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NATIONAL OPEN ACCESS SCIENTIFIC CENTRE FOR FUTURE ENERGY TECHNOLOGIES

OPEN R & D LITHUANIA

# TECHNOLOGY BASED MODELLING OF ECONOMY DECARBONISATION

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# Content of presentation

Overview of the energy and environmental situation in Lithuania

Presentation of the concept for analysis of economy decarbonisation

Overview of separate models to be used

Presentation of modelling and result examples

# Energy and environmental situation in Lithuania

# LITHUANIA: Key figures


| | |
|---|---|
| Area: | 65,300 km$^2$ |
| Population*: | 2,794,329 |
| GDP (nominal)* | 56 billion USD |
| GDP (PPP)*: | 107 billion USD |
| EU member: | since 2004 |

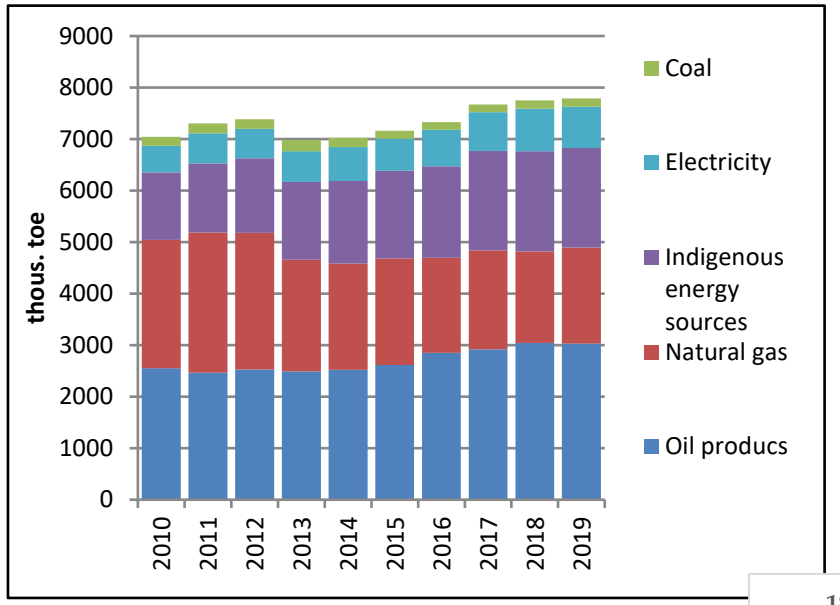
Climate: temperate with both maritime and continental influences

Average temperatures in Vilnius:
−6 °C (21 °F) in January and
17 °C (63 °F) in July

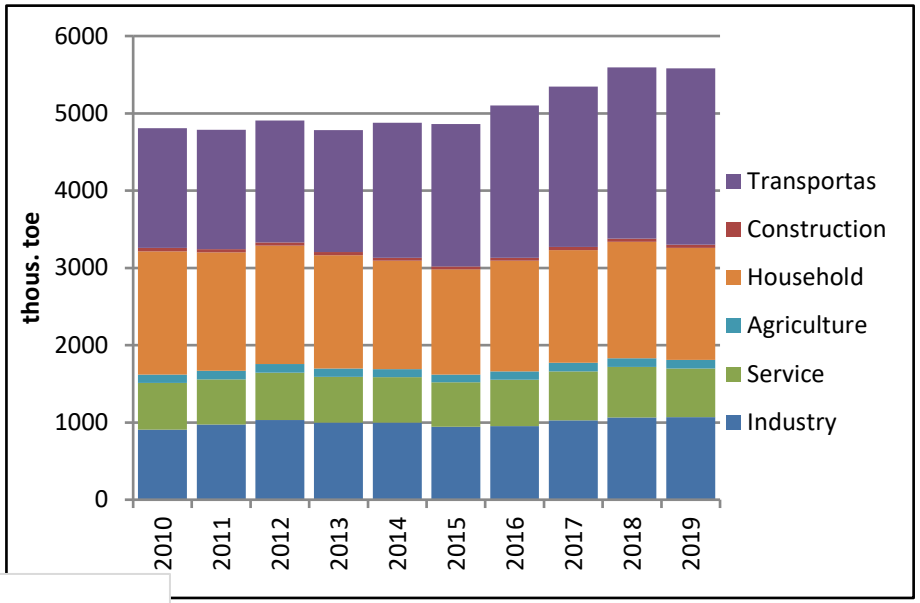
* - 2020 estimate

# Energy demand and production

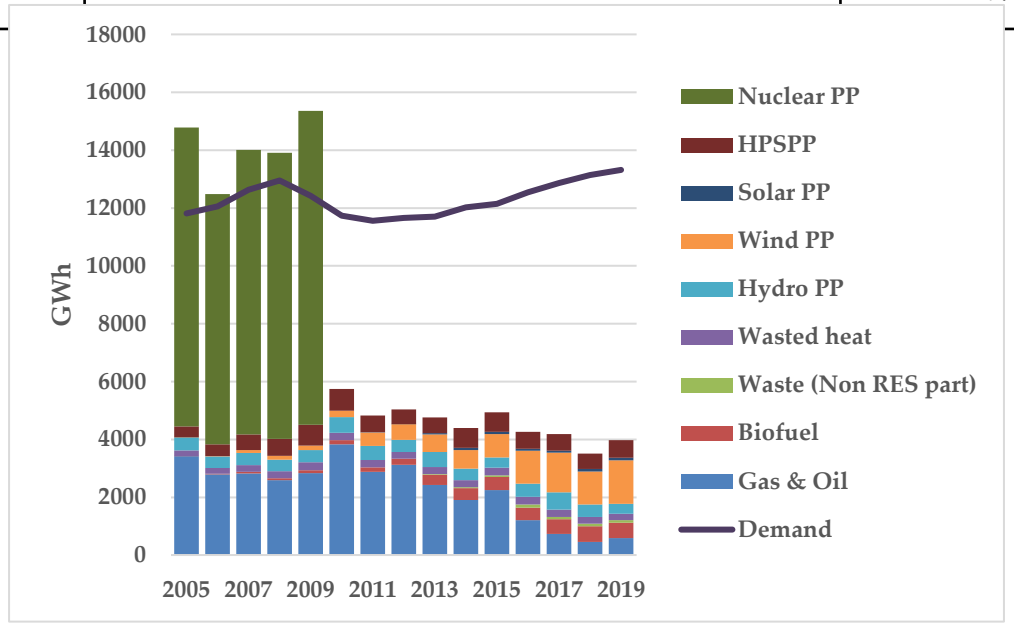
## Primary energy requirements




## Final energy



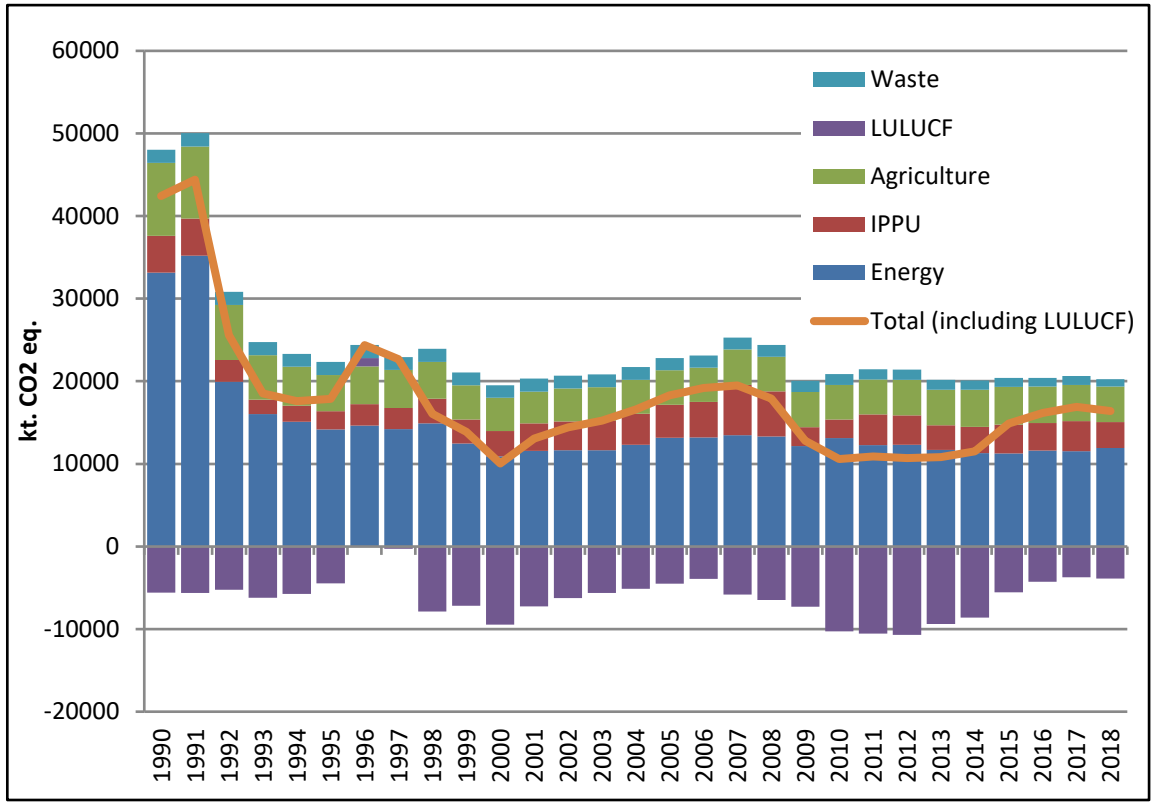

## Electricity generation



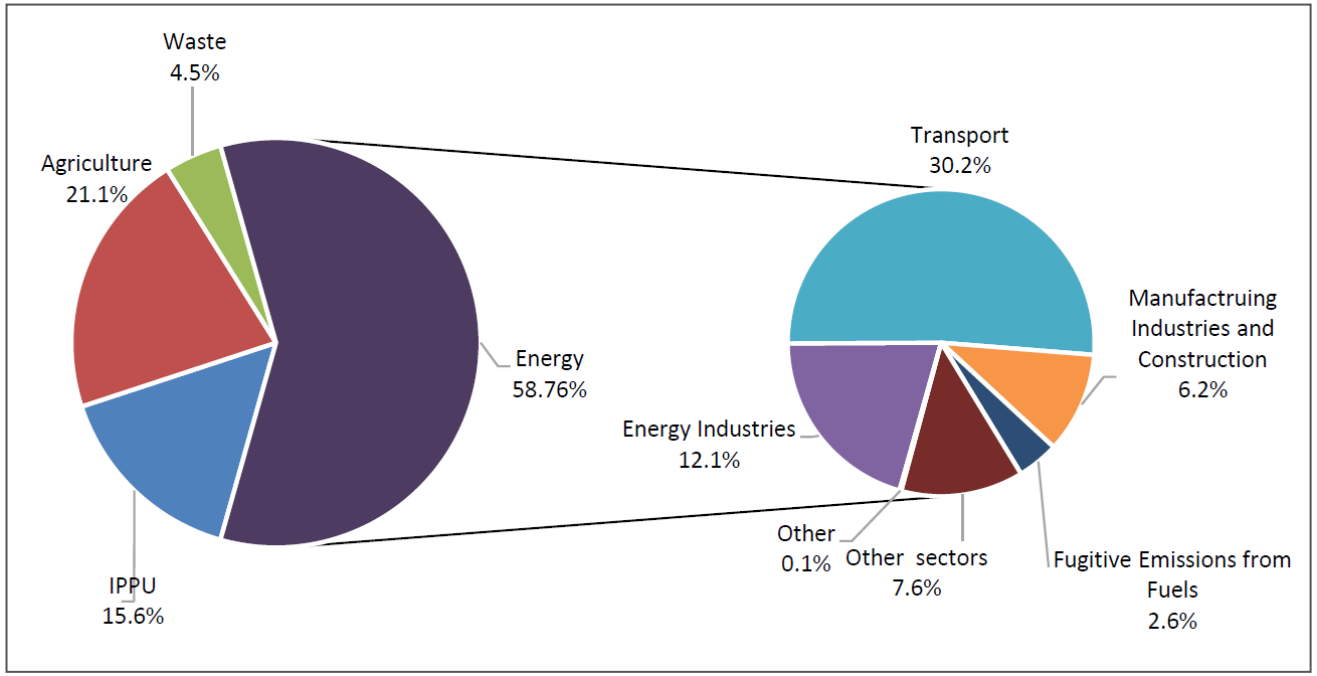

Source: Department of statistics

# GHG emissions in Lithuania

## Dynamics of GHG emissions




## The composition of Lithuanian GHG emissions (CO2 eq.) by sectors (excl. LULUCF) in 2018




Source: Lithuania‘s national inventory report 2020

# GHG reduction targets

| | ETS | Non ETS |
|---|---|---|
| **2008-2012** | -8% compared to 1990 levels | |
| **2020** | -21 % compared to 2005 levels | +15 % compared to 2005 levels |
| **2030** | -43 % compared to 2005 levels* | -12 % compared to 2005 levels* |
| **2050** | Reduced by 80-95% compared to 1990 levels* | |

***Remarks:***

***** GHG reduction limits for EU member states for 2030 and 2050 have not yet been formally approved.

# Energy strategy goals


| | 2020 | 2030 | 2050 |
|---|---|---|---|
| RES share in total final energy consumption | 30% | 45% | 80% |
| RES share in district heating | 70% | 90% | 100% |
| RES share in transport | 10% | 15% | 50% |
| RES share in electricity consumption | 30% | 45% | 100% |
| Domestically produced electricity | 35% | 70% | 100% |

Translated from https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.429490/asr

# Concept for analysis of economy decarbonisation

# DECARBONISATION: General principles applied

Decarbonisation of economy is analysed **in the context of economy sectors development** and implementation of emission reduction measures and policies

Development of **individual economic sectors is closely interlinked**. (These interlinkages are also strongly highlighted in the provisions of Energy Union of the EU). Interlinkages are taken into account when preparing suitable models for decarbonisation analysis

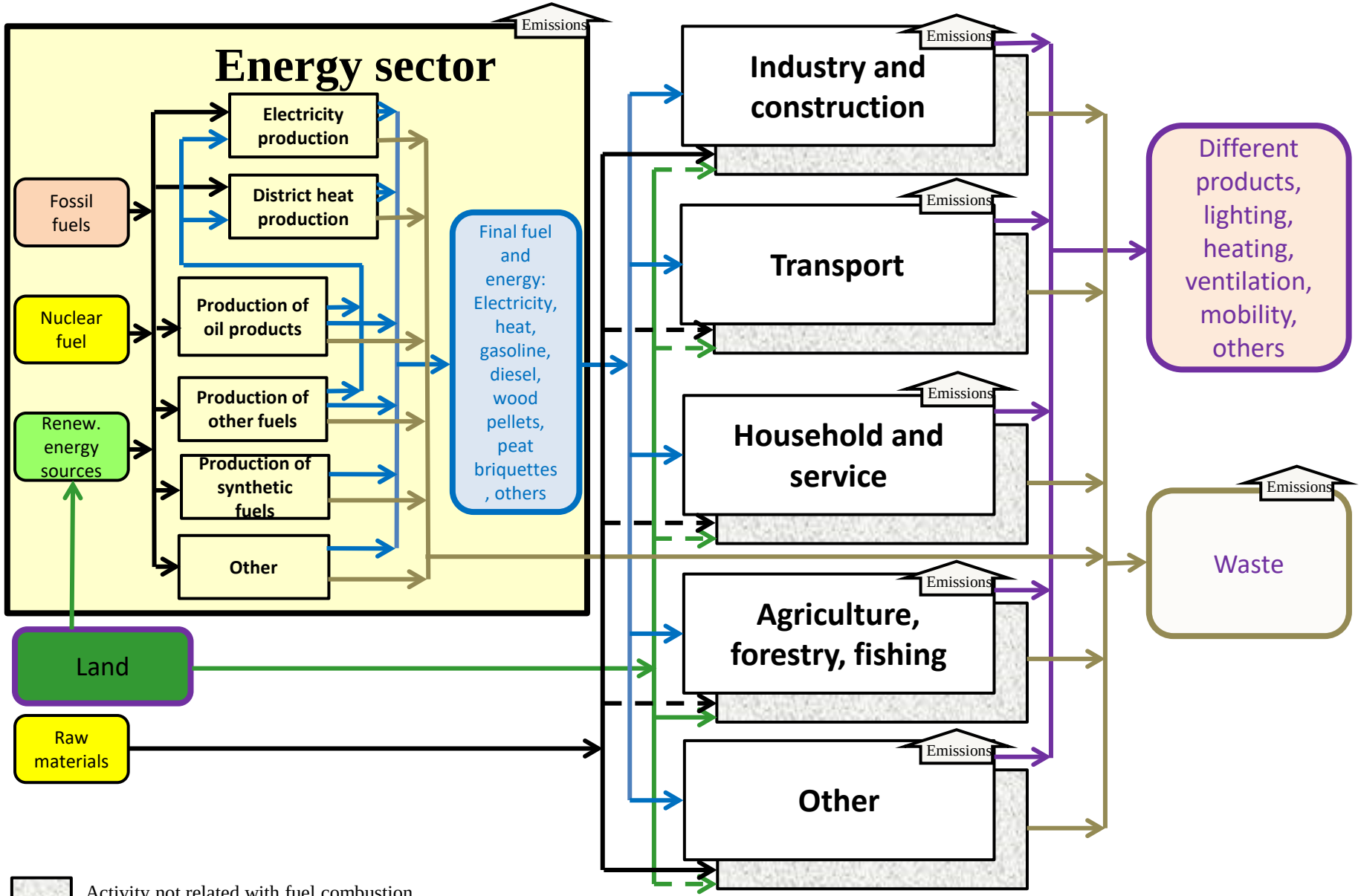
**Botom-up** modelling approach is used

Current situation in terms of **experience and information availability**, as well as expected opportunities are taken into account

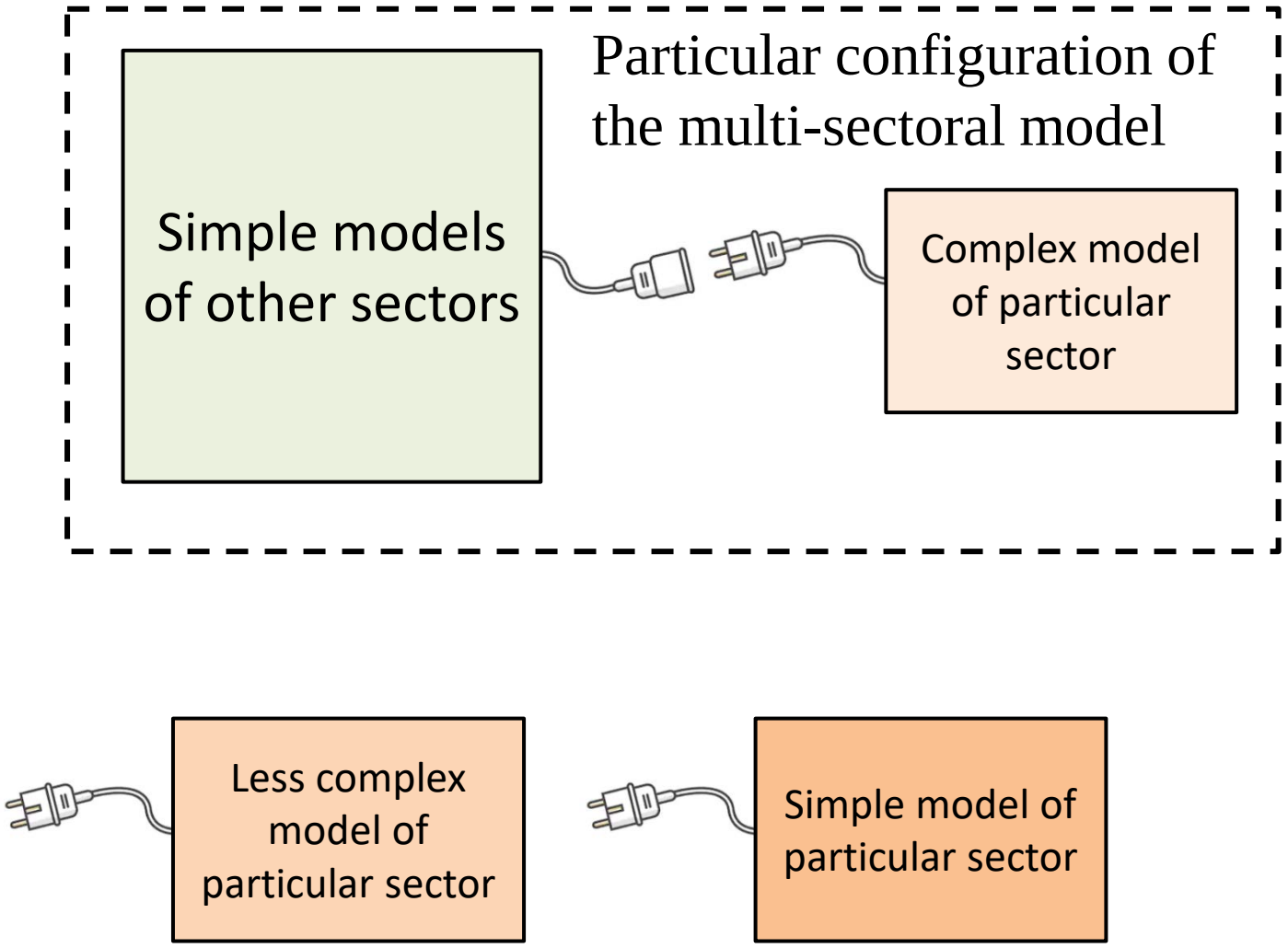
**Gradual improvement** of used tools and development of the new ones is foreseen in order to elaborate rational strategy of decarbonisation of the country's economy

Counting of **GHG emissions is based on the modelled activities of individual technologies**. A distinction is made between the emission trading and non-trading sectors. Different emission control measures are used in these sectors

# Flowchart of mathematical models



# Possible settings of the multi-sectoral model

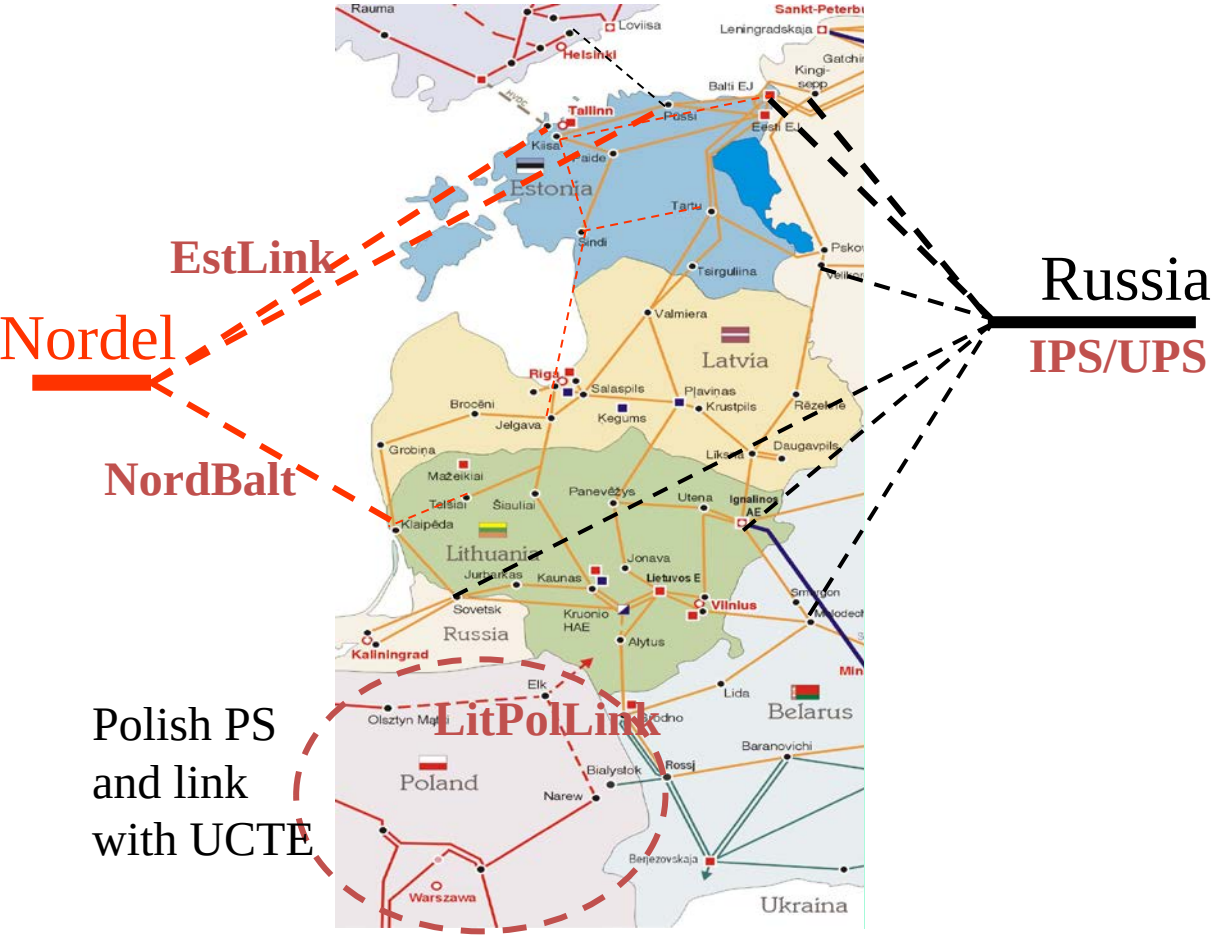



Mathematical models representing separate sector will have few complexity stages.

A higher-detail mathematical model representing a single sector, combined with lower-detail models from other sectors, will allow for a more detailed analysis of the selected sector, maintaining links with other sectors and only slightly increasing the size of the whole multi-sectoral mathematical model.

# Overview of separate models

# Energy sector




Main focus is given to electricity and district heating systems. These systems are represented in big details

Significant attention is given to:

- balancing of RES electricity generation
- provision of all types of reserves
- security of energy supply
- synchronization of electricity system with the system of Continental Europe

Options for production, import and export of all types of fuels and energies are represented (including power to gas options)

# Industry and construction

**Industries represented:**

- Chemicals and chemical products
- Food products
- Non - metallic mineral products
- Construction materials
- Paper and paper products
- Other

**Processes within industries:**

- Thermal processes
- Cold production
- Mechanical power
- Space heating, conditioning, hot water preparation
- Lighting and office appliances
- Other processes

**Construction** (simple way)

# Transport

**Passenger transport** (Road, rail)

Road: Travel mode (short, long distance)
Type (public, individual)
Vehicle classes (A-B, B-C, D-E, J)
Fuel used (diesel, gasoline, SNG, electricity, hydrogen)
Age of the fleet (age distribution)
Travel time budget

Rail: Fuel type (diesel, electricity)

**Freight transport** (Road, rail)

Fuel used (diesel, SNG, electricity, hydrogen)

**Water transport**

**Aviation**

# Household and service

**Processes represented**:

Space heating
Hot water preparation
Air conditioning
Cooking
Lighting and appliances

**Factors taken into account**:

Urban and rural
Connection to system of district heat supply
Availability of natural gas supply infrastructure
Types of fuels and energy
Support schemes

# Agriculture and forestry

**Agricultural production** (Energy crops, rye, wheat, maize, oilseed rape, etc.)

Factors taken into account:

Land use

Soil type

Agricultural technologies

**Forestry**

Factors taken into account:

Land use

Soil type

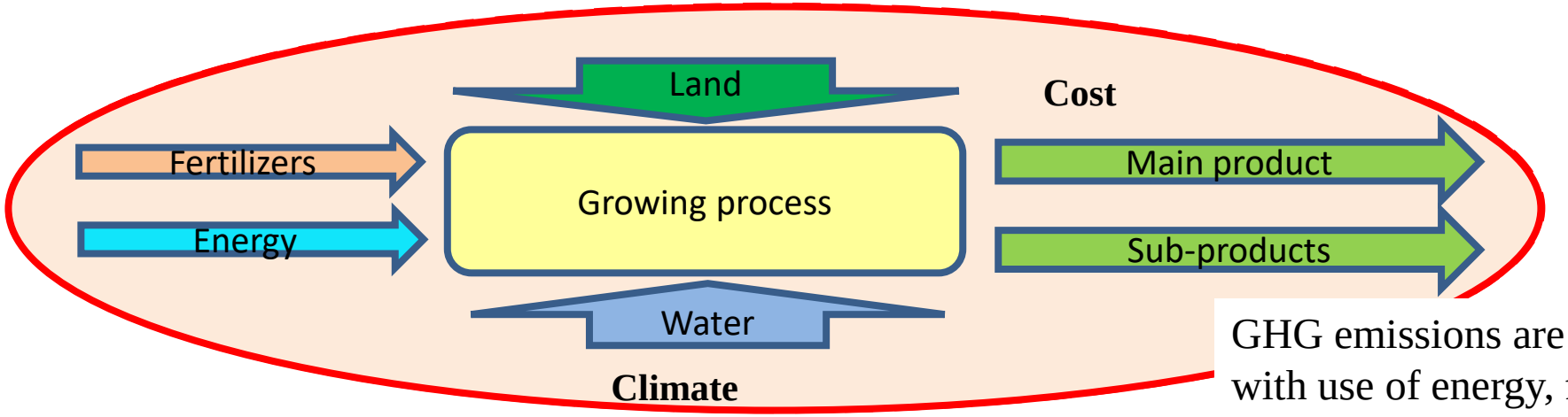
Forest type (spruce, pine, mixed, fast-growing shrubs)

**Livestock** (Raising of cattle, pigs, sheep, poultry, etc.)

Feeding rations are taken into account

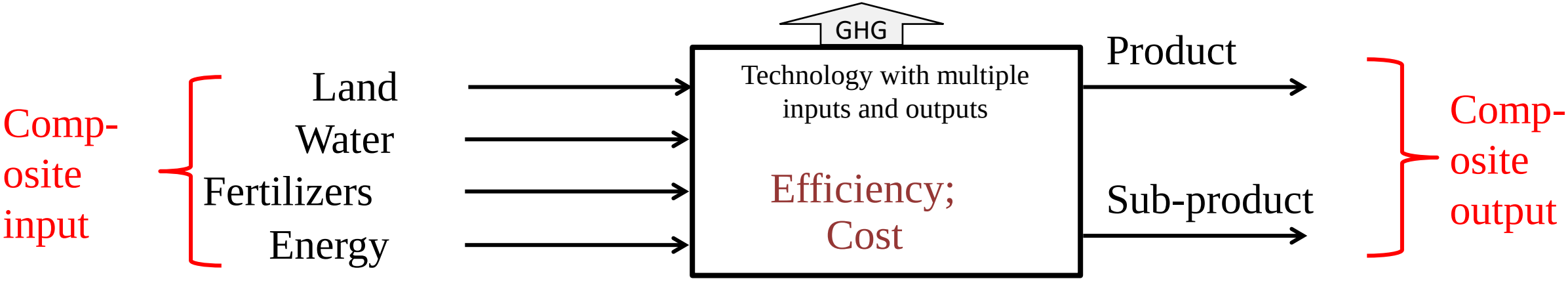
# Modelling and result examples

# Modelling of growing agricultural product (1)




GHG emissions are associated with use of energy, fertilizers and changes in soil.

## Representation as technology in the mathematical model

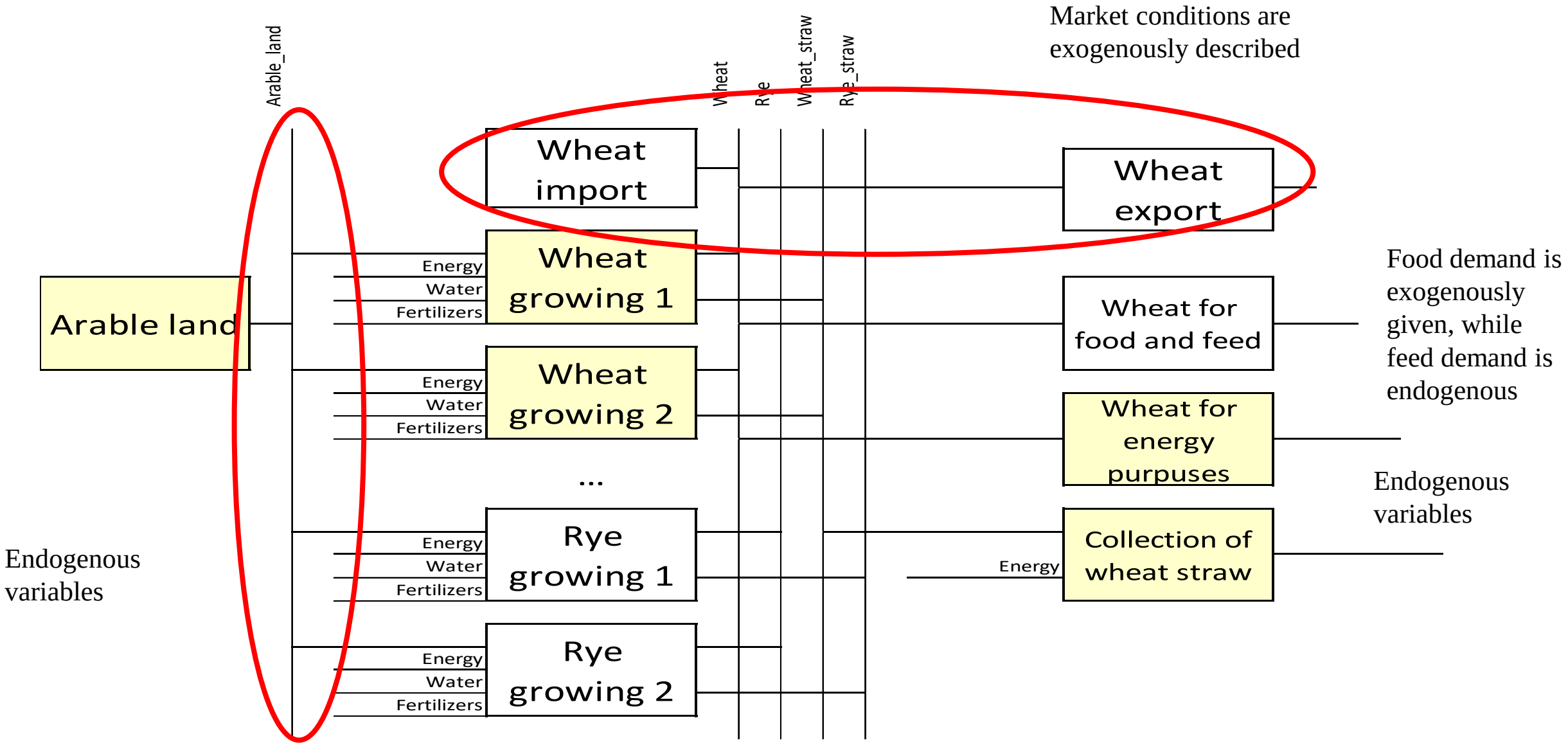



$$\text{Efficiency} = \frac{\text{Main product}}{\text{Land}}$$

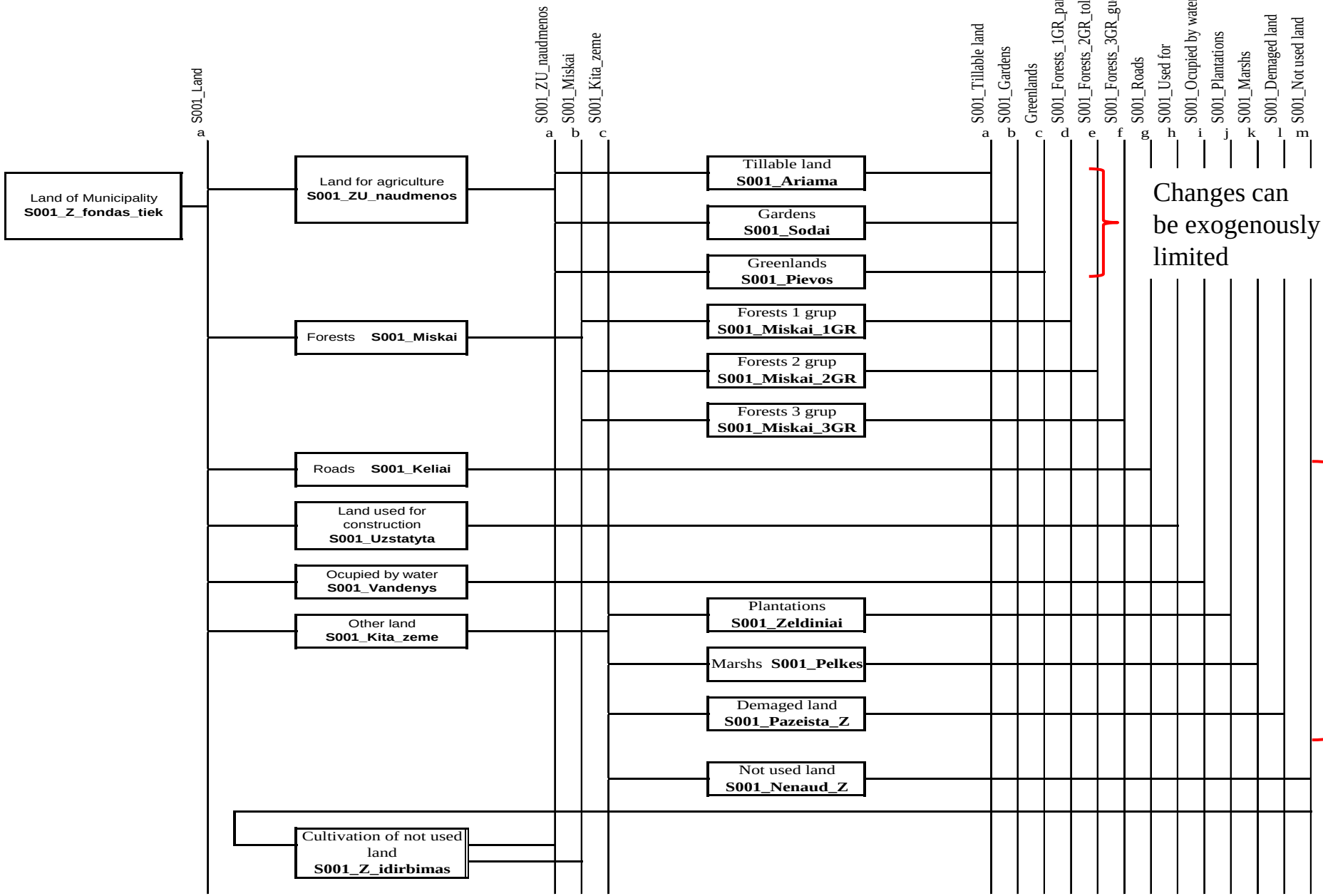
Depend on climate

$$\text{Cost} = \frac{\text{Growing cost}}{\text{Main product}}$$

# Modelling of growing agricultural product (2)



# Land balance (example)



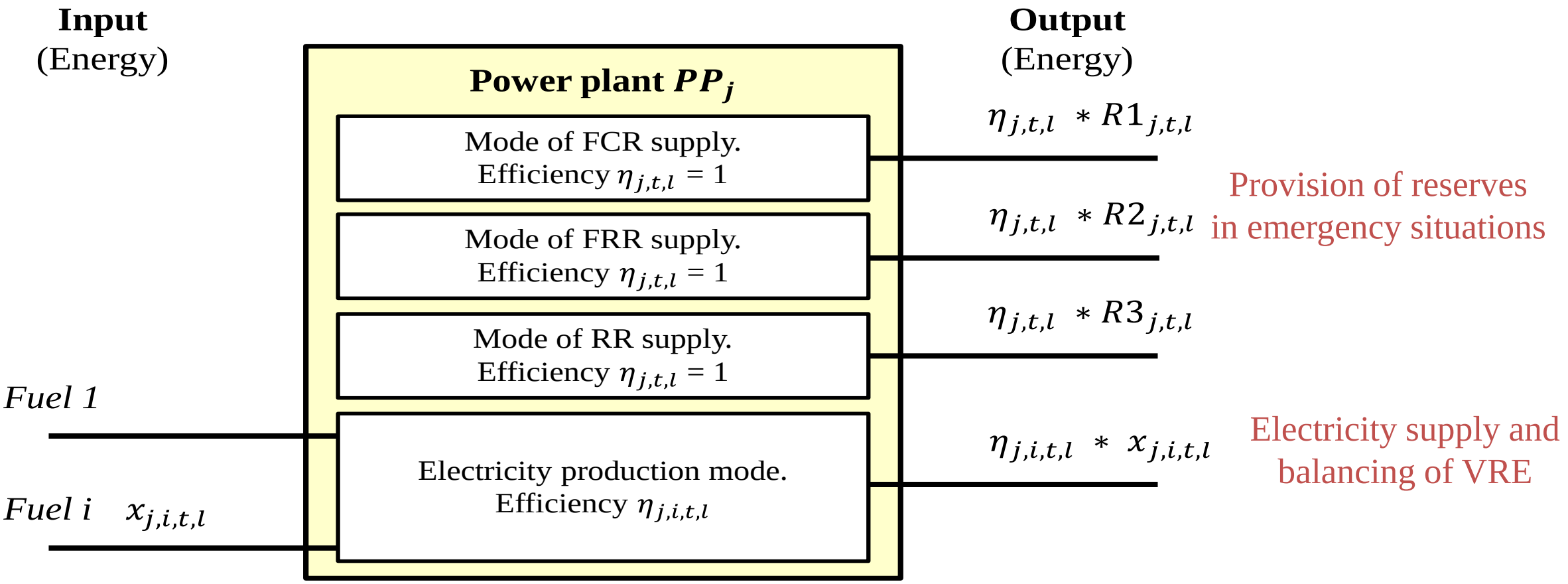
# Energy sector. Reservation issues addressed

| | | |
|---|---|---|
| How much it is necessary to have | FCR?<br>FRR?<br>RR? | Depend on biggest disturbance possible |
| How much it is necessary to have locally | FCR?<br>FRR?<br>RR? | Depend on normatives of systems |
| How much it is possible to get from | UCTE?<br>NORDEL?<br>IPS/UPS? | Depend on througput capacity of links, import-export flows, type of links |

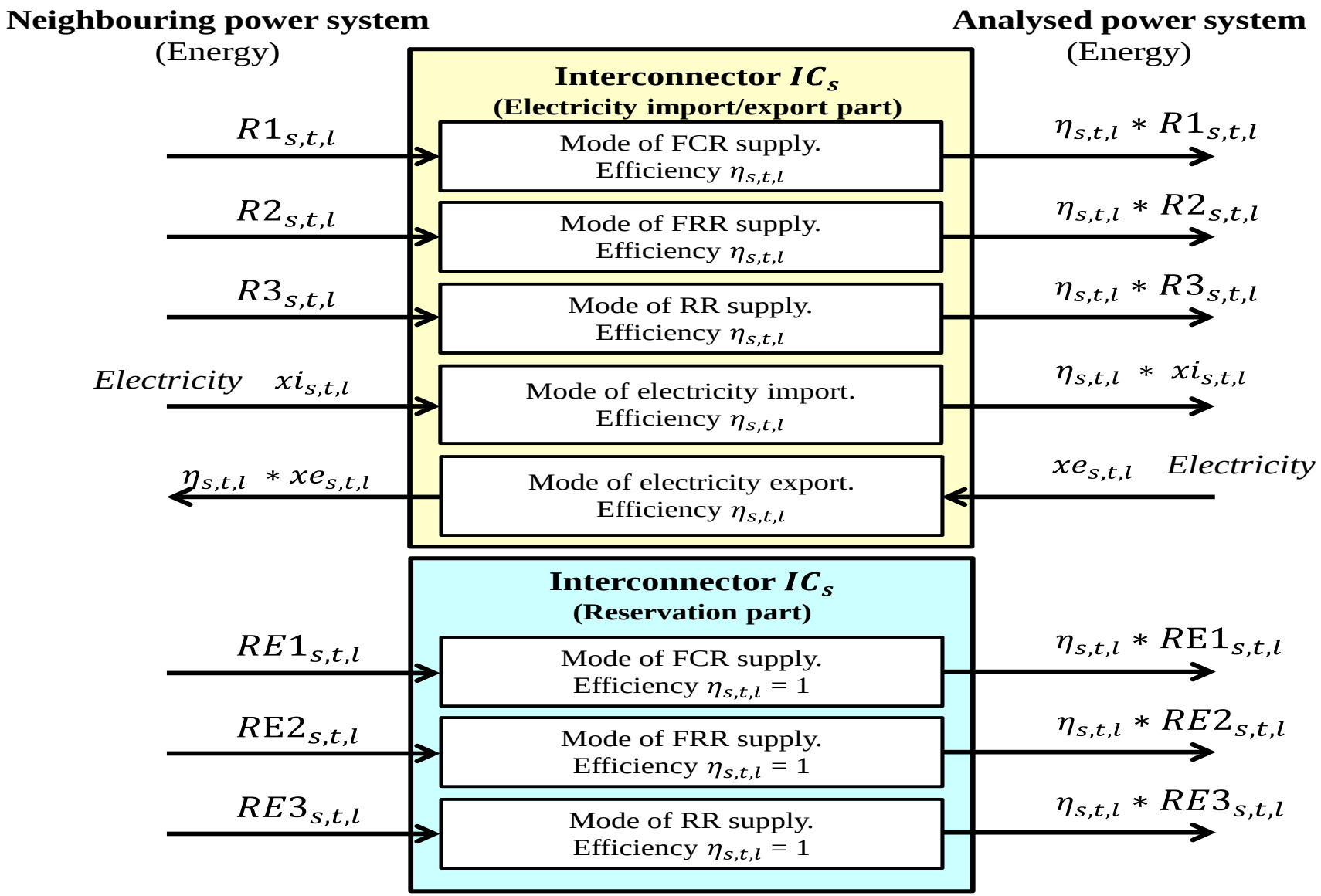
**Where, when, how big and what kind of reserve capacity should be located?**

**What should be structure of power plants, their load, import-export of electricity in order to fulfill all this?**

# Energy sector. Representation of single power plant



# Energy sector. Representation of interconnectors

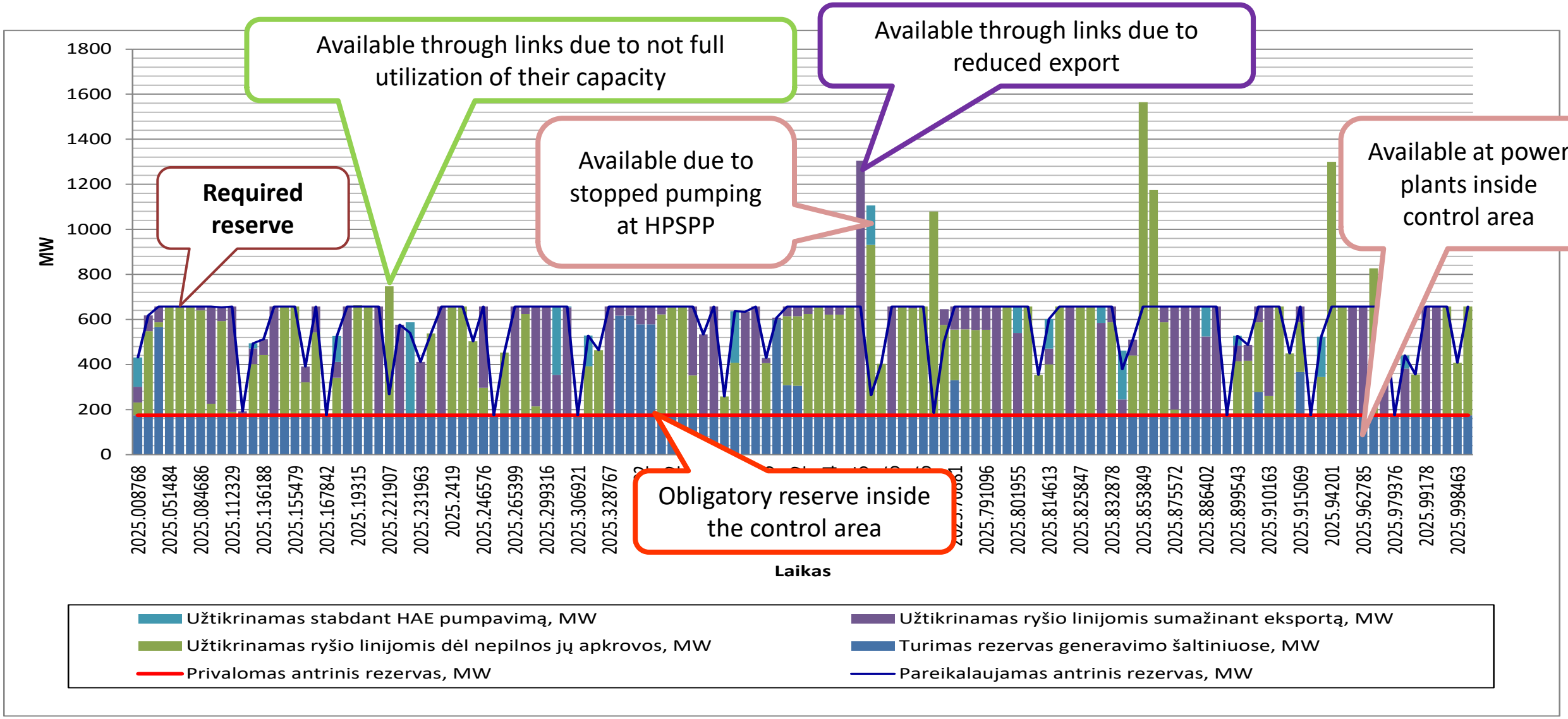



Provision of reserves in electricity import regime

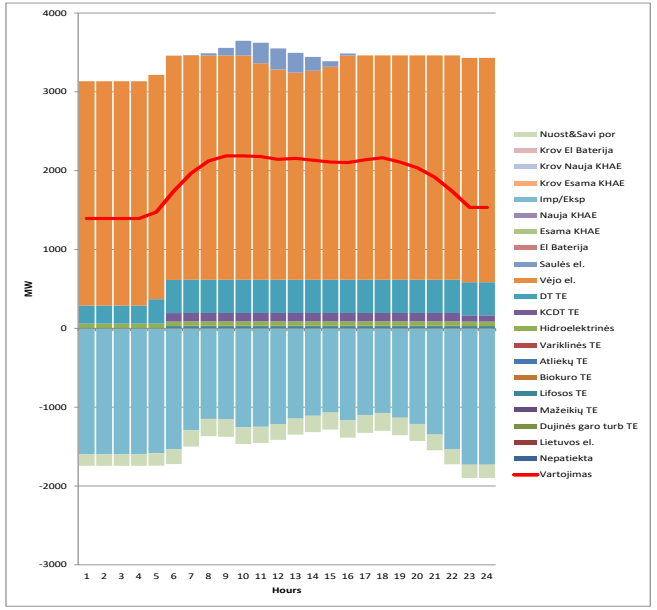
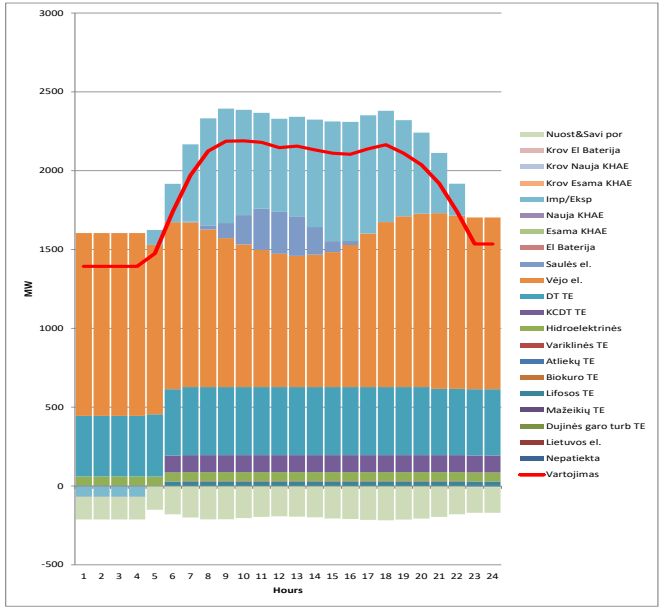
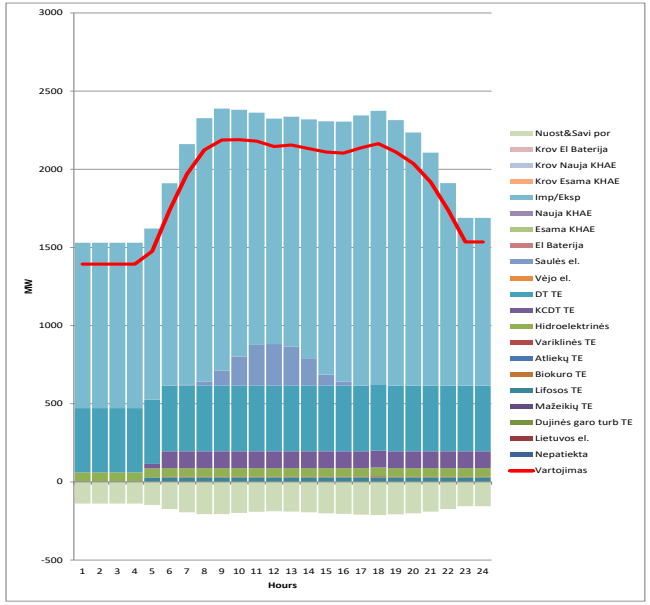
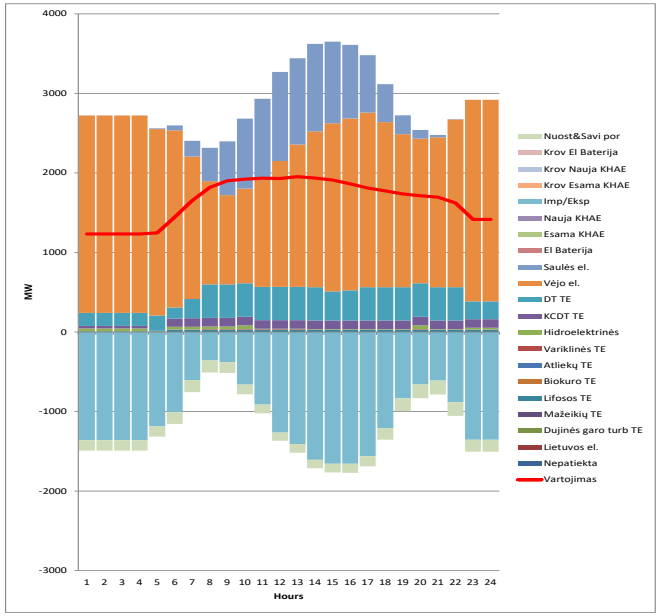
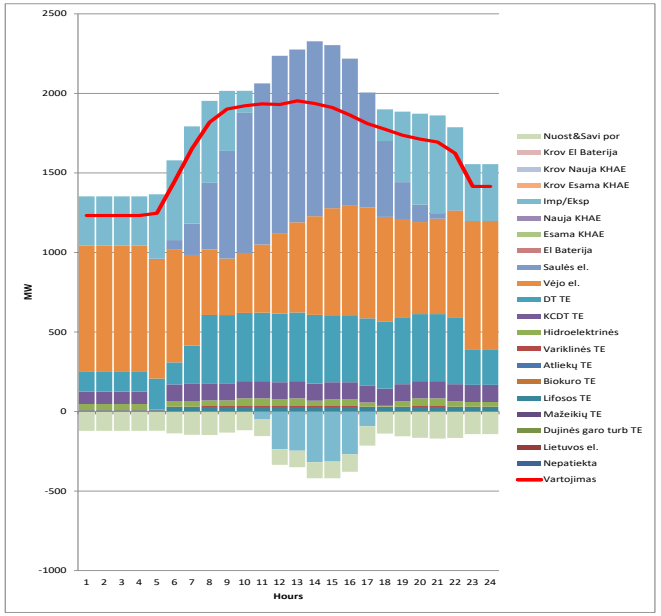
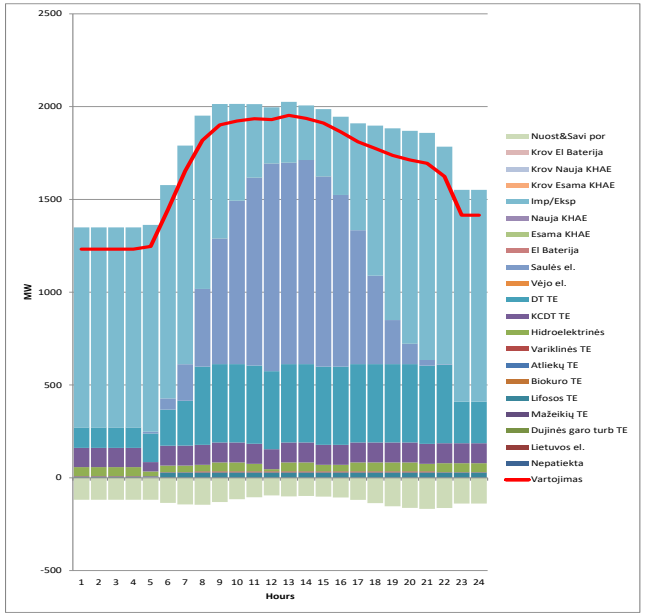
Import/export of electricity and balancing of VRE

Provision of reserves in electricity export regime

# Provision of FRR (Example)



# Operational regimes of power plants (example)

| | Strong wind | Moderate wind | No wind |
|---|---|---|---|
| Winter working day |  |  |  |
| Summer working day |  |  |  |

# Thank you for your attention

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