

# Modeling of National Energy Systems using MESSAGEix

Behnam Zakeri

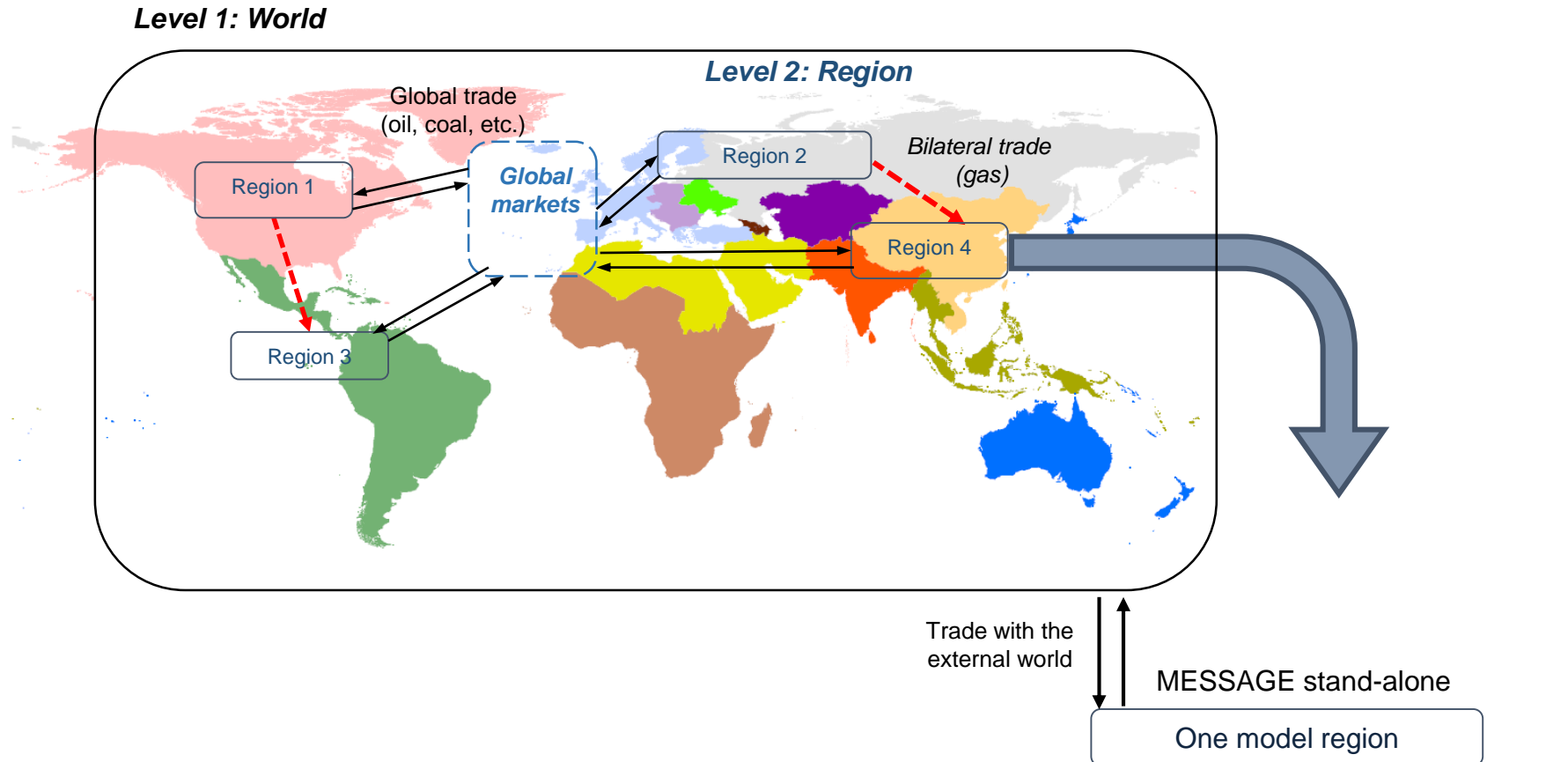
This work is built upon the efforts of:

Clara Orthofer and Mariana Imperio

# Why National Energy Modeling?

- To assess national energy policies and NDCs in more detail
- The interest of specific projects and/or stakeholders
- Heterogeneity across energy systems presented under one region
  - Energy resources, technology mix, etc.
  - Energy policies, development status, demand, etc.

## Building a Stand-alone Country Model

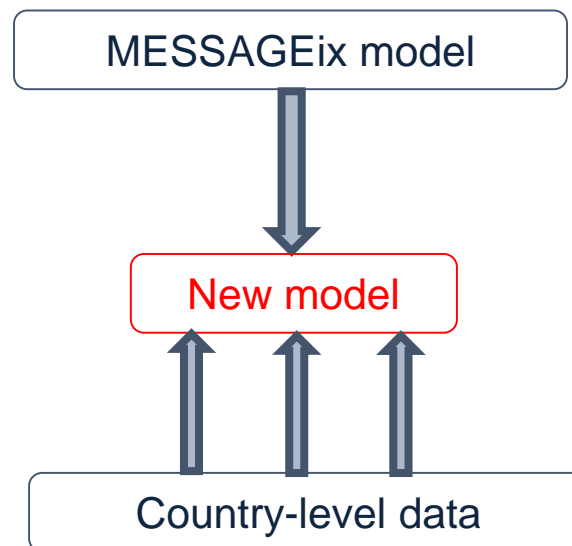


# Modelling Method

- A combination of a top-down and bottom-up method:

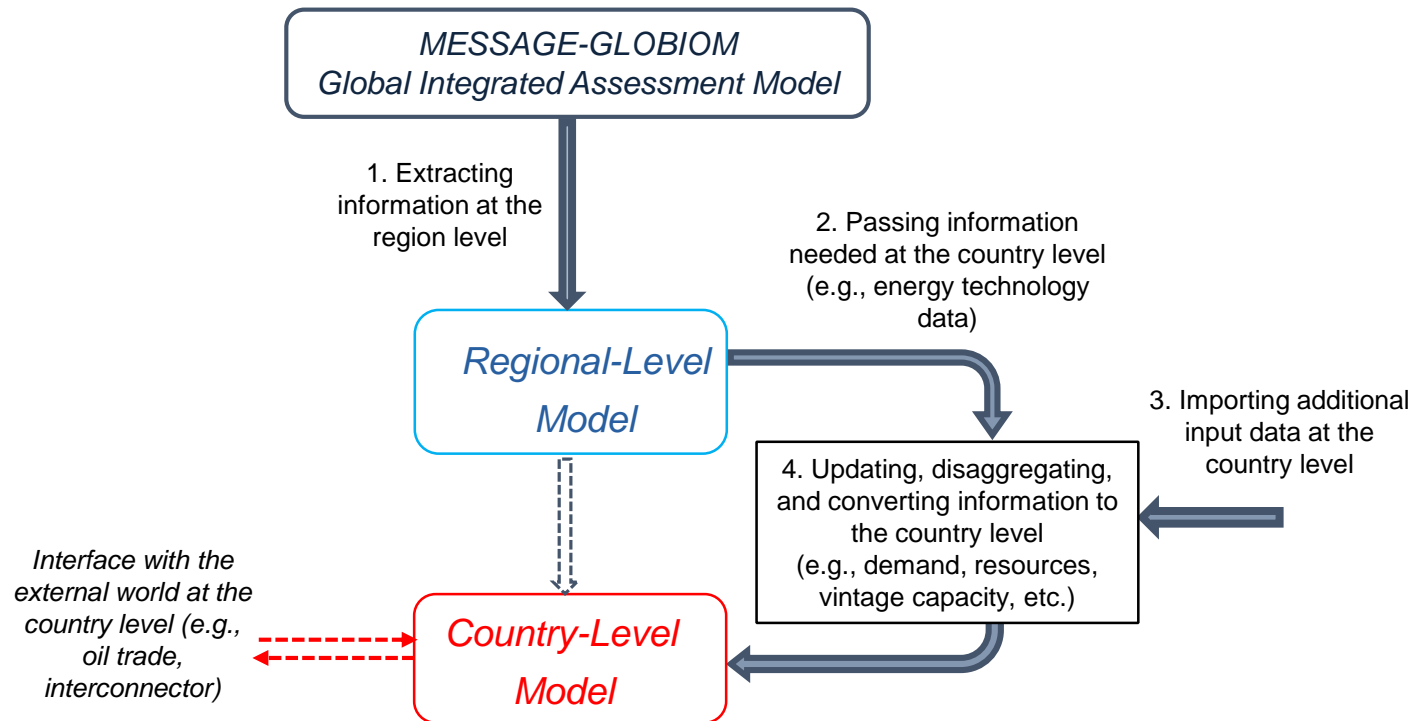
**Top-down:** structure, sets, and parameters from MESSAGE

**Bottom-up:** collecting data at the country level from databases



## Modelling Method (2)

- A combination of a top-down and bottom-up method:



# Required Information for the Mathematical Model

## Sets

- technologies, emissions, relations, categories, levels, commodities etc.

## Parameters

- lifetime, input/output, dynamic growth rates, initial activity, etc.
- Note: demand, historical data, resource volume and costs, renewable potentials

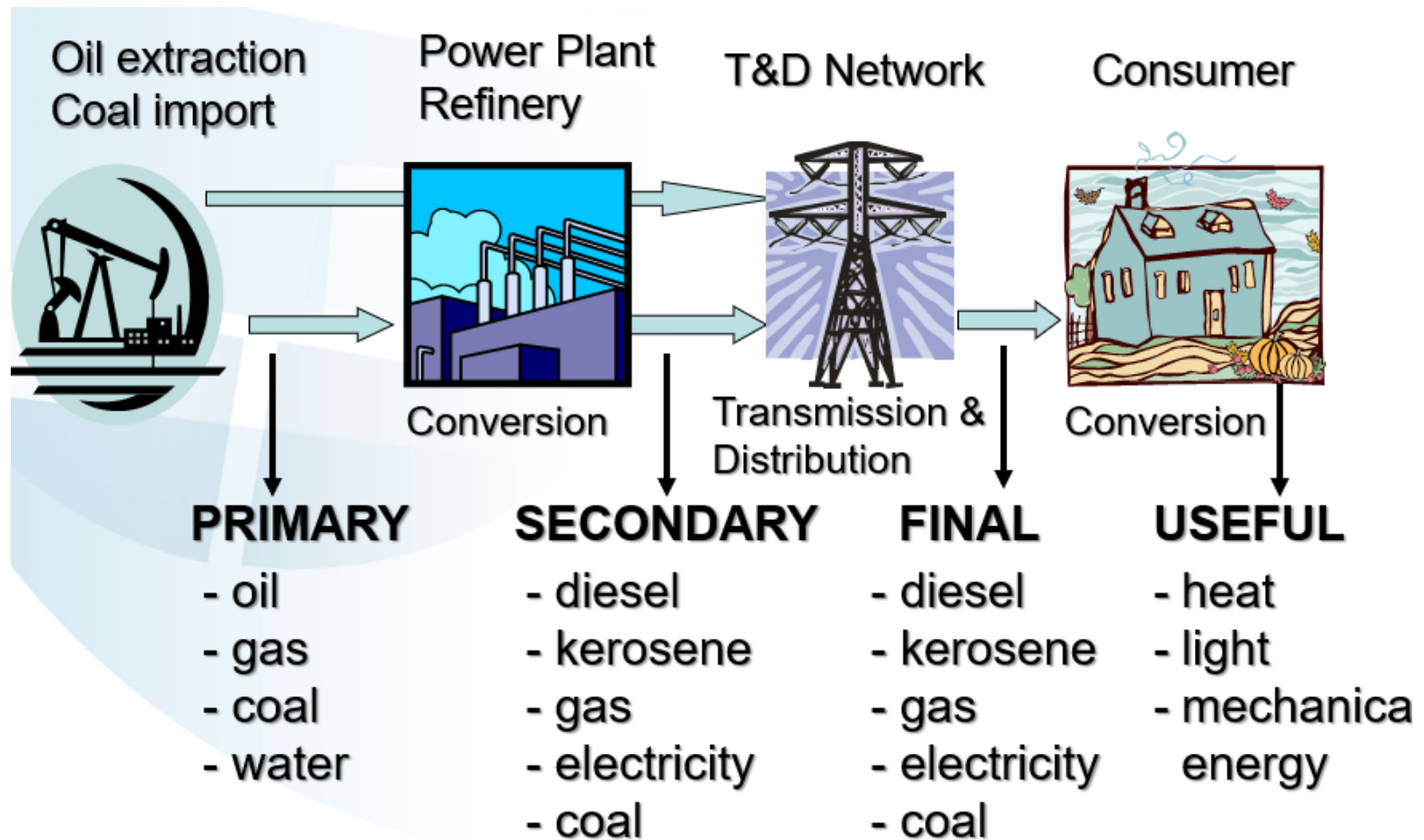
## Energy Trade

- Import and export prices, historical capacities, etc.

## Adjustments

- Bounds, parameters of new technologies, etc.

# Data Requirements



# Modeling Package: MESSAGE Stand-Alone

- Available on Github (please download and test)  
[https://github.com/iiasa/message\\_single\\_country](https://github.com/iiasa/message_single_country)
- Three main components:
  1. Interface
  2. Generic functions (Python files)
  3. Data and settings (Excel files)

iiasa / **message\_single\_country** Private

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behnam2015 Excel data cleaned up and parcopy additions Latest commit cc5652d 15 hours ago

..		
functions	pycatche utilities added	6 months ago
modelData	Excel data cleaned up and parcopy additions	15 hours ago
interface_standalone.py	Excel data cleaned up and parcopy additions	15 hours ago
readme	Update readme	6 months ago

Motivation

Energy model

Data

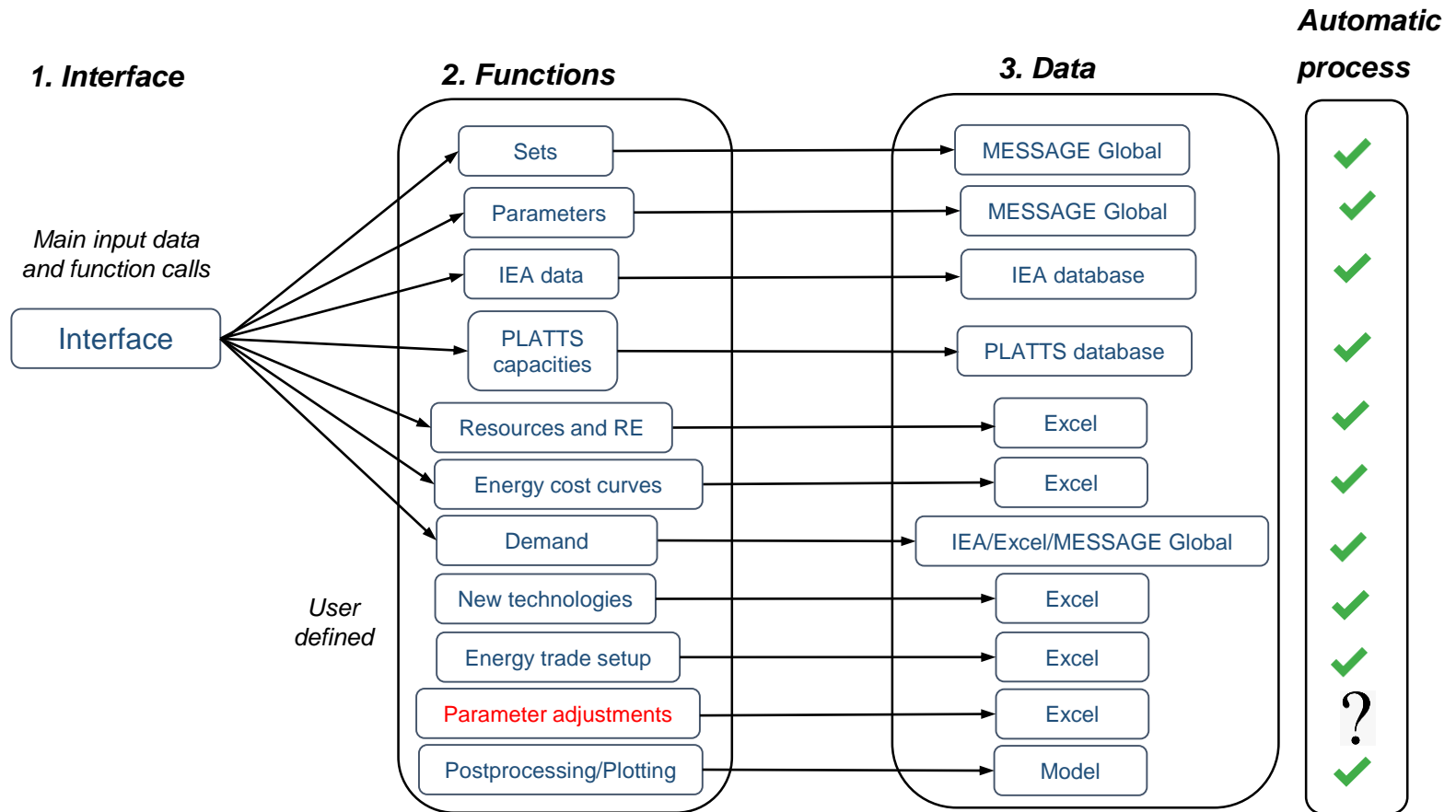
Method

Final Notes



# MESSAGE Stand-Alone: Structure

- Interface for the interacting with functions and databases



# Sets and Parameters from Global MESSAGE

- Sets: excluded the sets related to land use, cooling, water
- Parameters:
  1. Excluded parameters
  2. Copied parameters as they are
  3. Copied parameters to be updated later
- Treatment of bounds and relations
- New implementation of renewable energy resources
- Trade possibilities added and commodity prices decided (import and export)

# Parameters from Global MESSAGE

abs_cost_activity_soft_lo	yes	growth_new_capacity_lo	yes	ref_extraction	n
abs_cost_activity_soft_up	yes	growth_new_capacity_up	yes	ref_activity	n
bound_activity_up	n	historical_extraction	n	ref_new_capacity	n
bound_activity_lo	n	historical_land	n	relation_activity	n
bound_emission	n	initial_activity_lo	yes	relation_cost	yes
bound_extraction_up	n	initial_activity_up	yes	relation_lower	yes
bound_new_capacity_up	n	initial_new_capacity_up	n	relation_upper	yes
capacity_factor	yes	input	yes	resource_cost	yes
construction_time	yes	interestrate	yes	relation_total_capacity	n
commodity_stock	n	inv_cost	yes	resource_remaining	yes
dynamic_land_up	n	land_cost	n	resource_volume	yes
emission_factor	yes	land_emission	n	soft_activity_lo	yes
emission_scaling	yes	land_output	n	soft_activity_up	yes
fix_cost	yes	land_use	n	soft_new_capacity_lo	yes
fixed_land	n	level_cost_activity_soft_lo	yes	soft_new_capacity_up	yes
growth_activity_lo	yes	level_cost_activity_soft_up	yes	tax_emission	yes
growth_activity_up	yes	operation_factor	yes	technical_lifetime	yes
growth_land_scen_lo	n	output	yes	var_cost	yes
growth_land_up	n				

Motivation

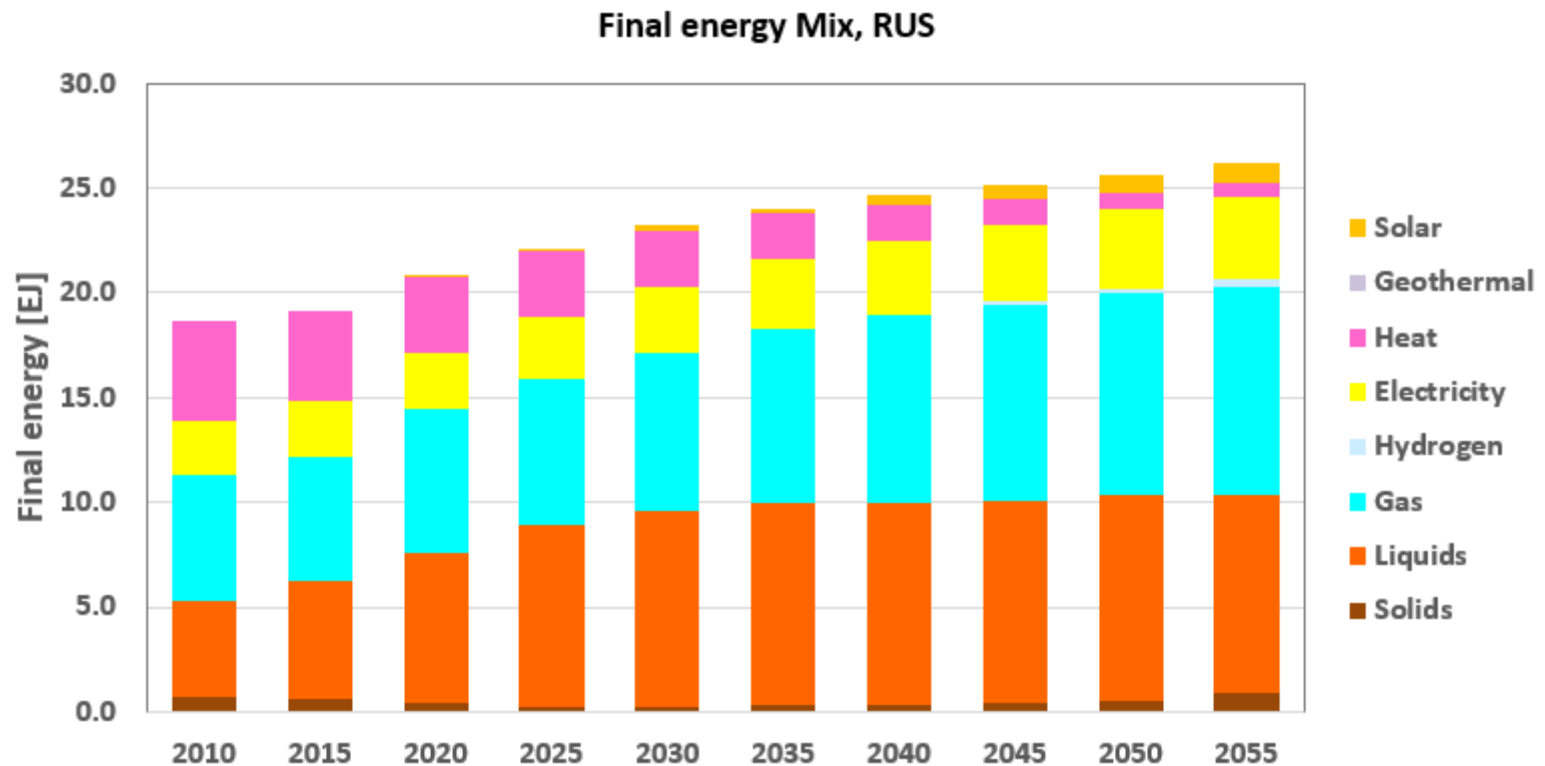
Energy model

Data

Method

Final Notes

# Results: Russian Federation (Final Energy)



Motivation

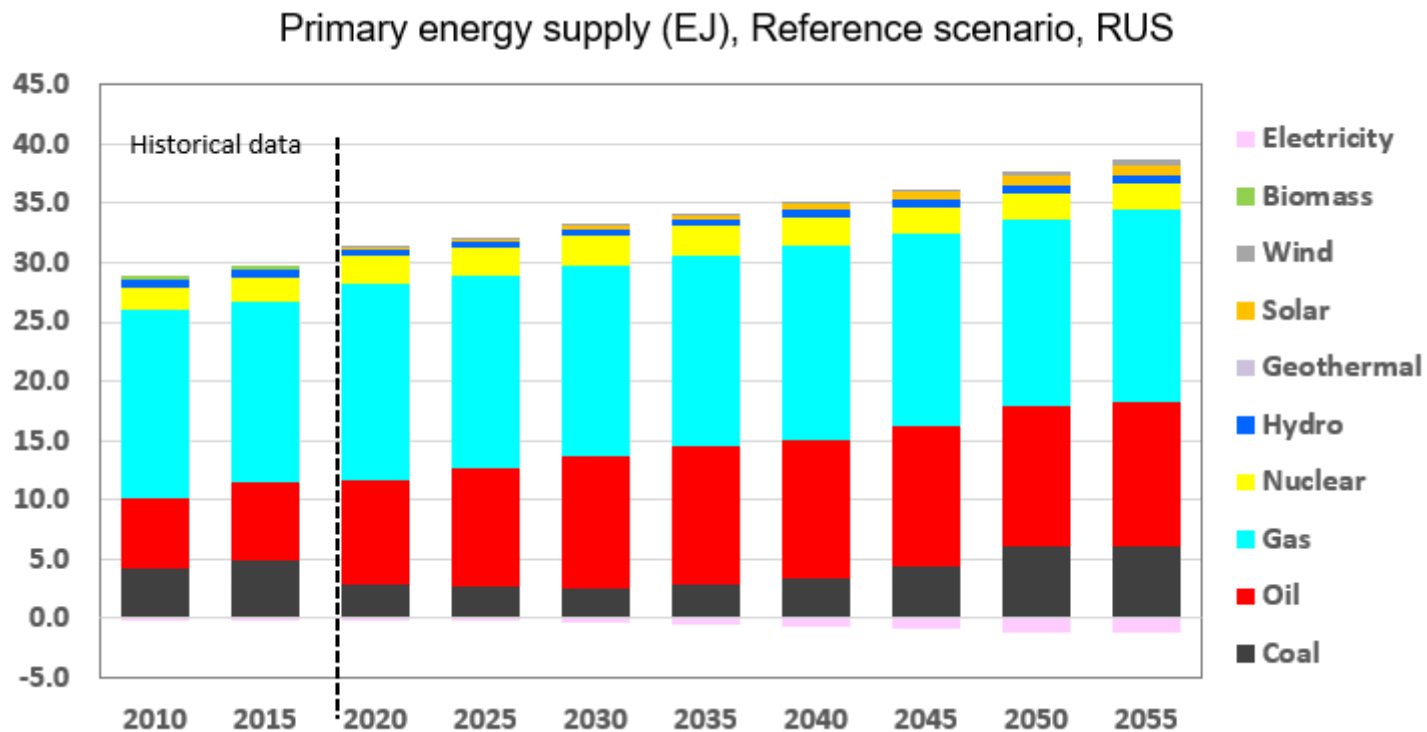
Energy model

Data

Method

Final Notes

# Results: Russian Federation (Primary Energy)



Motivation

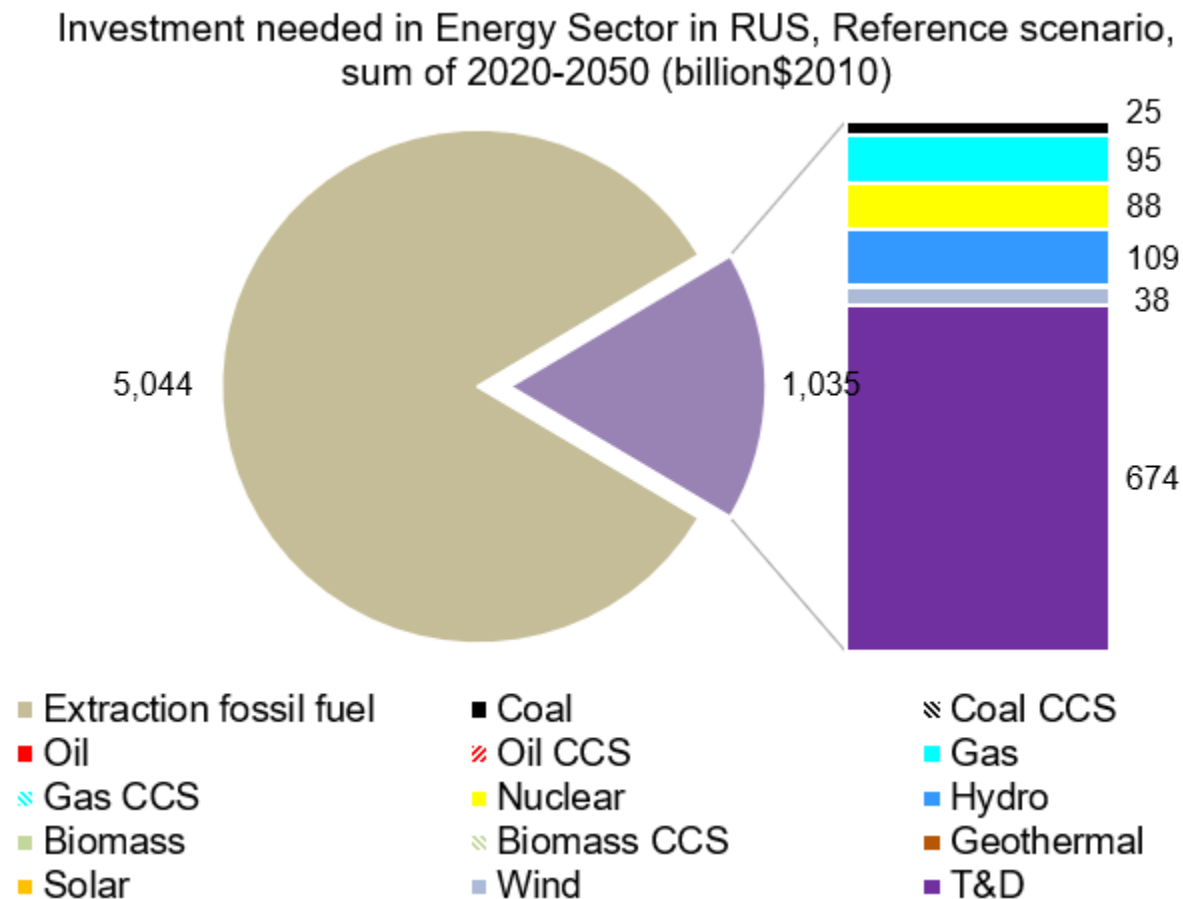
Energy model

Data

Method

Final Notes

## Results: Russian Federation (Investment)



Motivation

Energy model

Data

Method

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# Questions

- Automatization of the remaining processes
- The possibilities for data repository
- Treatment of main time steps (possible down to yearly time steps)
- Treatment of sub-annual time steps and data
- Defining other requirements for a national level model
- Treatment of additional sectors and details

Thank you for your attention and feedback!

Motivation

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International Institute for  
Applied Systems Analysis