

# OpenModelica use for forecasting in the MegaGame Energy Project

Lena Buffoni  
(LiU)

# Att vända strömmen (Switching the current)

## Att Vända Strömmen

Energisystem

Gestaltning

Klimat

Målkonflikter

Medborgardeltagande

Näringsliv

Samhälle

Scenarier

A cross disciplinary project between Linköping University, Högskolan i Skövde and Jönköping University

"The project aims to create increased understanding of different stakeholders' perspectives on energy systems, society, environment and climate "



2024-02-05

2

# Learning together

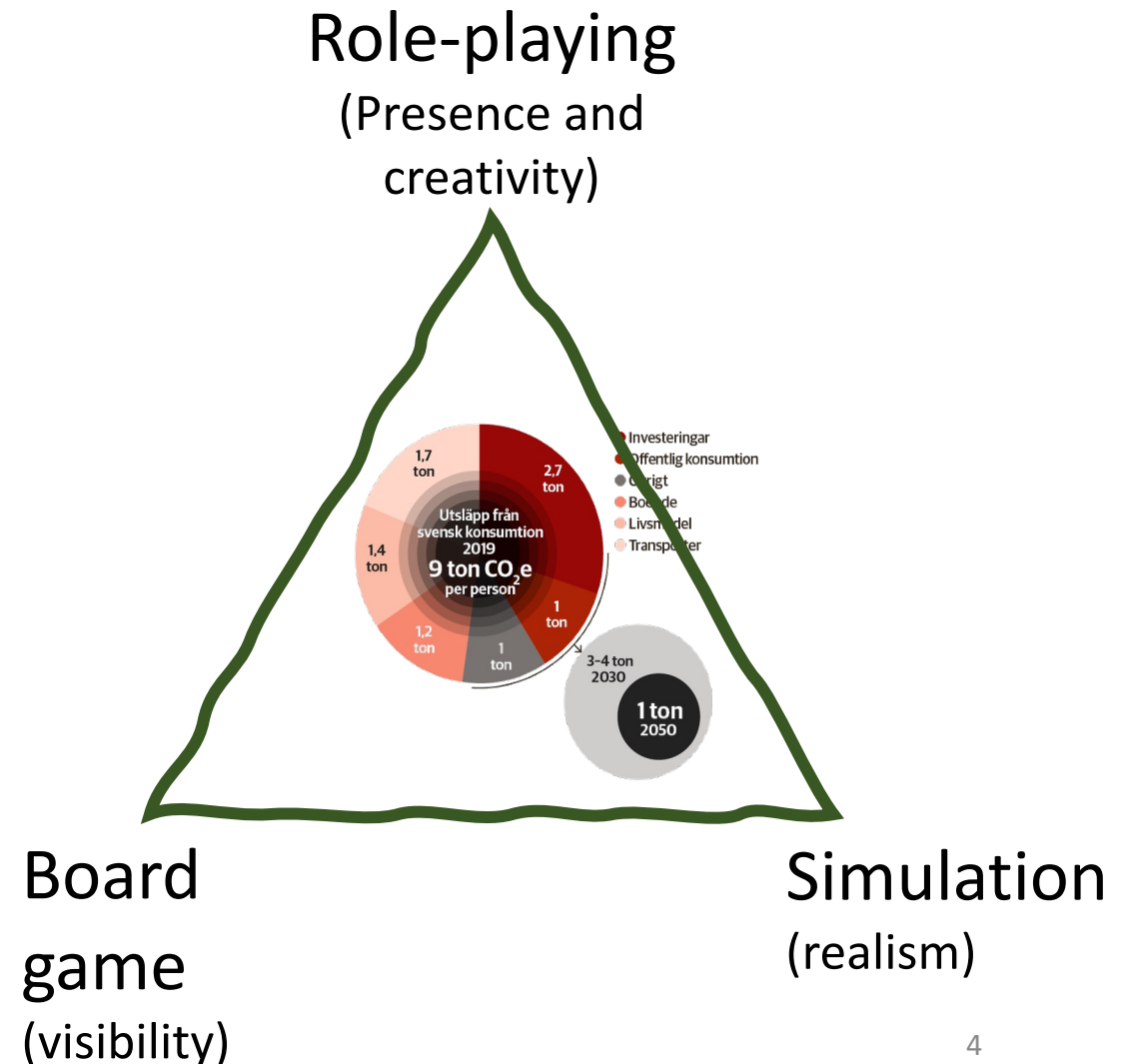
- The first step to a sustainable future is understanding the different perspectives and conflicts and getting a better overall view of the complexity of energy systems
- Mega game = game with 20-100 participants



# Switching the current as a serious game

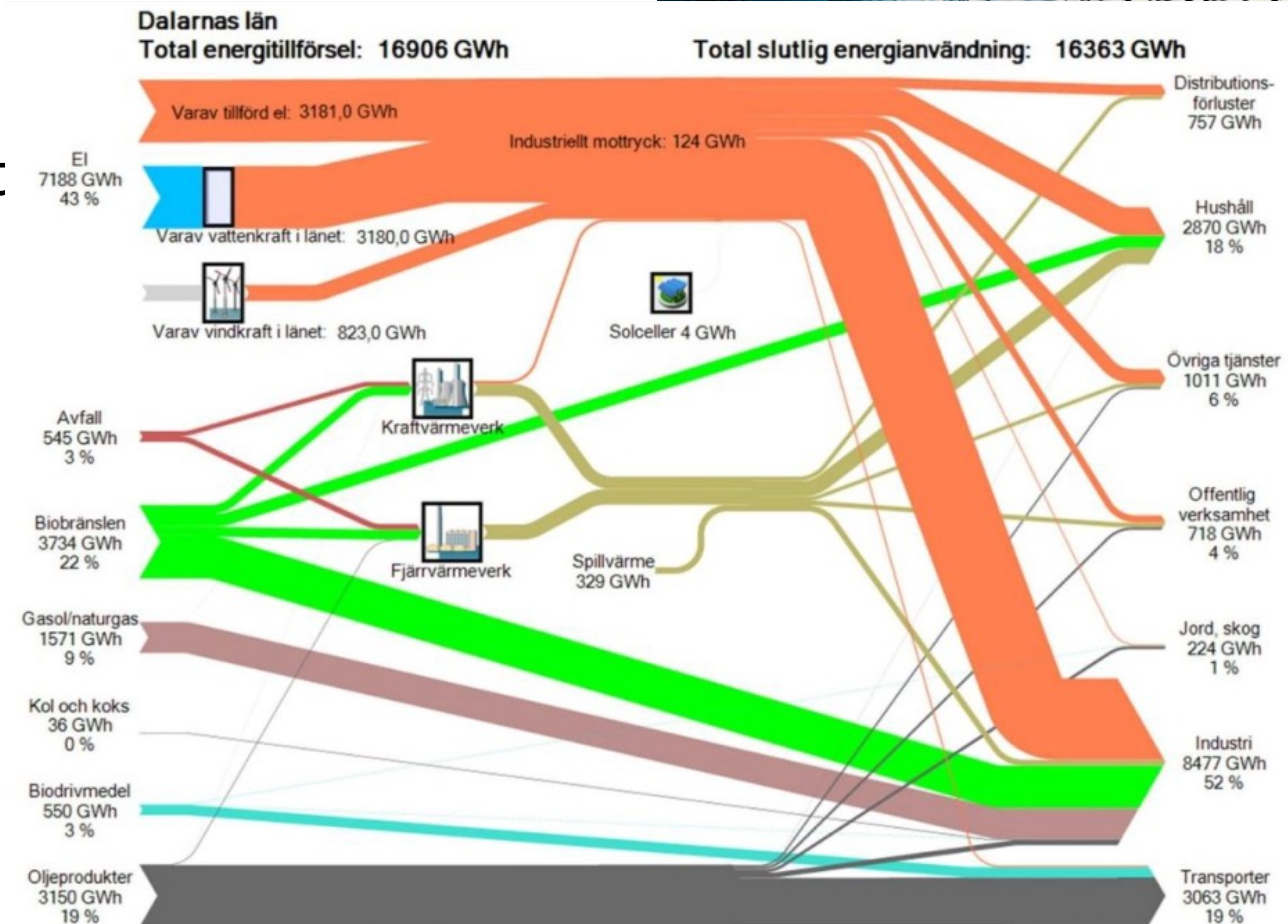
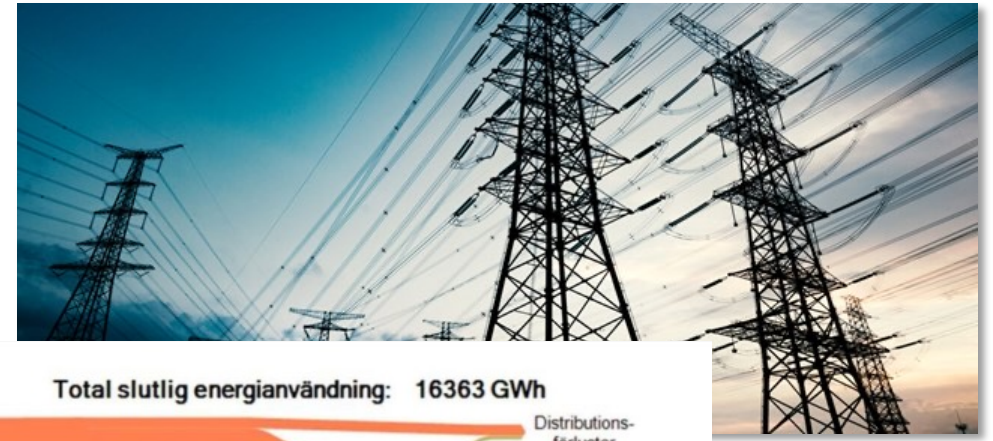
- *Serious games* are primarily designed for more than just having fun
- The goal is ...
  - Create an experience of transformation
  - That visualize relations, challenges and possibilities
  - And create arenas for creative encounters
- Make perspectives and interests visible
- Therefore *mega-game*
- Therefore a region

2024-02-05



# Understanding the scale

- Making sustainable decisions means understanding the impact of our choices on a large scale
- The simulation is built on the data collected from the game as well as region specific data
- The simulation is also built on theoretic scenarios from academia on future trends

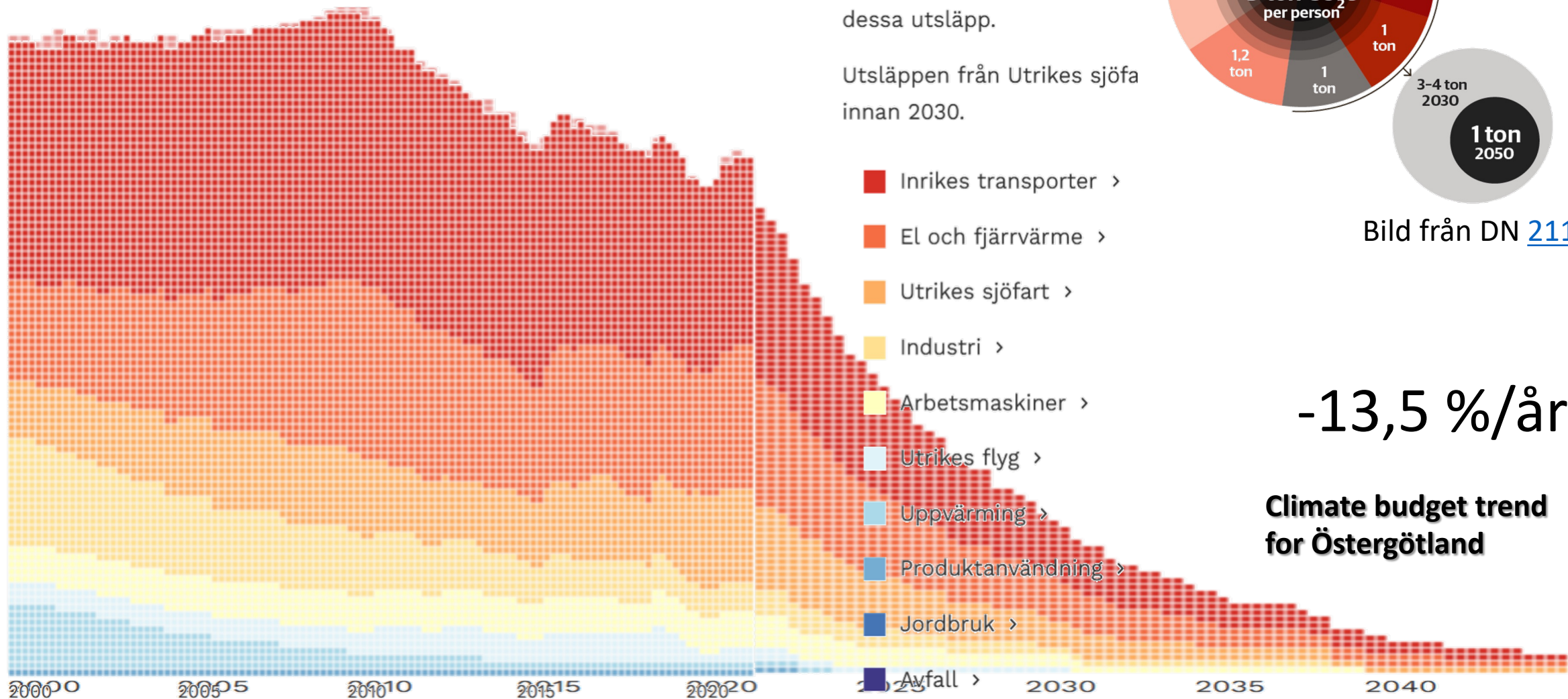


El producerat genom industriellt mottryck synliggörs i Sankey-diagrammet, men inkluderas inte i total energitillförsel eller industrins slutanvändning. Istället inkluderas bränslen som åtgår vid denna produktion.



# Our goal: reduce CO2 emissions

•The Swedish parliament has decided that Sweden shall be carbon neutral by 2045



dessa utsläpp.

Utsläppen från Utrikes sjöfart innan 2030.

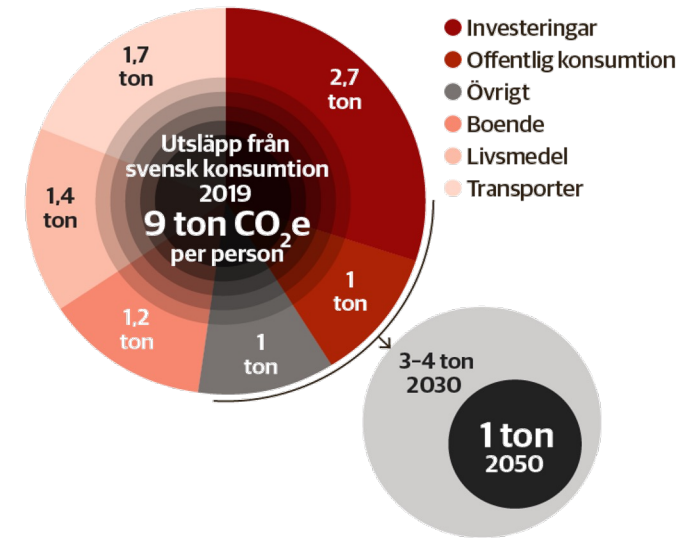


Bild från DN [211203](https://www.dn.se/2019-08-28/11203)

-13,5 %/år

Climate budget trend for Östergötland

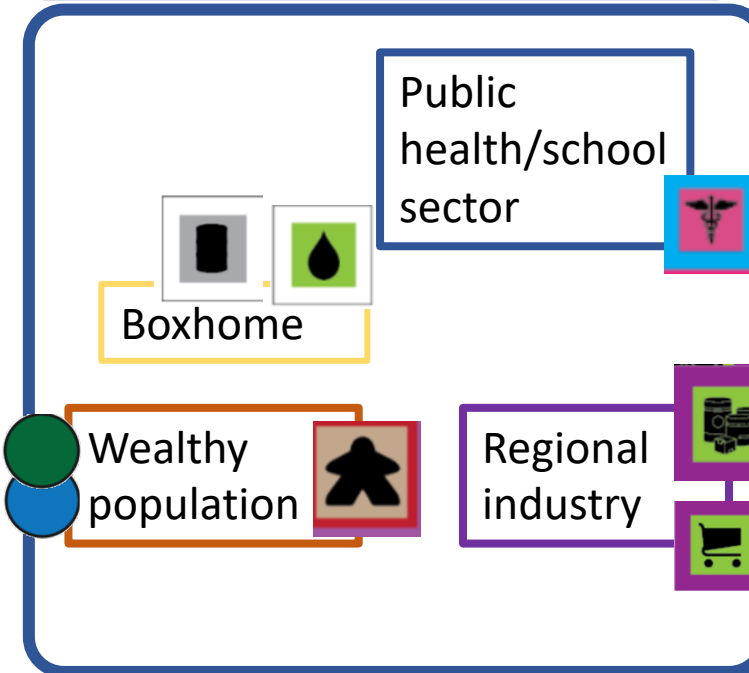
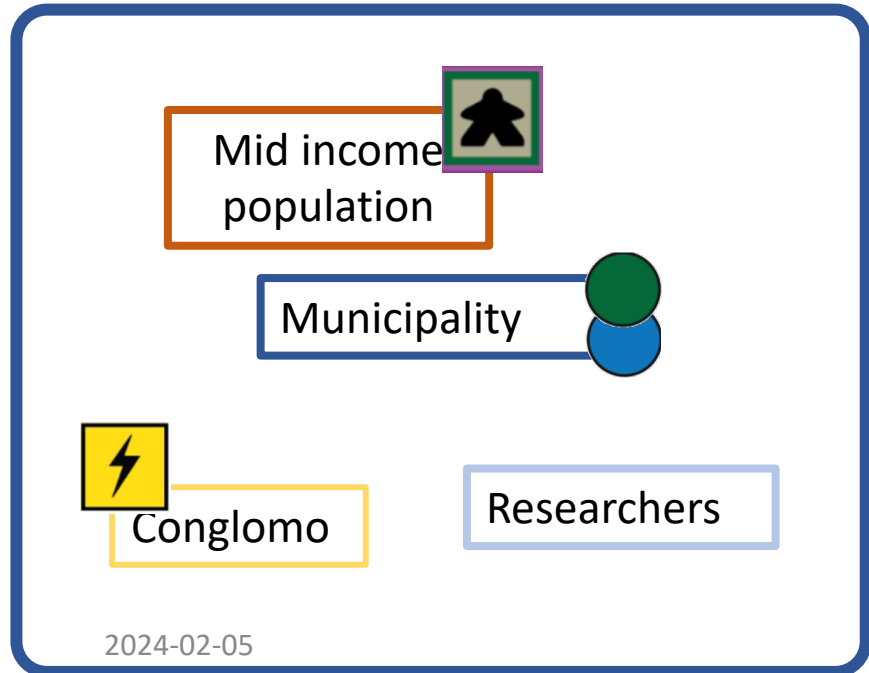
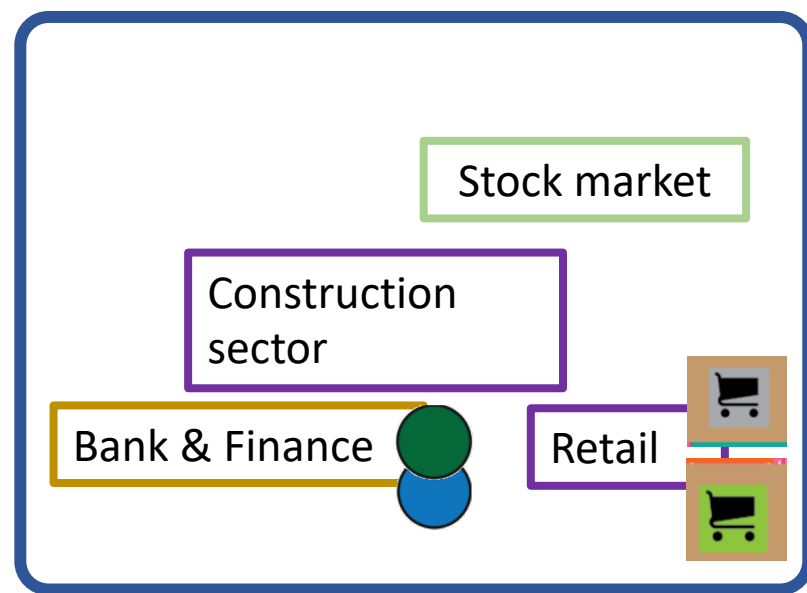
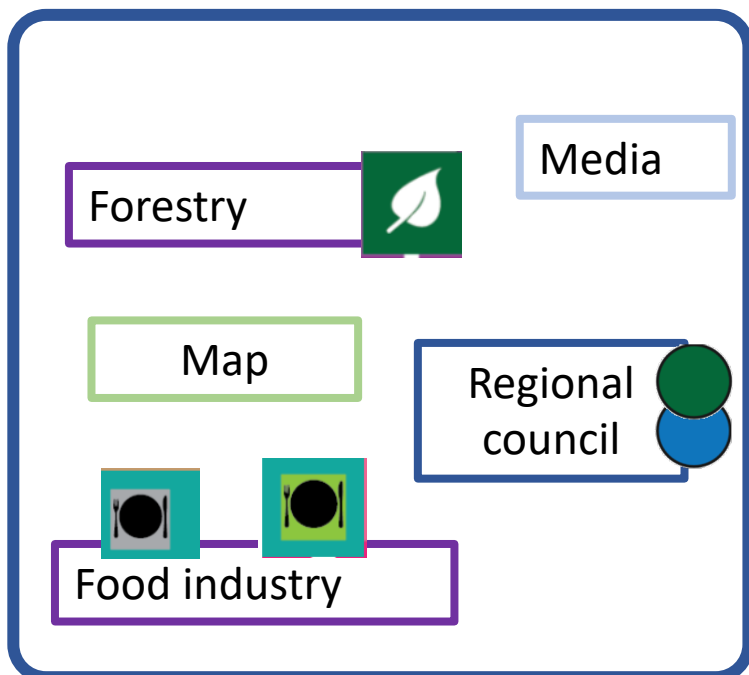
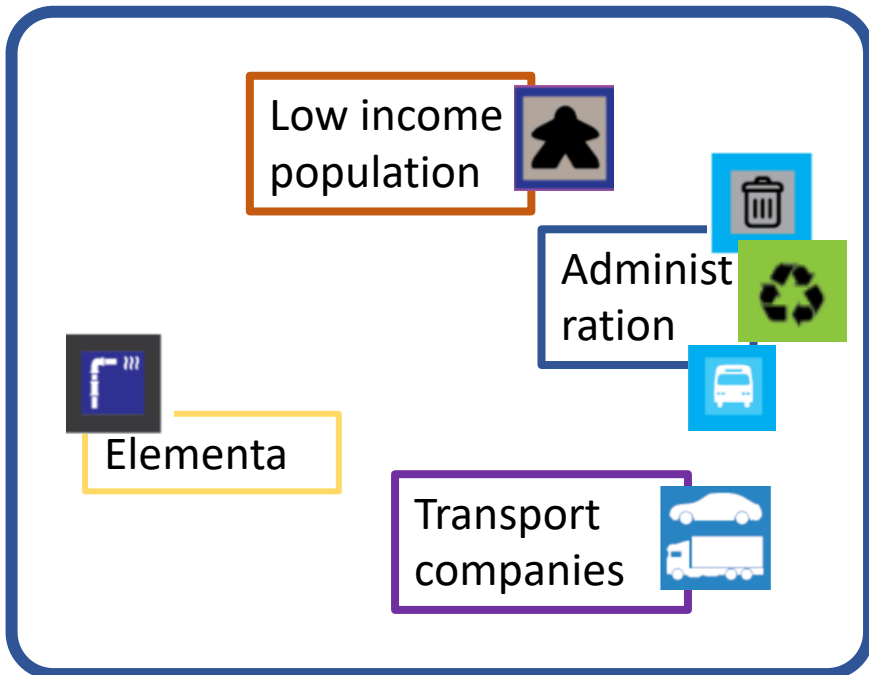
<https://www.climatevisualizer.com/>

# Game structure

A full day activity (9-16):

- An introductory round
- 3-5 Rounds of 45-60 minutes
- Debriefing after each round
- Summary and result presentation at the end





Game layout for last event 70+ high school students in Uddevalla



# Game boards

**Production**

80  
(8)

**Boxhome**

Kassa: \$22

**Income**

Resource	Price
Fertilized wheat	\$10
Fertilized soybeans	\$10
Fertilized corn	\$10
Fertilized rice	\$10
Fertilized sorghum	\$10
Fertilized millet	\$10

**Expenses**

Resource	Cost
Market	\$20
Market	\$20
Market	\$20
Market	\$20
Market	\$20

**CEO**

**Projektort:**  
-  
Bioraffinaderier/sko  
g till diesel  
-

Avtals finns i ny version, ser ej ut som dessa

2024-02-05

# Population board

**Transport** \$\$\$

- Commuting (No income): -1
- Commuting (Half income): -1
- Shopping & hobbies: -2
- Vacation: -1

Unless there are tokens on each box on a card, the negative bonus printed on the card applies at the end of turn, lowering Quality of Life, ♥

**Housing** \$\$\$

- 16°C: -5
- 20°C: -1
- 22°C: -1
- Household appliances: -3

Unless there are tokens on each box on a card, the negative bonus printed on the card applies at the end of turn, lowering Quality of Life, ♥

**Food** \$\$\$

- Basic sustenance: -12
- Restaurant visits: -1
- Candy & snacks: -1
- Sec: -1

Unless there are tokens on each box on a card, the negative bonus printed on the card applies at the end of turn, lowering Quality of Life, ♥

**Goods** \$\$\$

- Basic clothing: -1 (Half income)
- White goods: -1
- Disposable items: -2
- Gadgets: -2

Unless there are tokens on each box on a card, the negative bonus printed on the card applies at the end of turn, lowering Quality of Life, ♥

**Health & Education** \$\$\$

- Primary health care: -3 (Half income)
- Basic education: -2
- Higher education: -2
- Specialist healthcare: -3

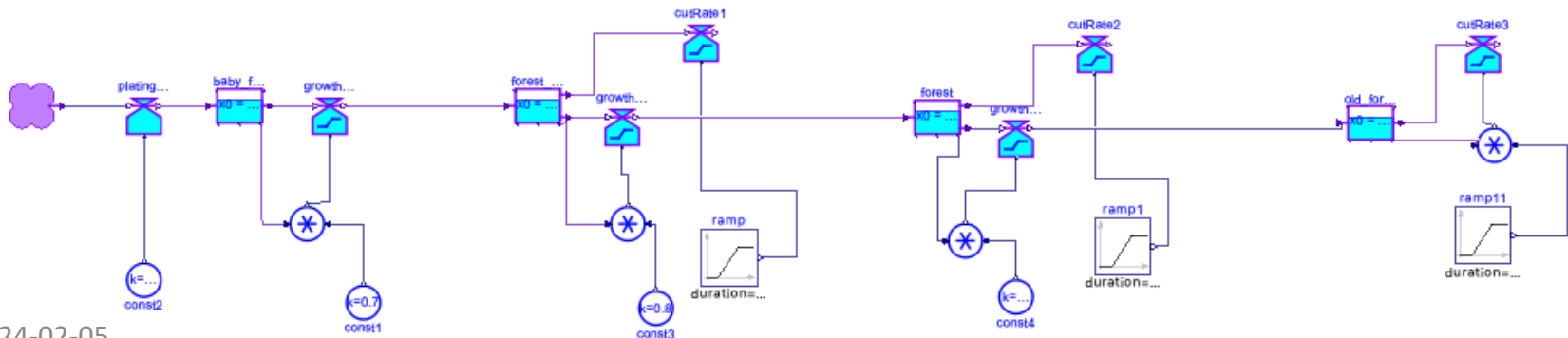
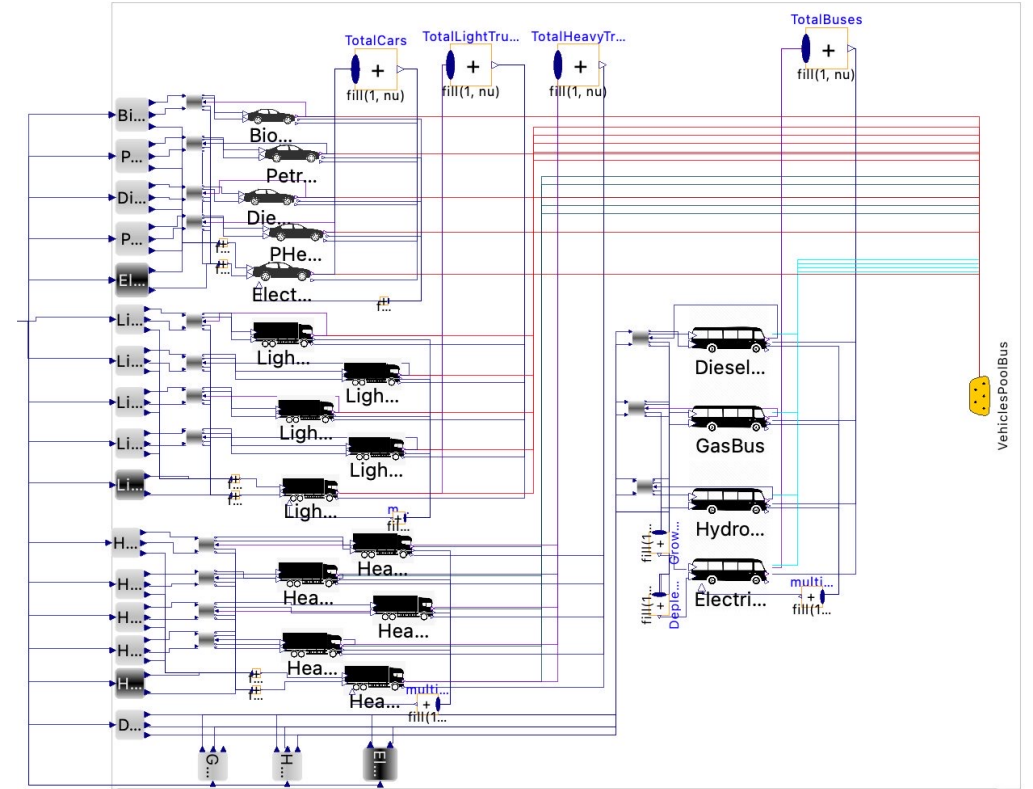
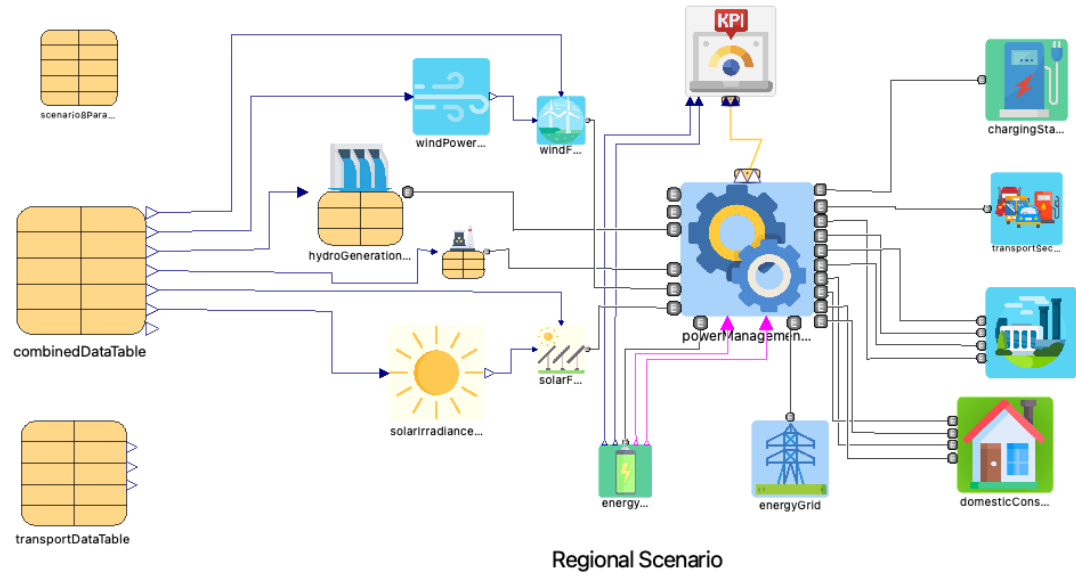
Unless there are tokens on each box on a card, the negative bonus printed on the card applies at the end of turn, lowering Quality of Life, ♥

Heart icon \$\$\$ | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | Heart icon | 18 | 19 | 20

**Dissent**

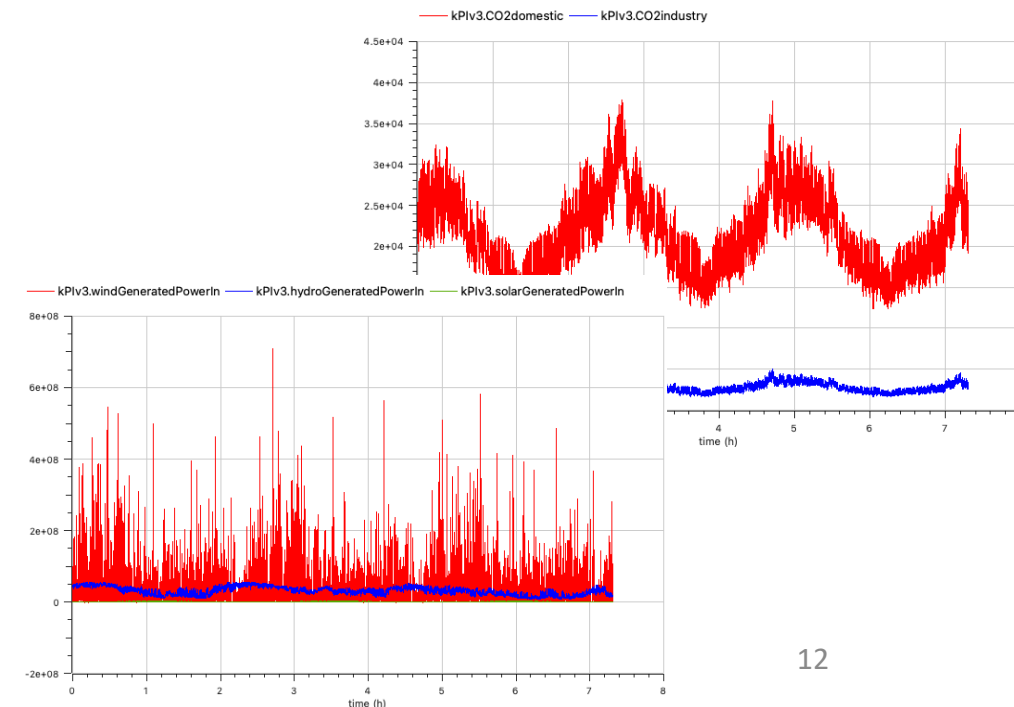
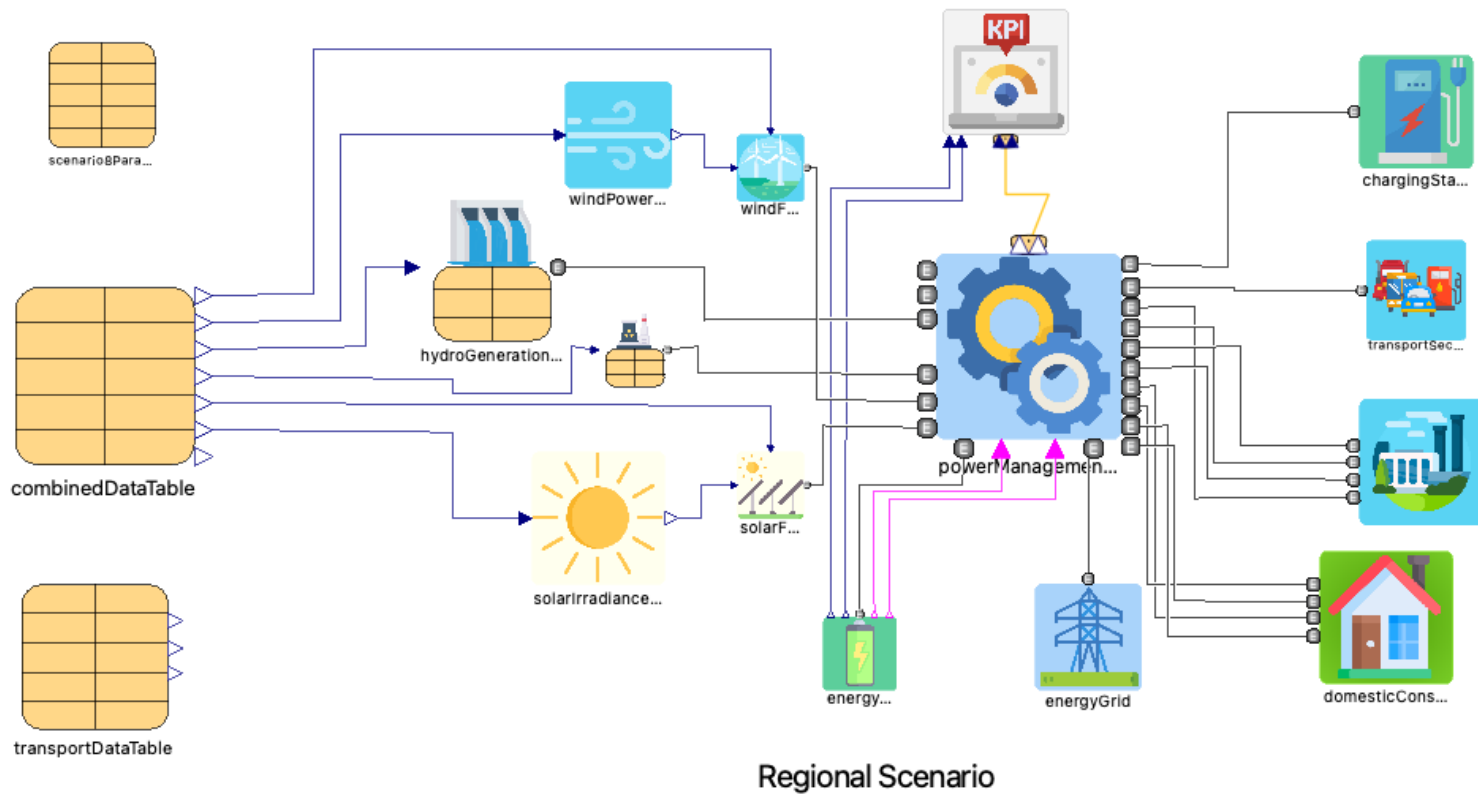
Changing type of token costs: ☹/\$1 | ☹☹/\$2 | Broken heart icon | No icon

# The simulation models

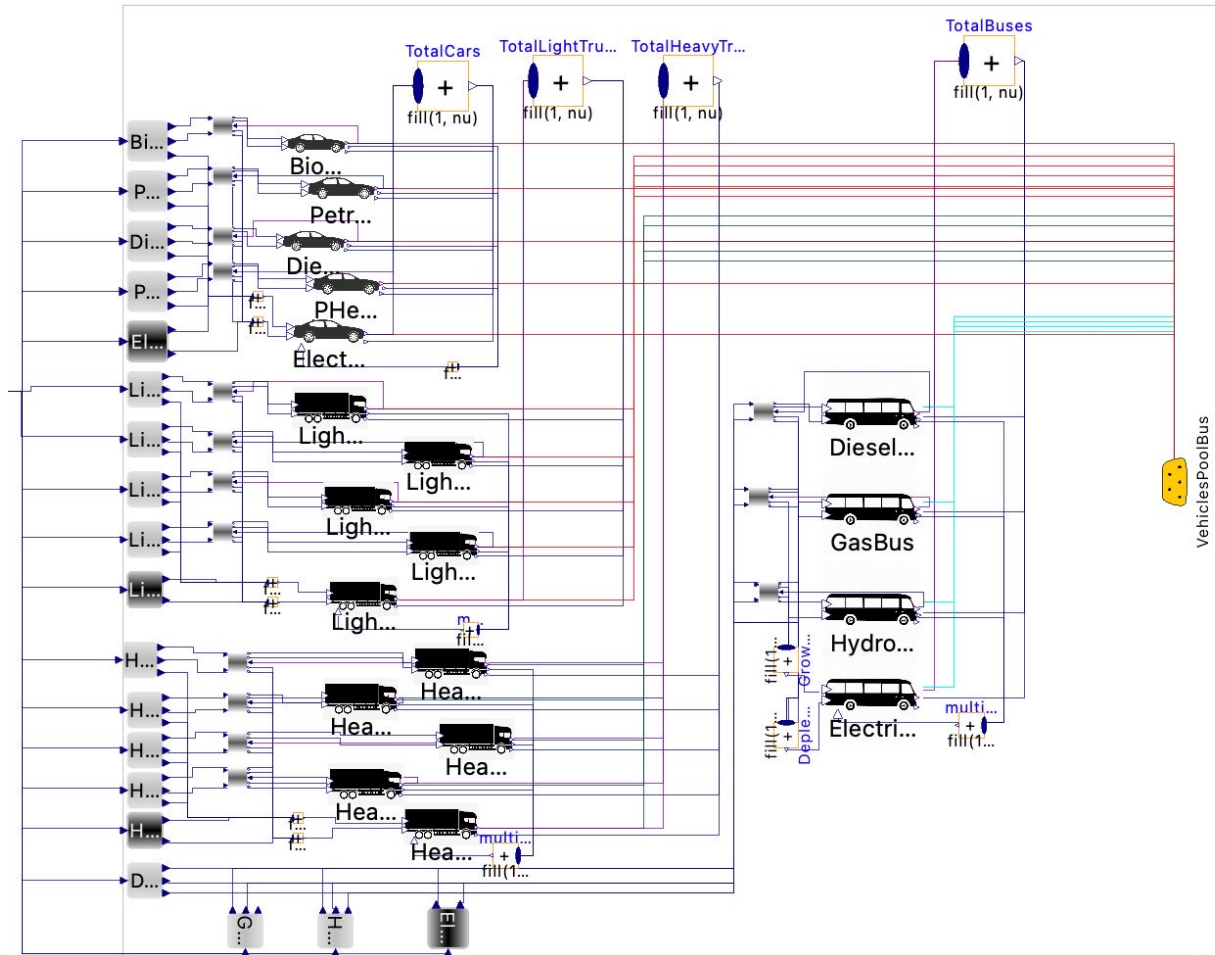


# Energy grid model

Parametrized using regional data (irradiation, wind speed, energy demand, # of vehicles...)

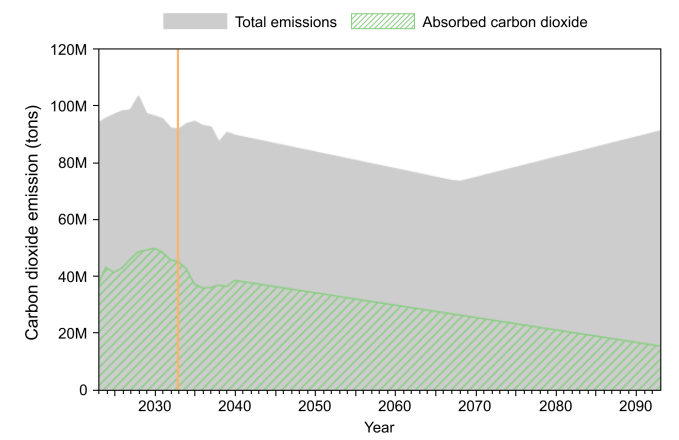
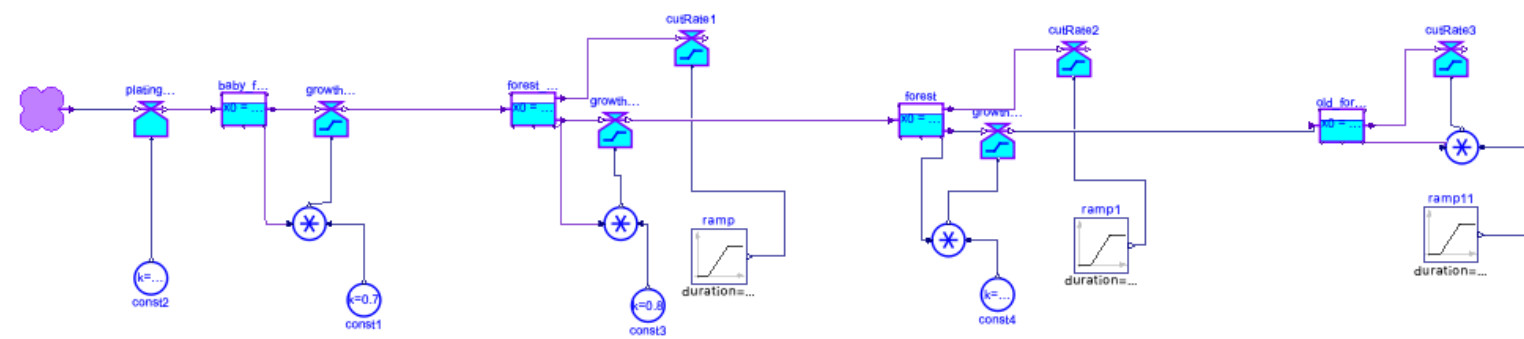
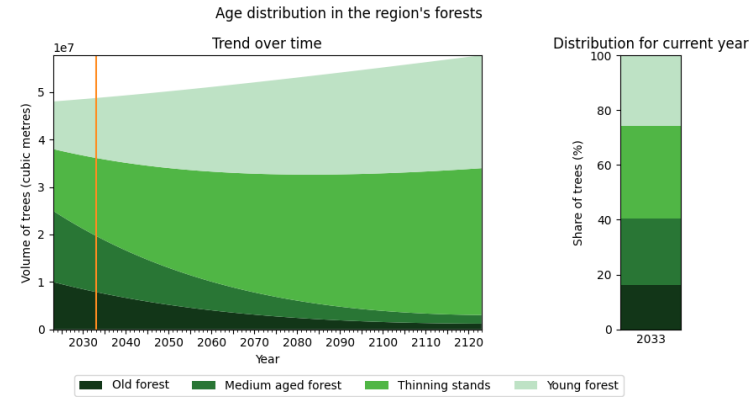
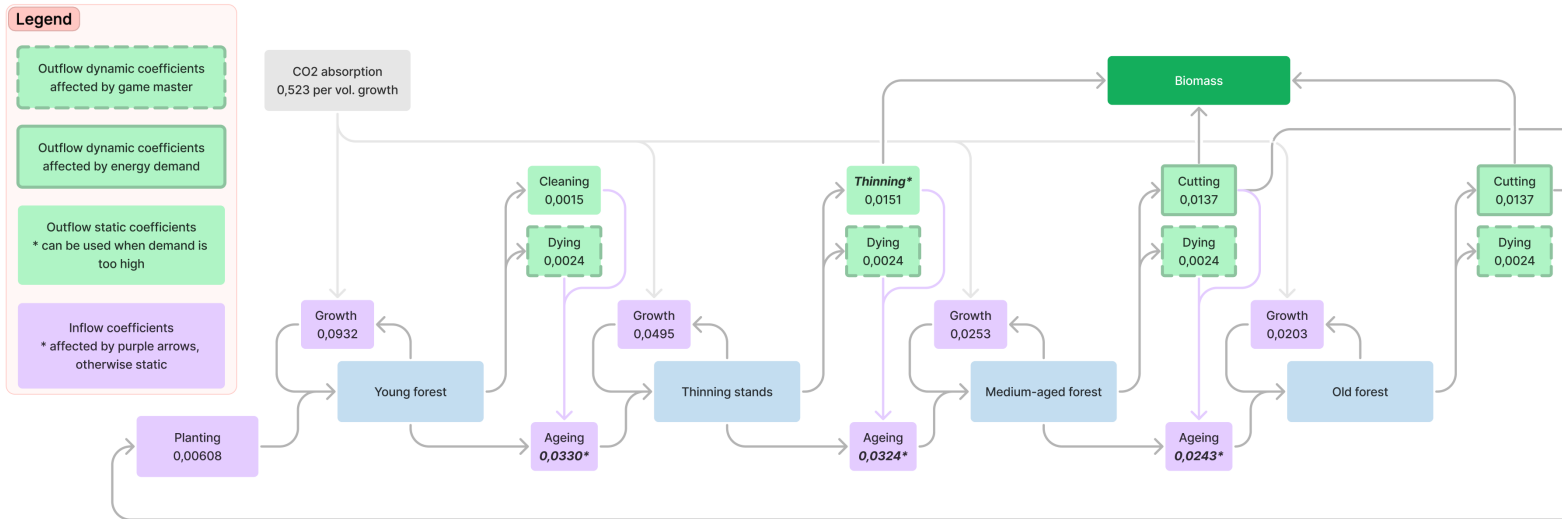


# Transportation model



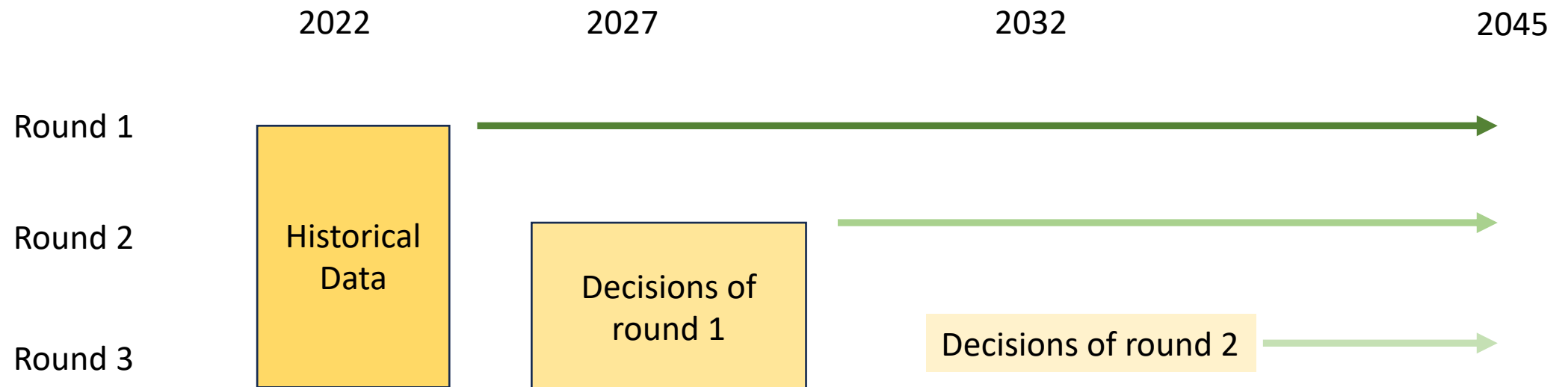
- used to calculate CO2 emissions
- parametrised with regional numbers and then based on later decisions

# Biomass model

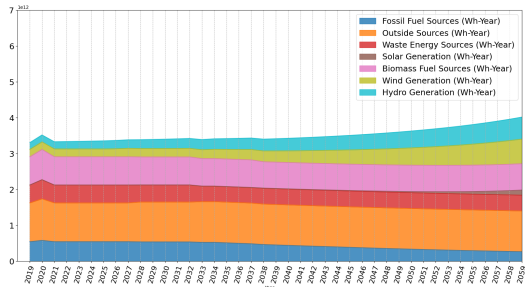
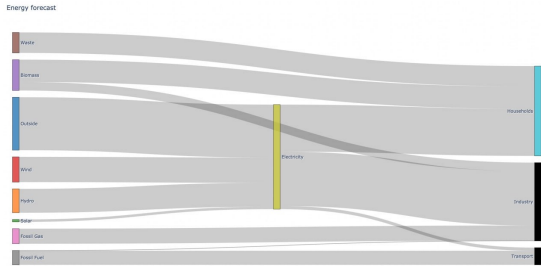


# Simulation

- Input data generated in iterations after each round
- Simulations cannot change the past
- Historical data + time series + trends in decisions + delays  
→ generated data



# Current work flow



2024-02-05

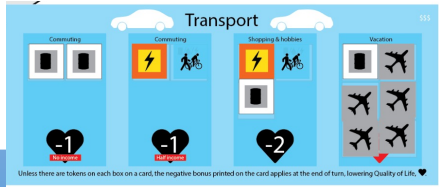
Generate graphs and present results



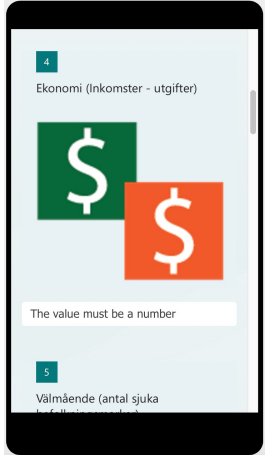
Simulate the models

Export Excel and extrapolate data to generate input for OM

Play round and make decisions



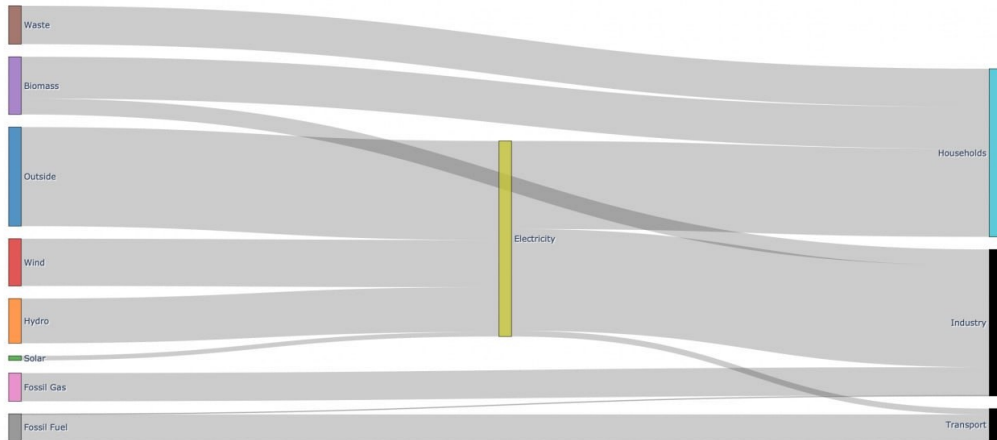
Count cards and Collect data through MSforms



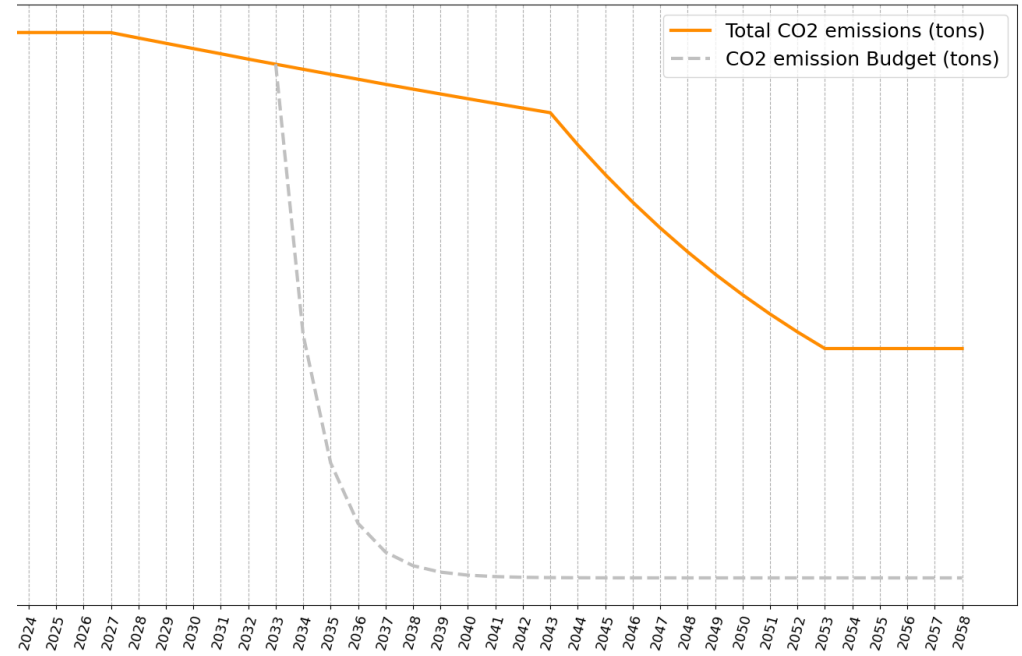


# Visualisation of results

Energy forecast



Energy flow Sankey diagram for 2030, based on game decisions



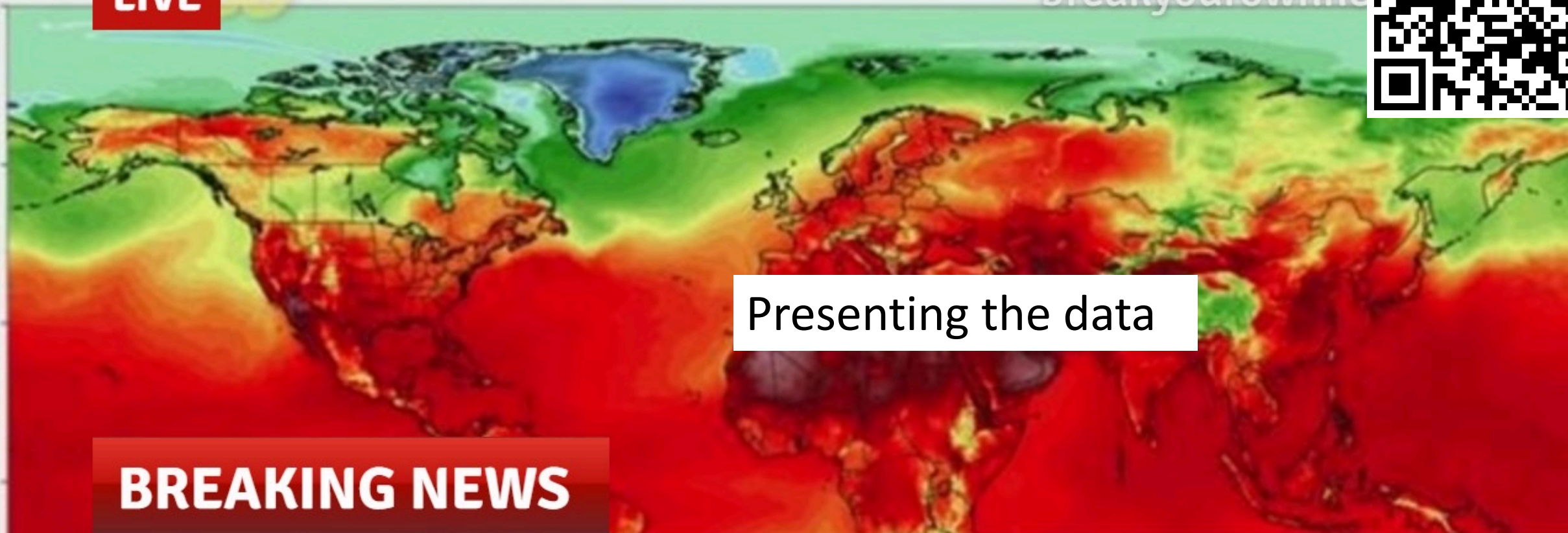
CO2 budget



Accessible via QR code



**LIVE**



Presenting the data

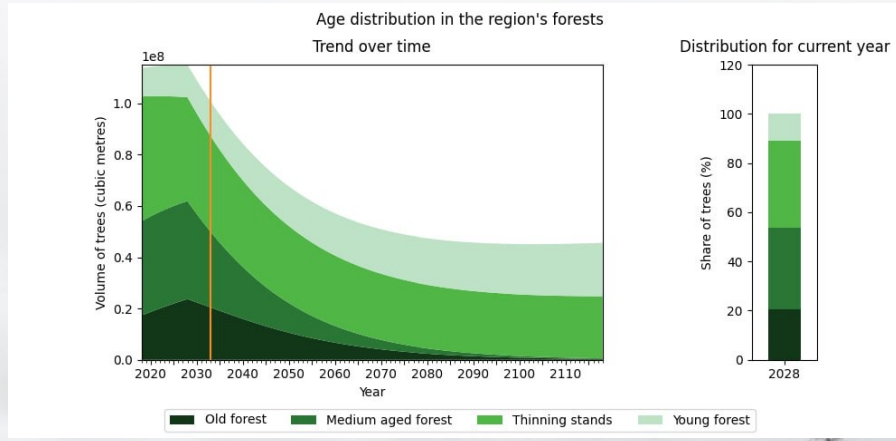
**BREAKING NEWS**

# GLOBAL HEATWAVE BREAKS RECORD

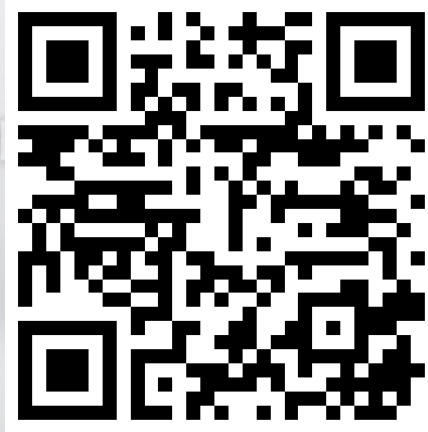
**10:46**

**DROUGHT THREATENS FOOD SYSTEMS, SWEDISH FARMERS HEAVILY AFFECTED**

LIVE



breakyourow



BREAKING NEWS

# KRITISKT LÄGE FÖR SKOGEN

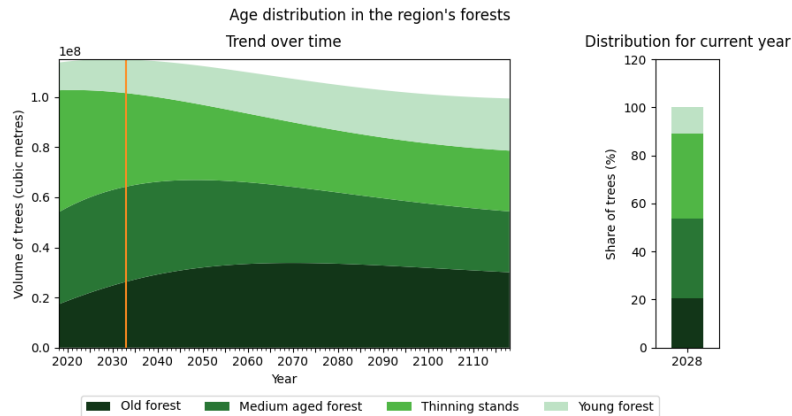
9:44

SLU: "HUNDRATALS RÖDLISTADE ARTER PÅVERKAS AV SKOGSAVVERKNINGEN"

2024-02-05

19

# Example scenario



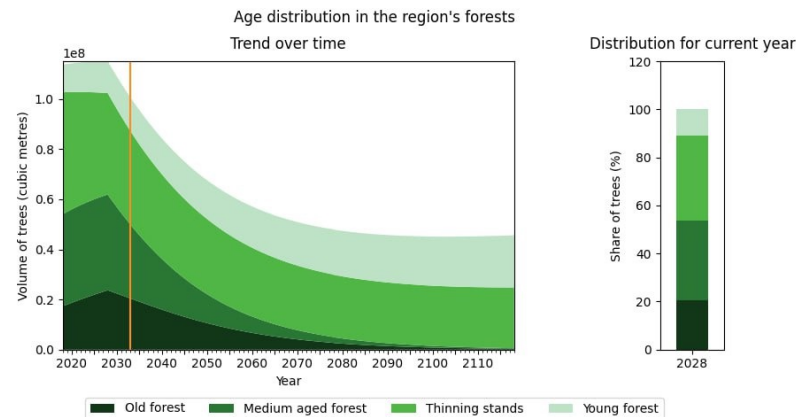
1

Based on historical data  
> 3% biomass volume  
can be harvested yearly

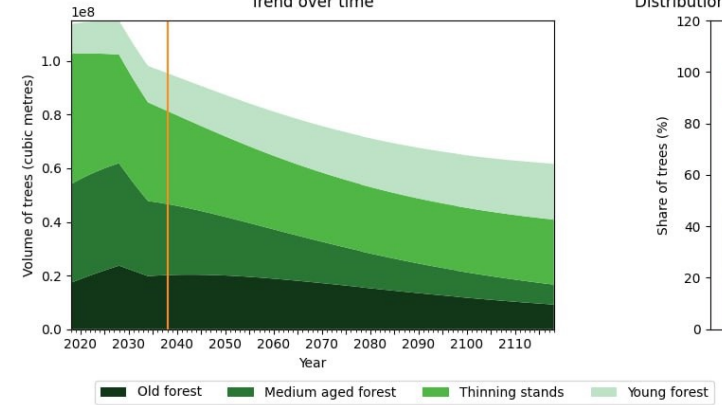
Lets GO GREEN!

.... OOPS?

2



Age distribution in the region's forests  
Trend over time



3

Ok, let's go less green,  
but we have a business to  
run

Certified wood from  
"Brazil"

# Evolution of the simulation

Nov 22

Dec 22,  
Jan 23

May 23

Nov 23



First game, about 20 people, 1 person data collection, model crashes because of unexpected parameters

Second and third games 20-40 people, more detailed simulation, parametrisation, script-based data generation based on round results, some graphs can be generated, but by the time they can be shown the round is over

Developed biomass Modelica model as a master thesis

Increased step size, much faster simulation, forms used to speed up data collection, tested on 70 players

What's next?

- Calculate more indicators (wellbeing or happiness for example)
- Integrate with a climate/environment model (Earth3?)
- More interactive visualisation (nicer graphs, better handling of scaling)
- Close the loop (control the imports better)



Thank you!