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System dynamics model analysis of pathway to 4th GDH systems in the Baltic States

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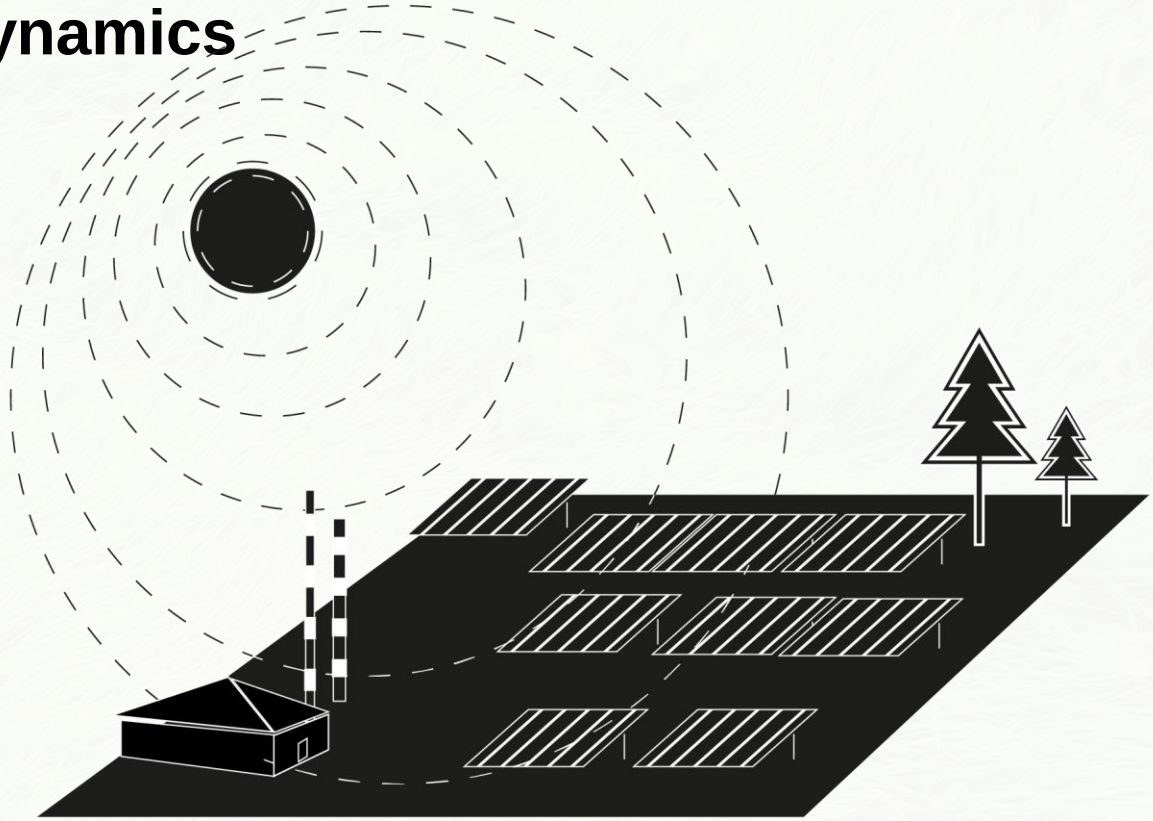
4DH
4th Generation District Heating Technologies and Systems

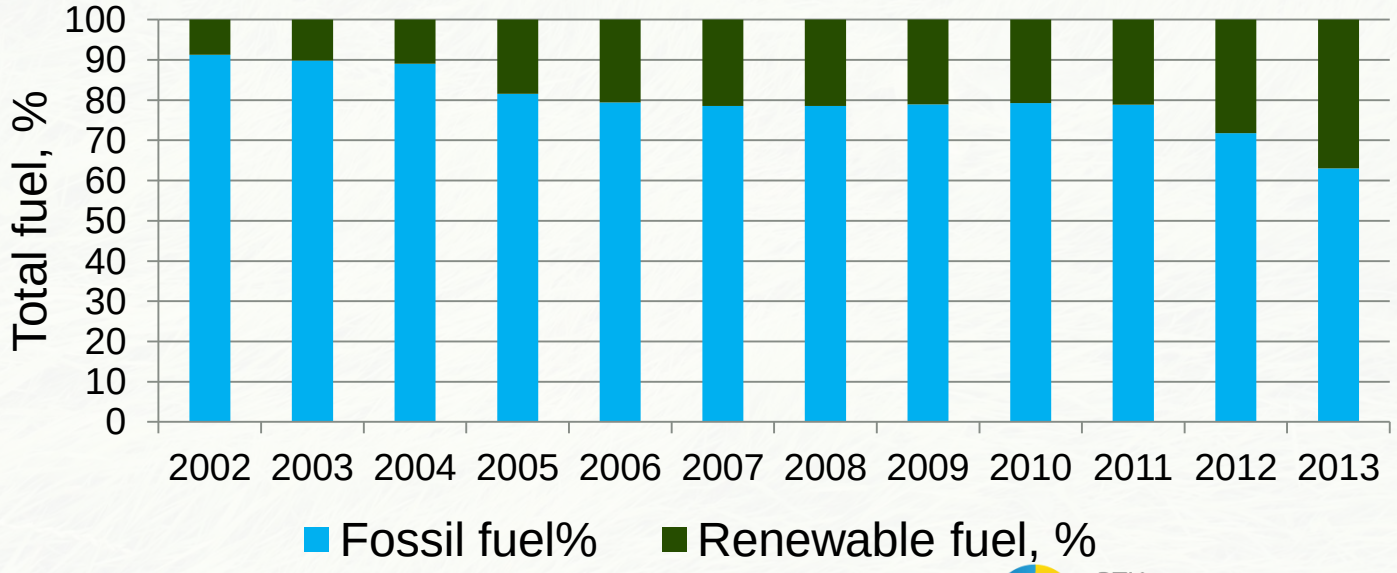
Contents

Goal of research

To evaluate policy tools to reach 4 generation DH system by use of system dynamics model

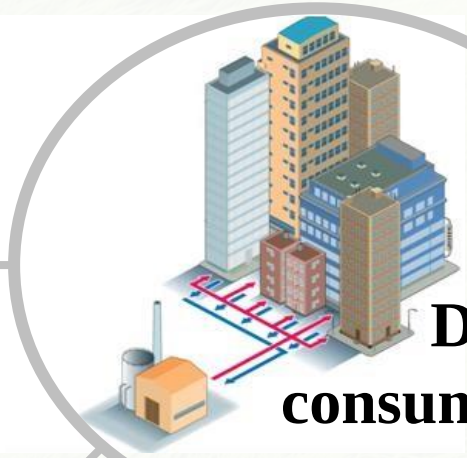


Current Situation in the Latvian District heating



4GDH elements of the existing system: the consumer

Heating substation

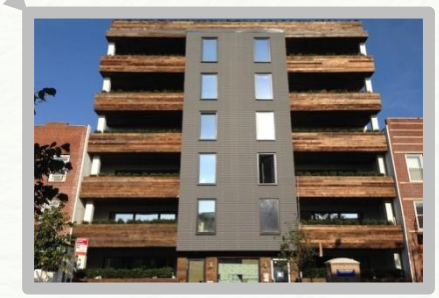


DH consumer

Low temperature heaters

LBN 002-01
80 kWh/m^2

Low energy buildings
45 kWh/m^2

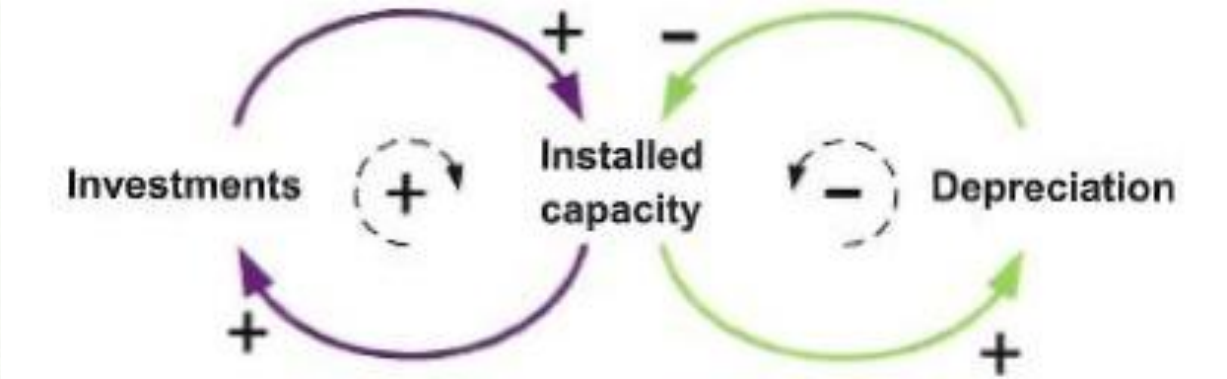


Passive building
15 kWh/m^2

Creation of dynamic hypotheses

The diffusion of 4GDH concept within traditional DH :

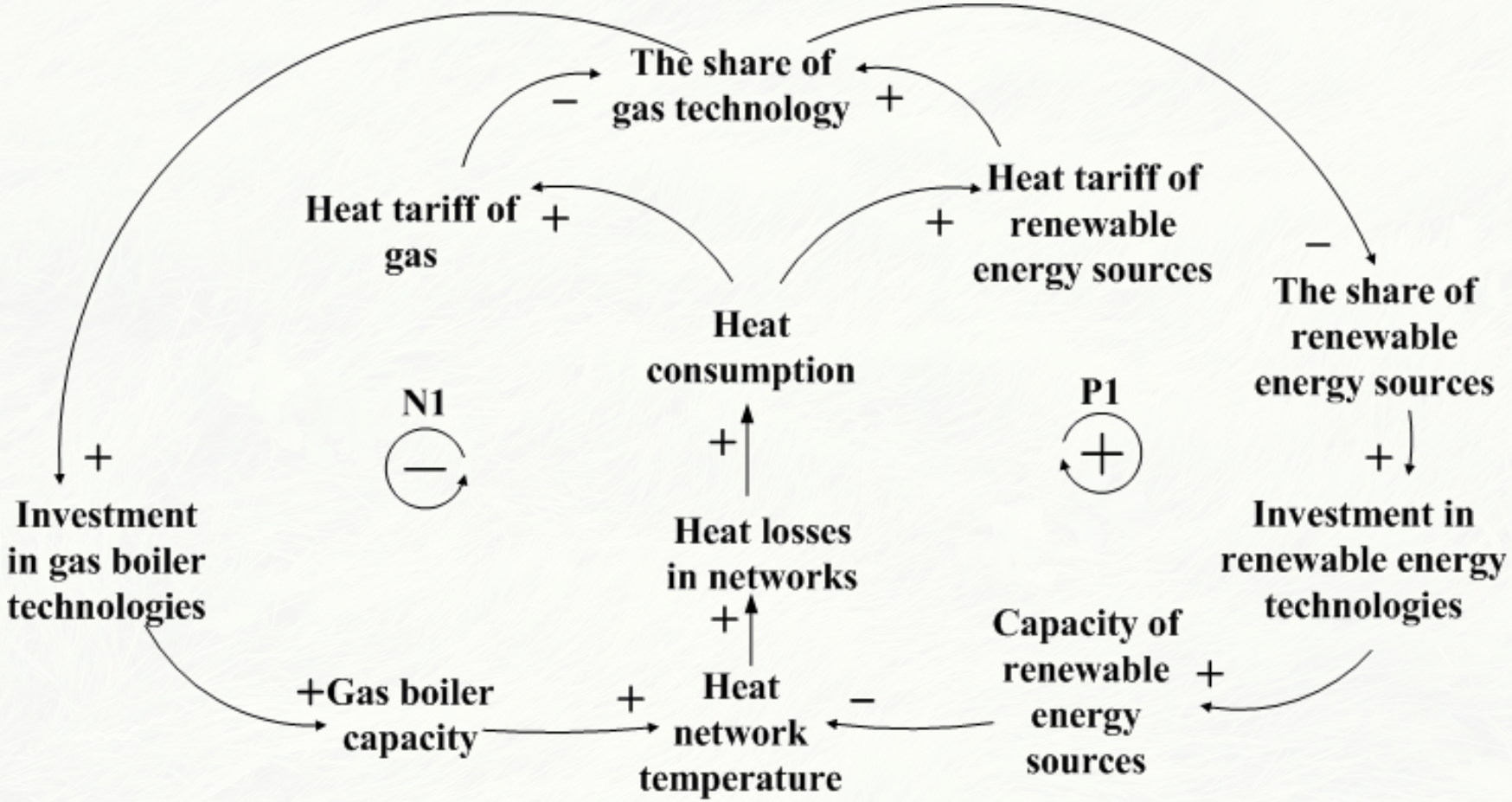
- a renewable energy technology,
- low temperature networks
- low energy consumers



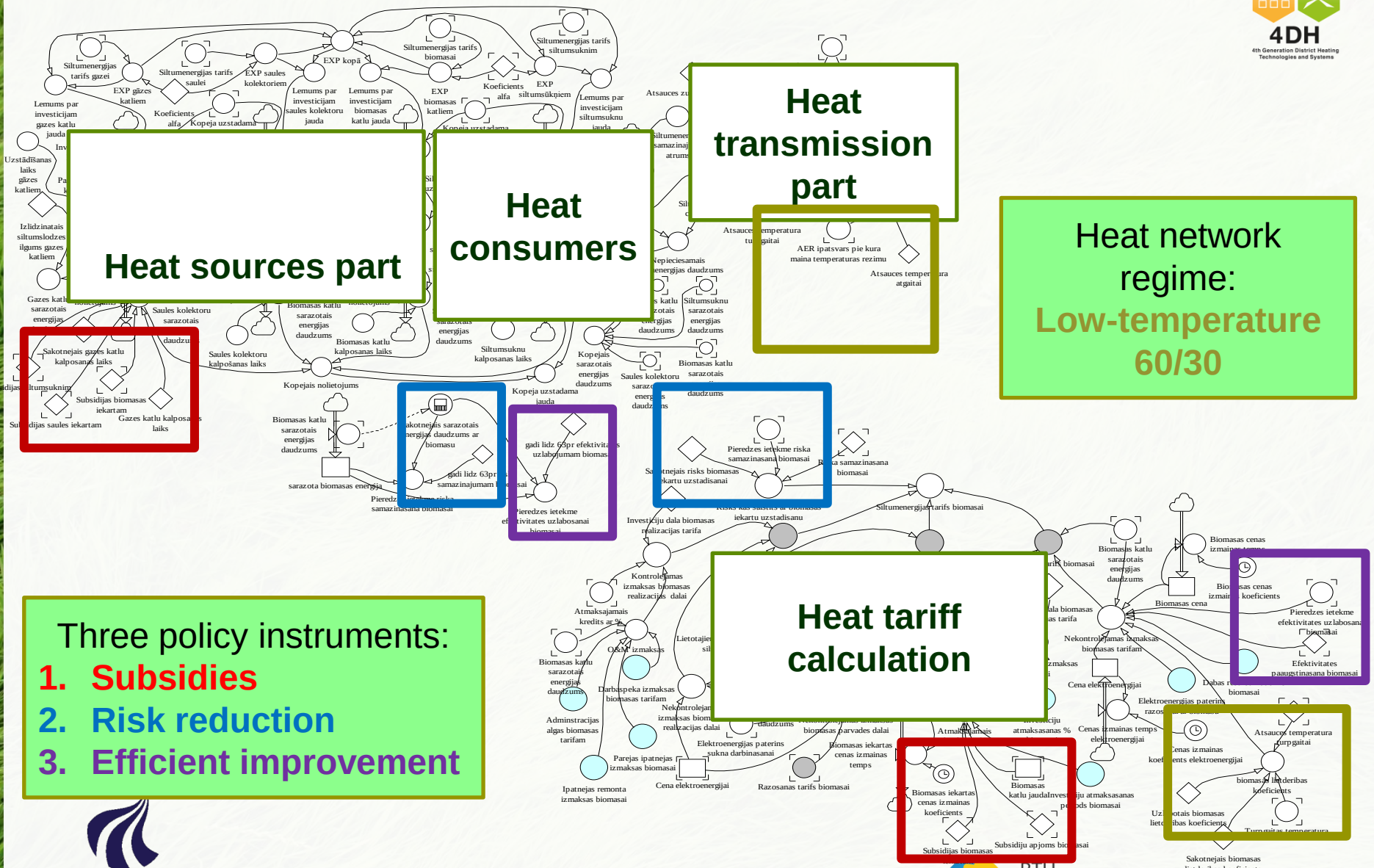
Causal loop diagram representing the relationships between the total capacity of installations and investment and depreciation flows *

*"System Dymamics" edited by A.Blumberga, RTU, 2011

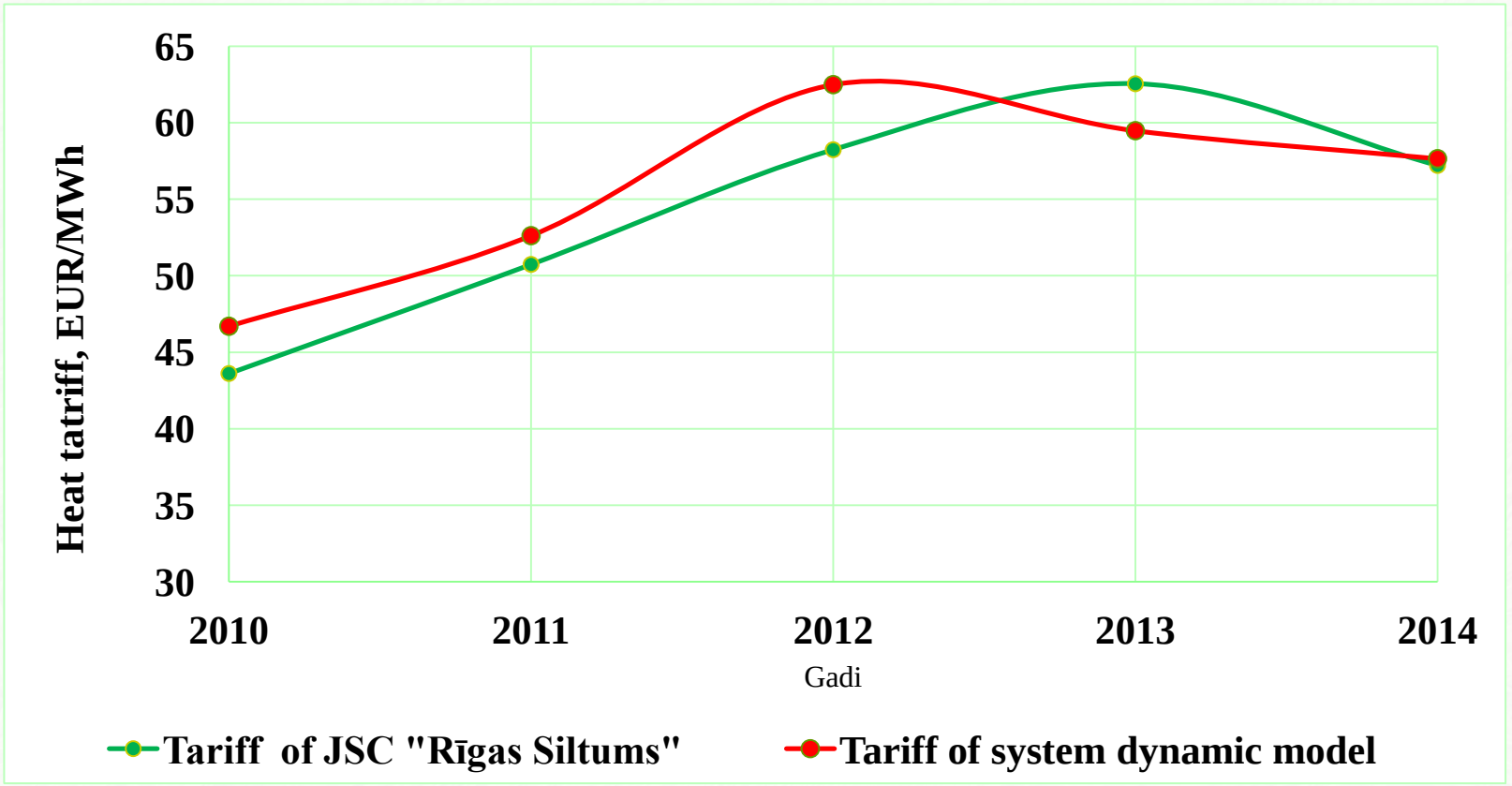
Causal loop


The share of gas technology
Heat tariff of gas
Heat tariff of renewable energy sources
The share of renewable energy sources
Heat consumption
N1
P1
Investment in gas boiler technologies
Heat losses in networks
Investment in renewable energy technologies
Capacity of renewable energy sources
Gas boiler capacity
Heat network temperature

System dynamics model structure



Model verification

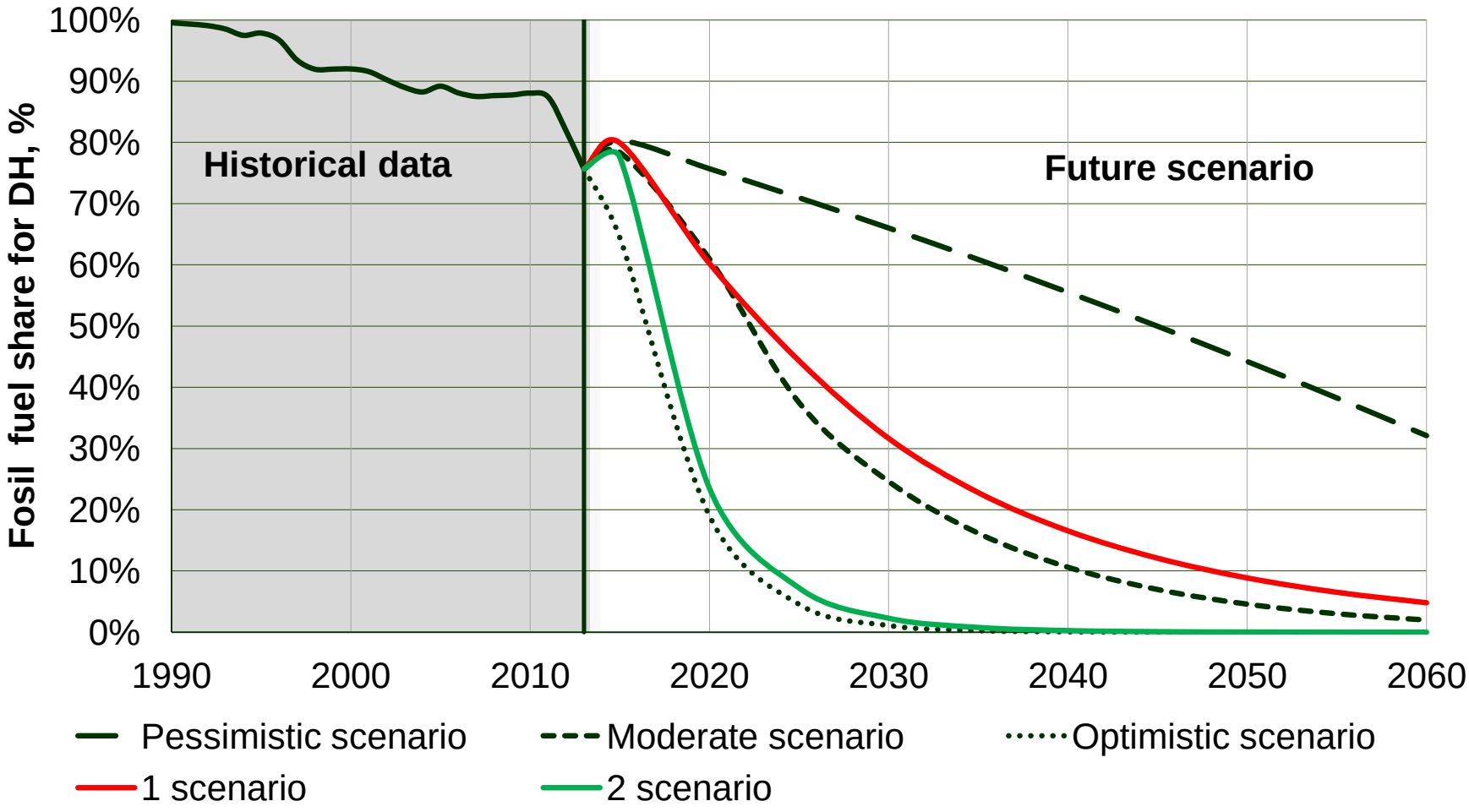


Description of Scenarios

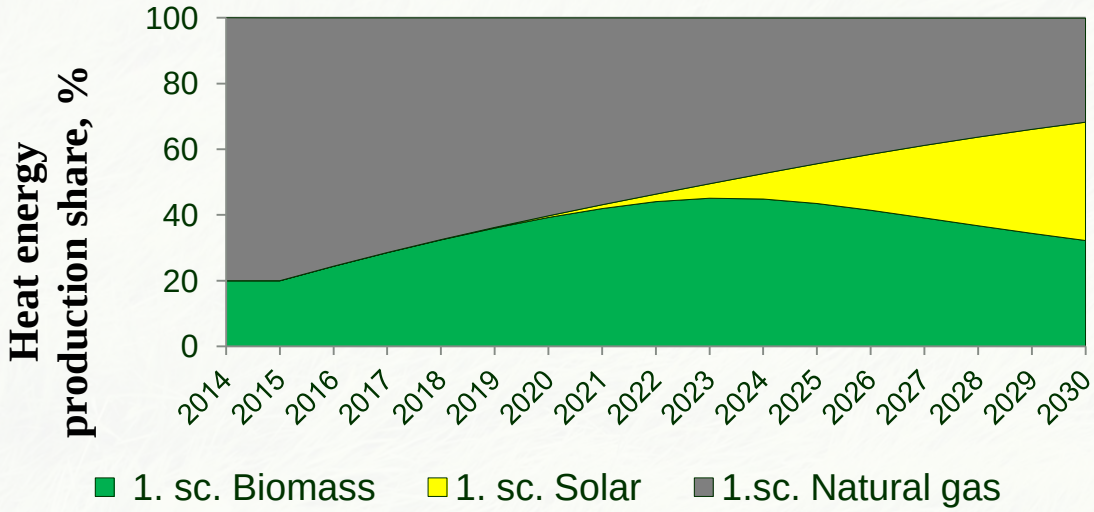
Scenarios	Policy instruments								
	Subsidies			Risk reduction			Efficient improvement		
	B*	S*	HP*	B	S	HP	B	S	HP
1st scenario	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
2nd scenario	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
3rd scenario	0	0	**1**	0	0	**1**	0	0	**1**
4th scenario	0	**1**	0	0	0	0	0	0	0
5th scenario	0	0	0	0	**1**	0	0	0	0
6th scenario	0	0	0	0	0	0	0	**1**	0

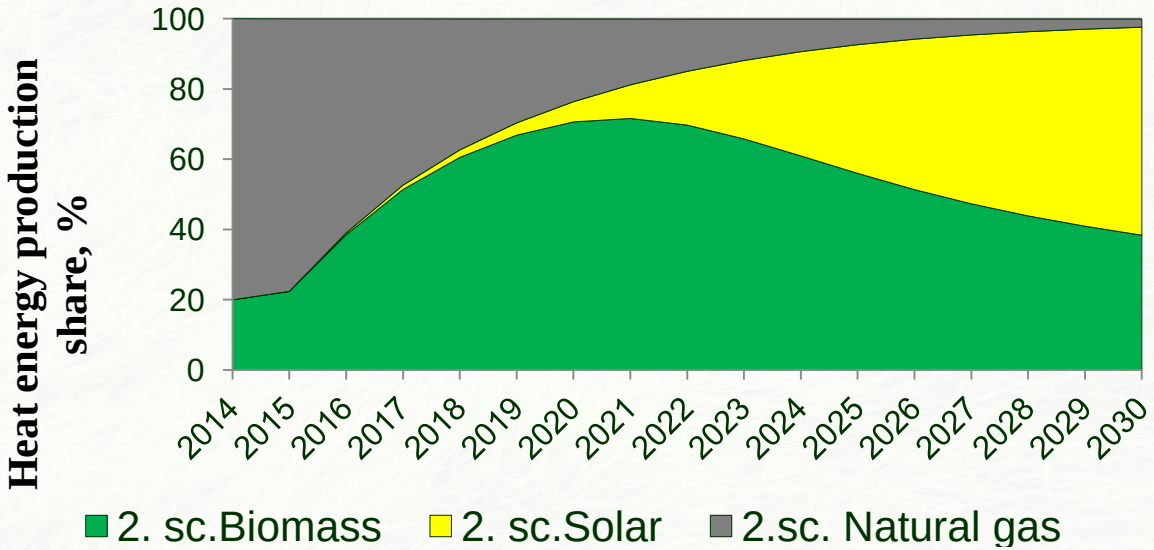
B - biomass; S- solar collector; HP – heat pump; 1- activ; 0- non activ

Hypothetical scenarios compared with the model results



Result of different policy strategies





Conclusions (1)

1. The modeled scenarios show that the pace of 4GDH implementation depends on the policies used by each country. Subsidies are the most effective mechanisms for increasing of renewable energy share.
2. The developed system dynamic model could be applied to other heating systems if corresponding initial data and other renewable technologies are added.
3. In the base scenario 68,4 % renewable share was achieved, thus confirming the hypothesis. Results are based on existing industry development pace and on fuel and technology cost dynamics. The proportion of biomass is projected to increase till 2024 but then part of renewable resources are replaced by solar energy technologies

Conclusions (2)

4. The transition to a low-temperature regime (60/30) at different share of renewable energy (60%, 80%, 95%) was included in system dynamics model. Thermal regime change increases the efficiency of renewable technologies, but does not change the share of renewable energy in the common system. Policy instruments contribute to a faster transition to a low-temperature regime.

Acknowledgements

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