



System Dynamics Approach

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Outline

- The Approach
- The Method
- Example: the 3DEE Model

System Dynamics

The Approach

Definition: “*SD deals with the time-dependent behavior of managed systems with the aim of describing the system and understanding, through qualitative and quantitative models, how information feedback structures governs its behavior and designing robust information feedback structures and control policies through simulations and optimization.*” [Coyle 1996, pp. 10].

Method for analysis and modeling (simulation) of **dynamic and complex systems**

Focus: Time-dependent behaviour of managed systems

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The Approach

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Method for analysis and modeling (simulation) of **dynamic and complex systems**

Focus: Time-dependent behaviour of managed systems

What is a complex system?

First definition: systems with multiple relationships, multiple possible states and dynamic (time-wise) dependency of those

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Method for analysis and modeling (simulation) of **dynamic and complex systems**

Focus: Time-dependent behaviour of managed systems

Method: feedback loops, time-lags, causal-effect relationships

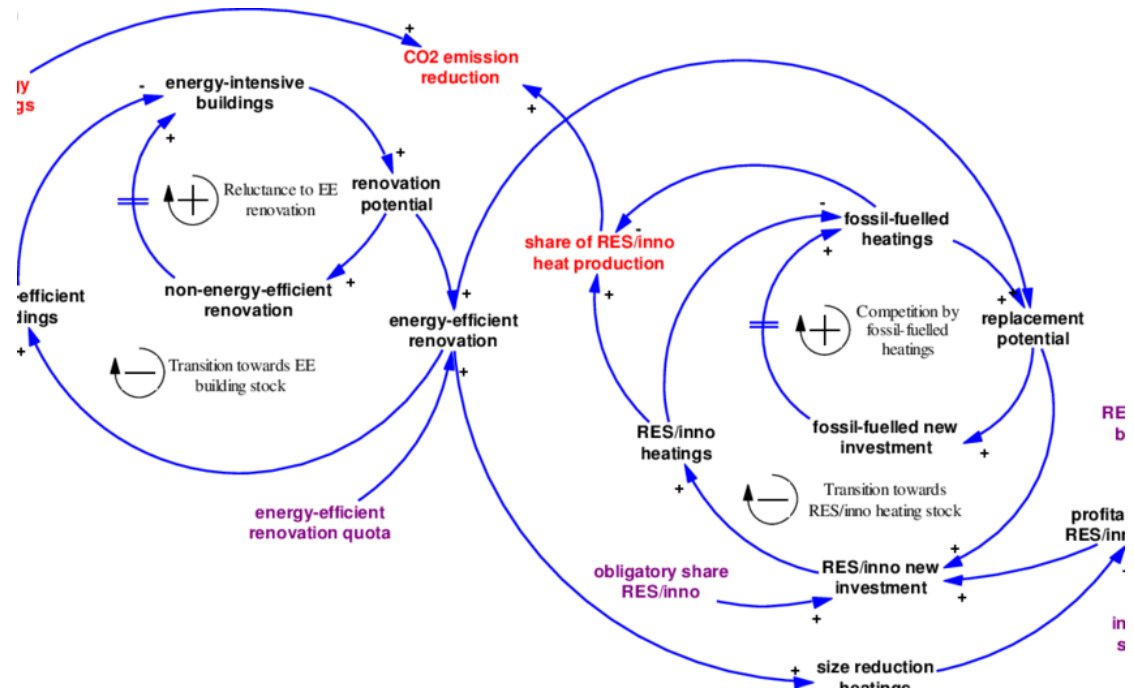
Uses: socio-economic context, World3 – Model (*The limits to Growth*), applicable also in socio-technical or socio-techno-ecological contexts

System Dynamics

The Approach

Particularity: **Closed systems!**

All variables are **endogenous!**: only initial state of variables and parameters (constant) given as input



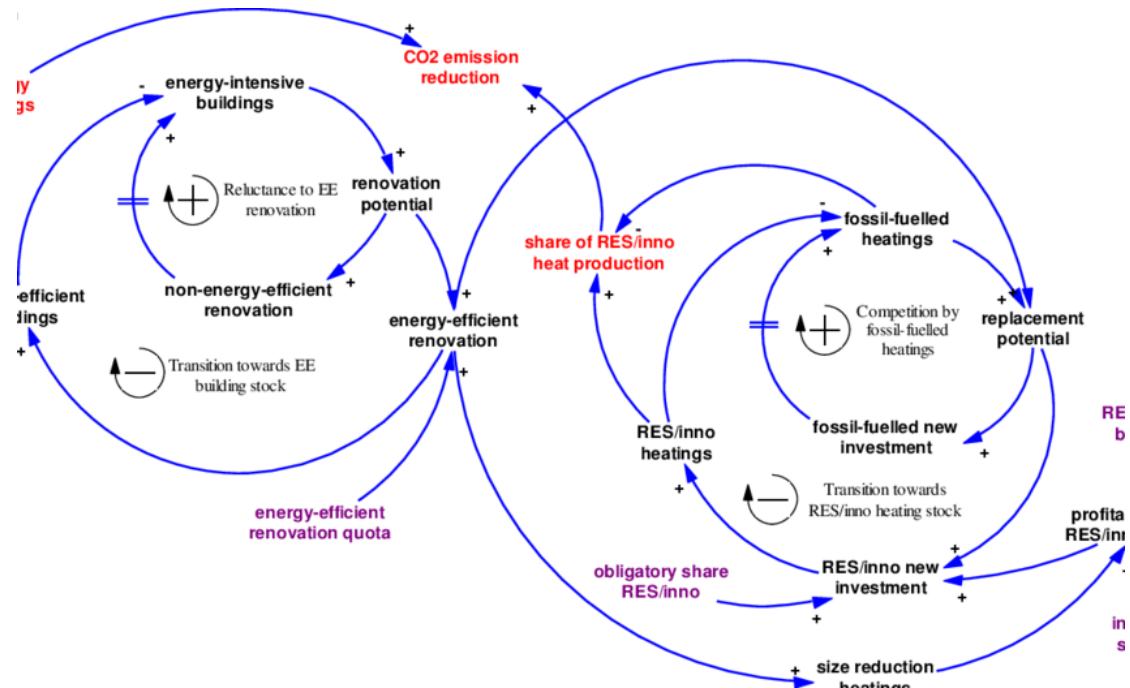
All variables of state
linked in feedback loops
→ determined **within**
the model!

System Dynamics

The Approach

Macro-level perspective (often criticized): main structures and elements defining the system, not details!

Non-linear behaviour



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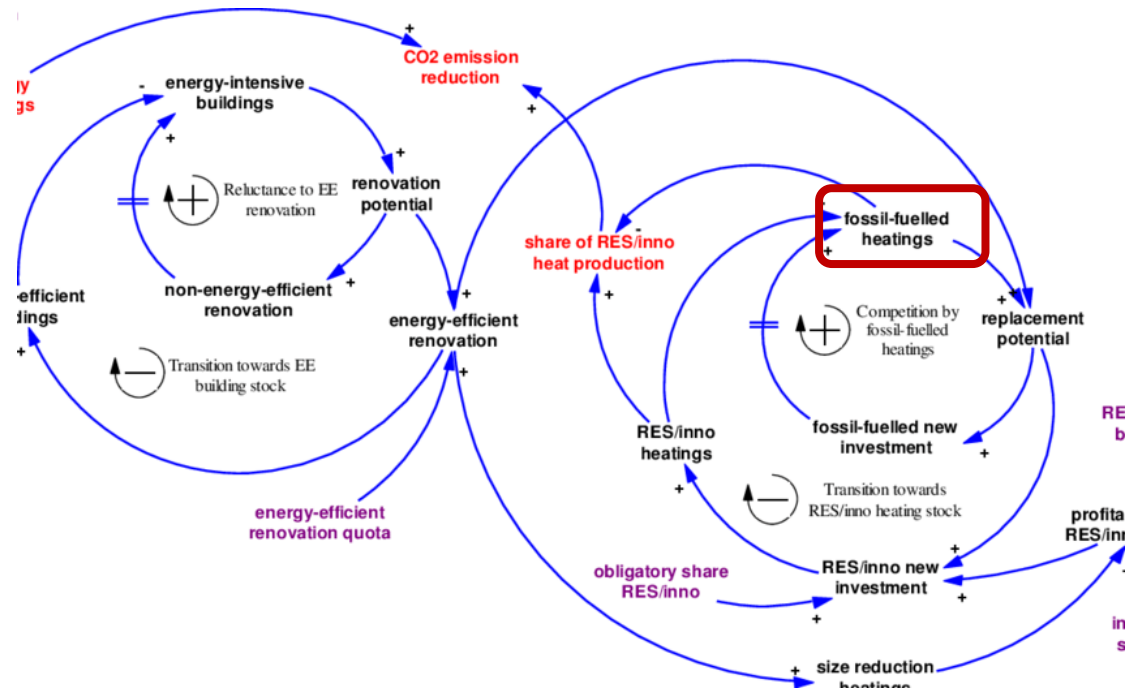
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The Method

Four main milestones:

- 1. Stock variables:** system variables which define current system state (e.g. fossil-fuelled heatings)



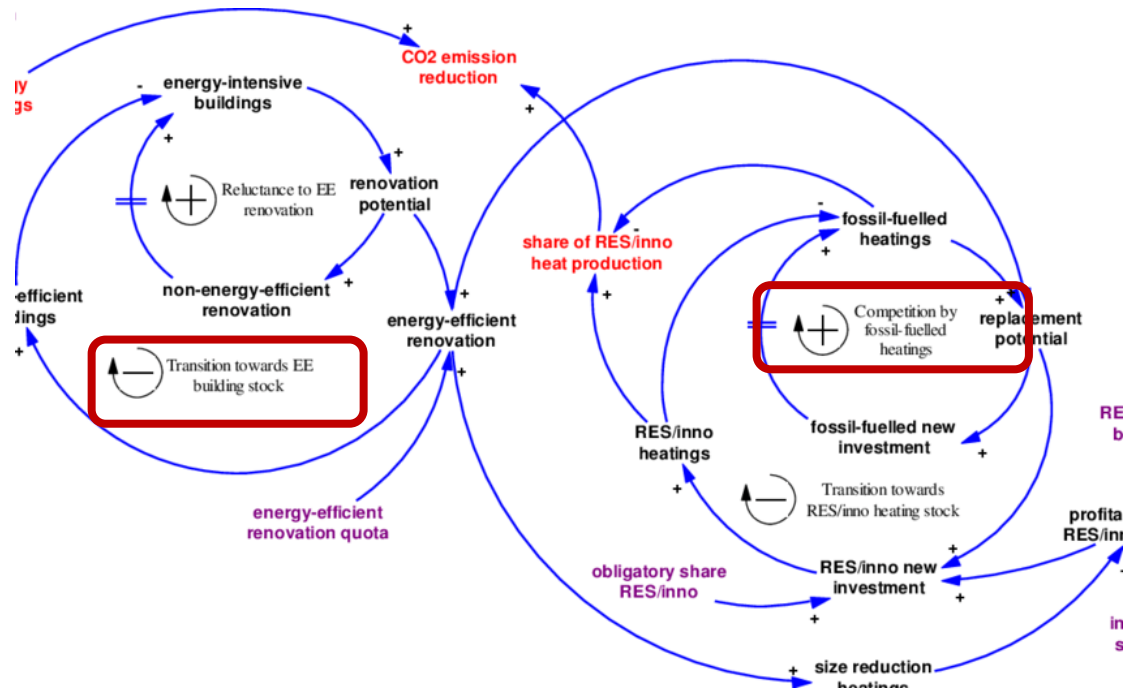
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System Dynamics

The Method

Four main milestones:

2. Feedback loops: positive or negative reinforcement



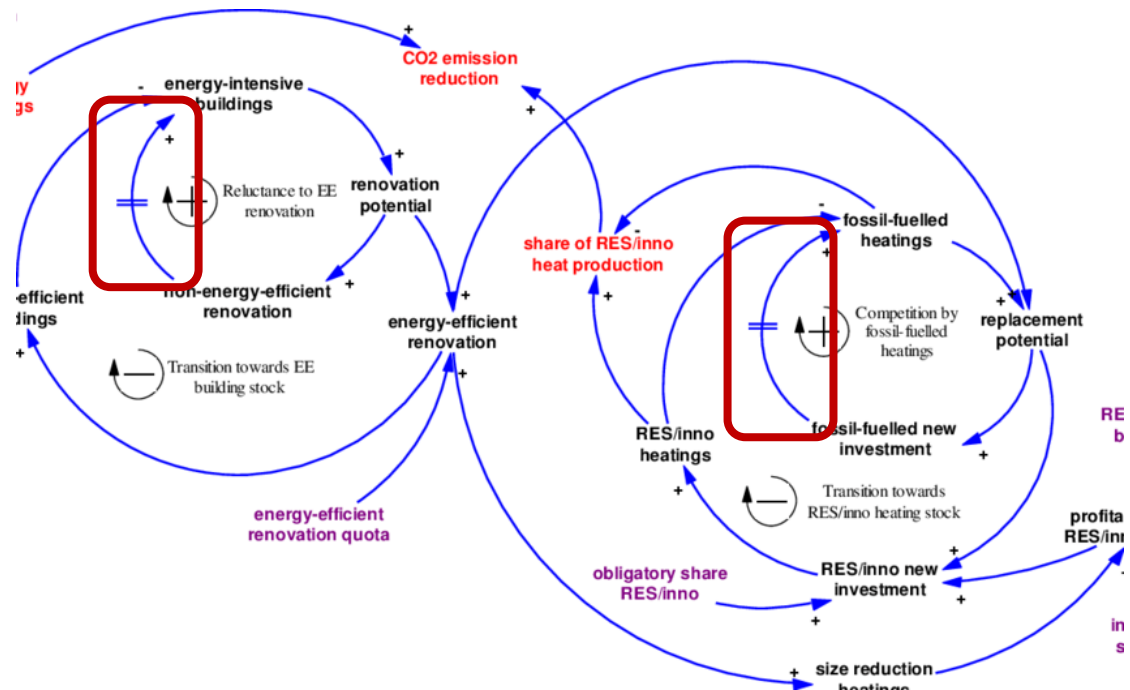
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Four main milestones:

3. Delays:



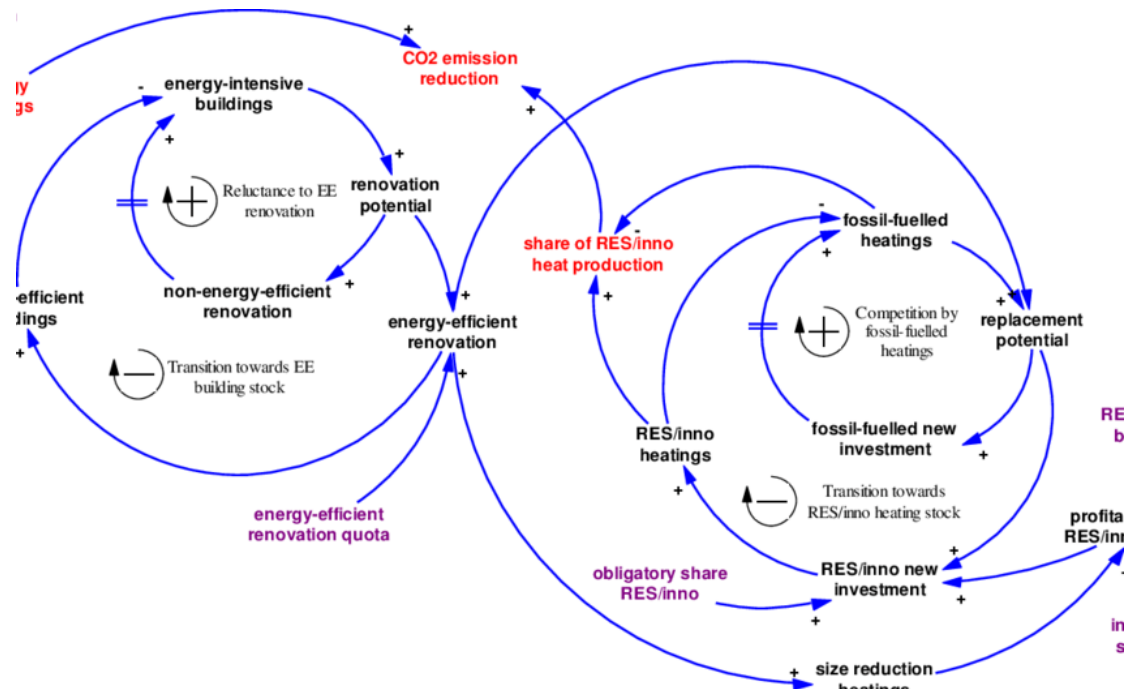
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System Dynamics

The Method

Four main milestones:

4. Non-linear behaviour: relations between variables governed by non-linear dynamics



All variables of state linked in feedback loops → determined **within the model!**

Source: Schmidt et al, 2012

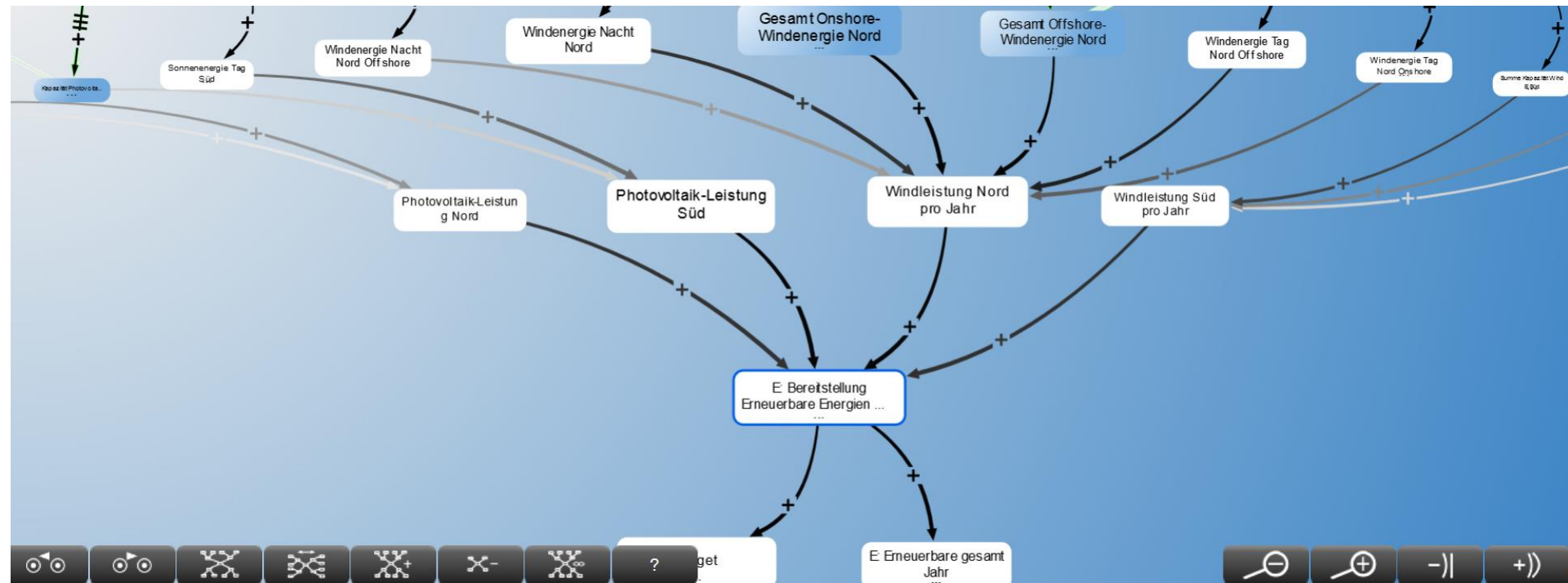
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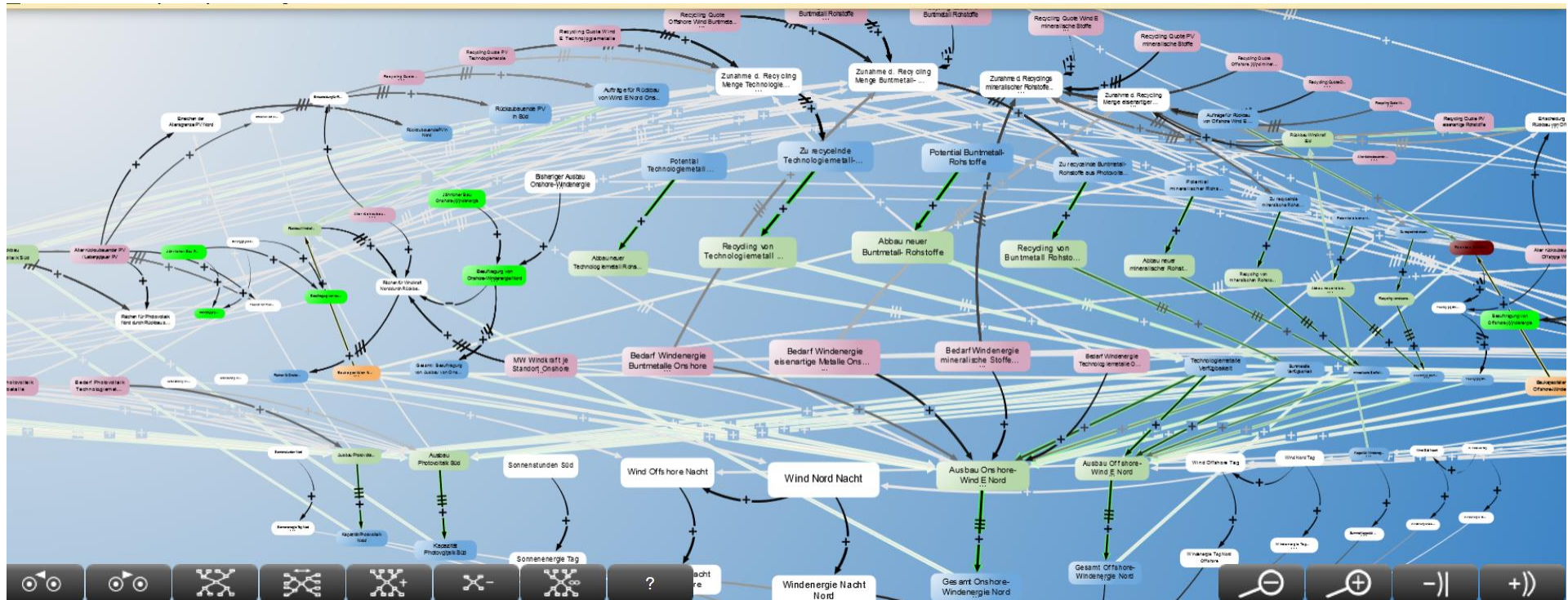
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System Dynamics

Example

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References

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Schmidt et al. 2012. The Transition of the Residential Heat Market in Germany - A System Dynamics Approach. July 2012, In: International Conference of the System Dynamics Society At: St. Gallen, Switzerland.

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