacity = "GW",
               activity = "PJ",
               varom = "MRMB/PJ",
               fixom = "MRMB/GW",
               invcost = "MRMB/GW"),
  cap2act = 31.536,
  afa = list(afa.up = 0.6),
  ceff = list(comm = "COA",
              unit = "PJ"))
```

energyRt: quick reports for objects *model* and *scenario*

A quick report for scenario "scen.BAU"

September 16, 2016

Quick reports include basic analysis for every commodity, technology, constrain – initial parameters and results
energyRt: current functionality

• Analysis of technologies:
  • Design flexible tech. processes
  • Visualize
  • Analysis of levelized costs
  • Comparison

• Design basic Bottom-Up (RES) models

• Running the models and analyze scenarios
energyRt development plan

- Coming soon
  - Time slices (not yet fully implemented)
  - Regions (not yet tested well)

- Mid-term
  - Check of inconsistencies in data, general bugs
  - Visualizations tools, including:
    - Geographic Information System (GIS)
    - Sankey plots (energy or any commodities flows)
  - Automatic units tracking and conversion

- Long term
  - More models included (Integrated assessment set)
Thank you for your attention!

http://energyRt.org

Welcome to energyRt Pages

energyRt is a package for R to develop Reference Energy System (RES) models and analyze energy-technologies.

energyRt package includes a standard RES (or "Bottom-Up") linear, cost-minimizing model, which can be solved by GAMS or GLPK. The model has similarities with TIMES/MARKAL, OSeMOSYS, but has its own specifics, f.i. definition of technologies.