

Ganymed – Generating Synthetic Industrial Load Profiles

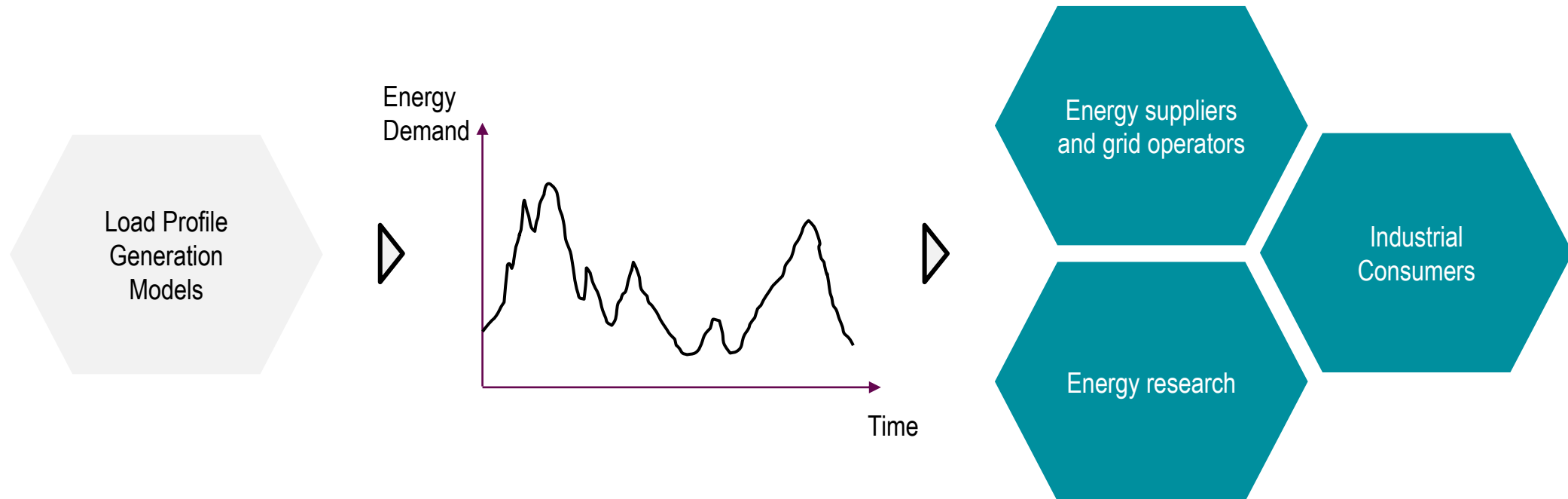
NEFI Conference 2022

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Motivation and Open Research Areas

- Increasing digitalisation and implementation of renewable energies demand the development of flexible and digitalised energy system models
- Time resolved load profile generation models are key for various challenges in energy related research areas



Motivation and Open Research Areas

- Recent holistic industrial load profile models are only developed within two categories:



- Our Aim: Development of a standalone application for generating time resolved energy consumption profiles of all industrial subsectors including all necessary process, production and subsector specific data

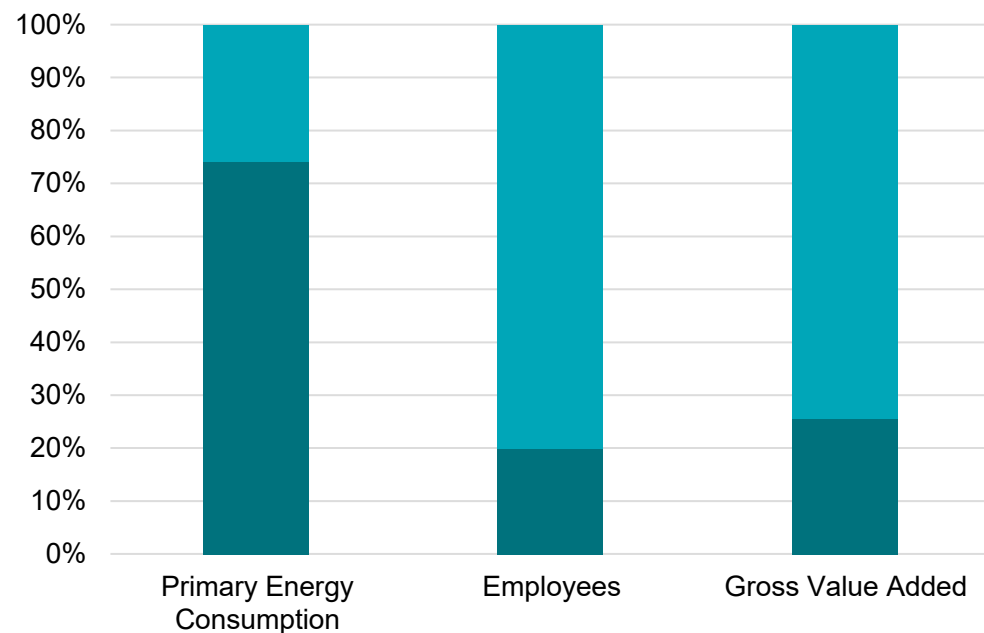
The Industrial Sector in Austria

Energy Intensive Subsectors

- Iron & Steel
- Pulp & Paper
- Chemical & Petrochemical
- Non-Metallic Minerals

Non-Energy Intensive Subsectors

- Wood & Wood Products
- Machinery
- Food, Beverages & Tobacco
- Mining & Quarrying
- Automotive
- Textiles & Leather
- Non-Ferrous Metals



- Both subsectoral classes are to be included in holistic industrial energy system analyses

[2]...Statistic Austria, Useful Energy Analysis Austria, 2022

[3]...Statistic Austria, Structural Business Analysis Austria, 2022

Developing *Ganymed*

■ Energy Intensive Subsectors



Bottom-Up

■ Non-Energy Intensive Subsectors



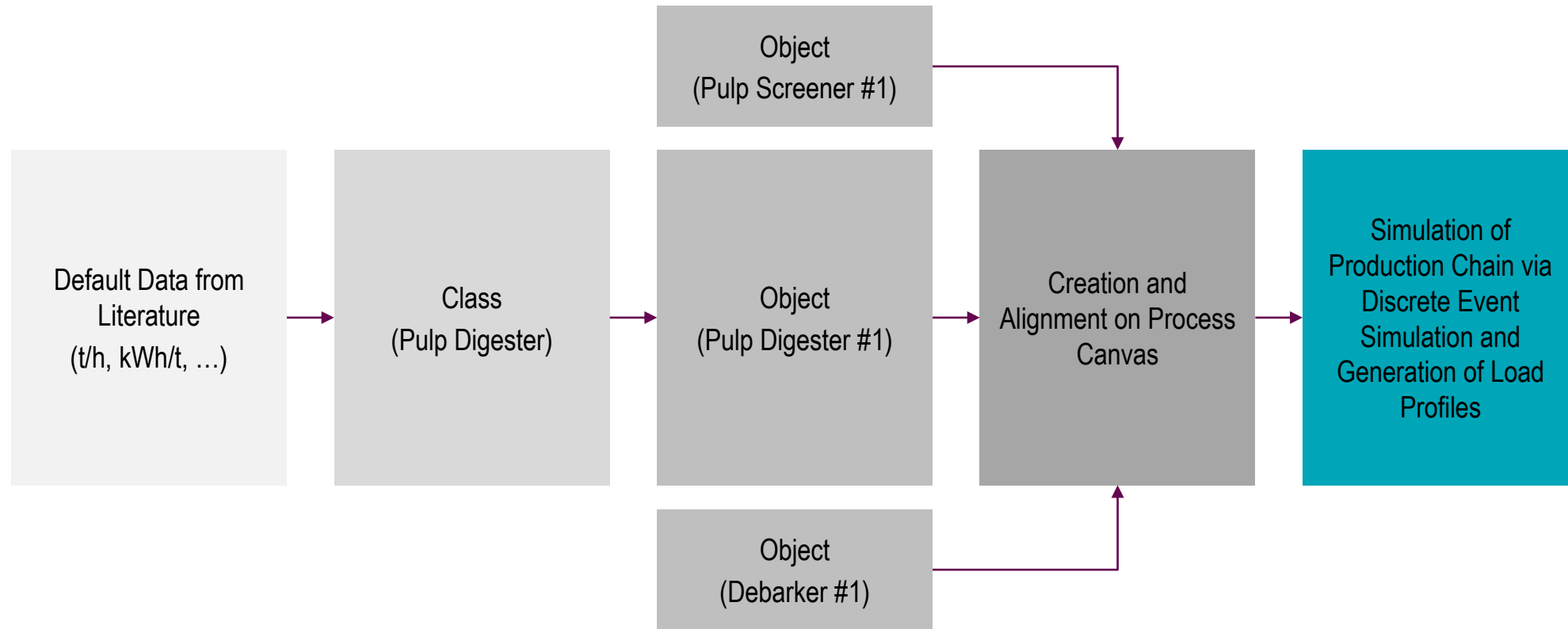
Top-Down

Number of Varying
Processes and
Principles

Well Documented
Process in Literature

Approach

Handling Energy Intensive Subsectors Bottom-Up



Handling Energy Intensive Subsectors Bottom-Up

Ganymed - Industrial Load Profile Generator

General Set & System Objects Processes Templates

Ganymed > New canvas Ready

Calculation & Results Sheet

Preferences for Pulper & Digester

Overall Process & Demand Settings **Excess Heat Settings**

Process Settings:

State of the Process: Continuous Batch

Unit Size: t_e

Turnover Time: min

Process Duration for Chosen Unit Size: min

Product Intake Temperature: °C

Operating Temperature: °C

Energy Demand-Related Specifications:

Specific Consumption Consumption Time Series

Specific Consumption of: kWh/t_e

Reference (re) Settings:

Defined Reference Stream: re

Mass Conversion: t_{re}/t_{main}

Stochastic Settings:

Standard Deviation of Demand for: kWh/t_e

Standard Deviation of Turnover Time: min

Probability of Usage (Products will be Bypassed): %

Delete Process Block Cancel OK

Start

Main Product

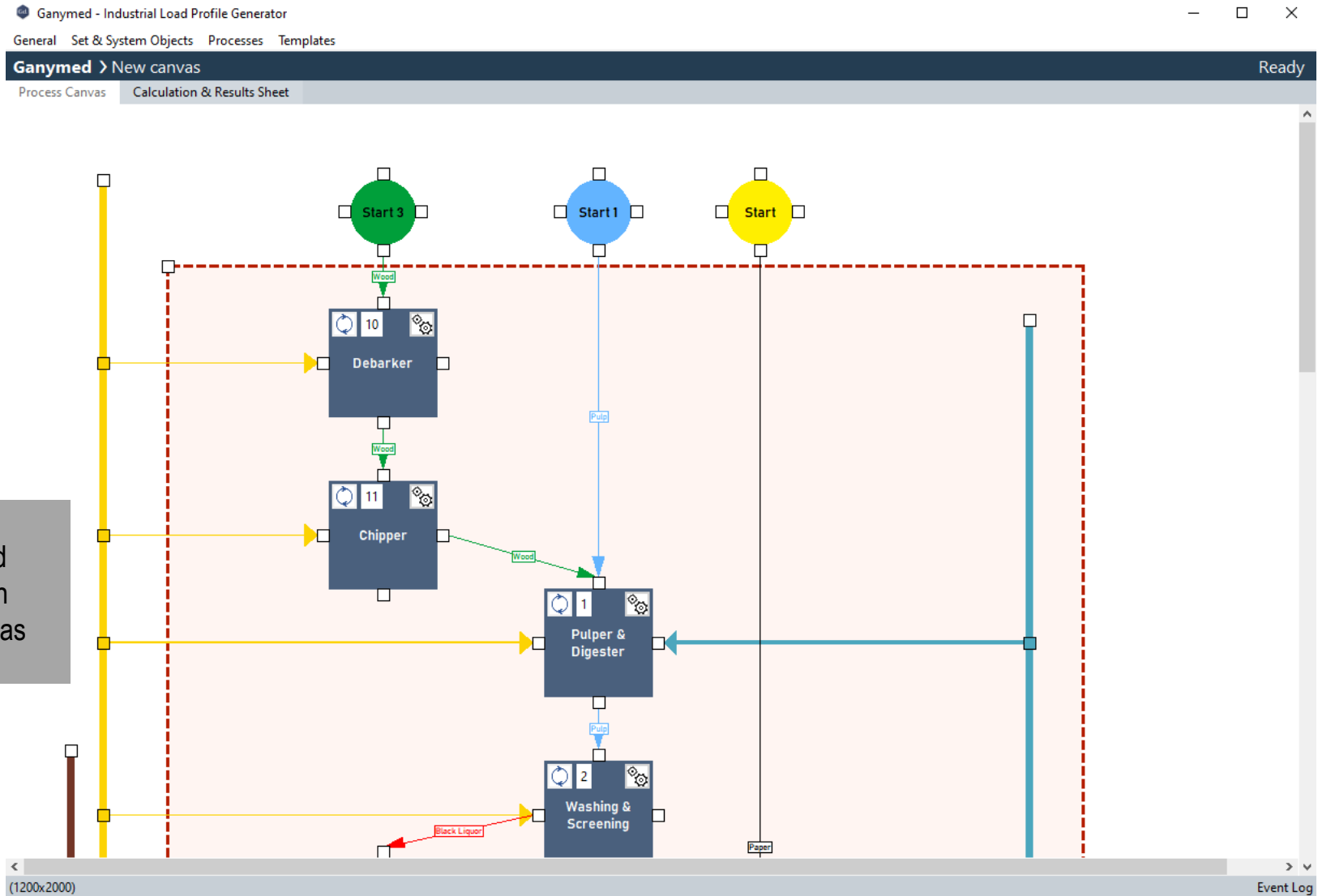
Pulper & Digester

Debarcker

Default Data from Literature

(1100x600) Event Log

Handling Energy Intensive Subsectors Bottom-Up



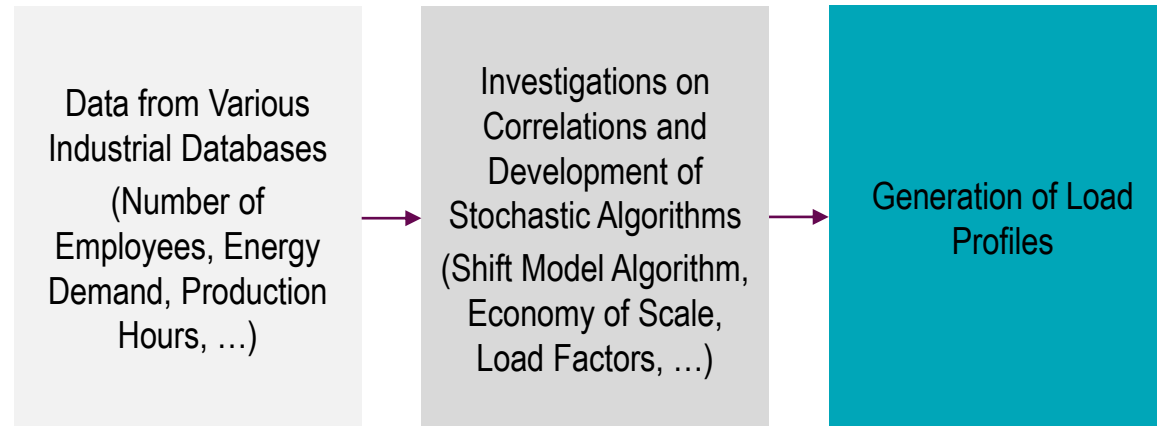
Creation and Alignment on Process Canvas

Handling Energy Intensive Subsectors Bottom-Up

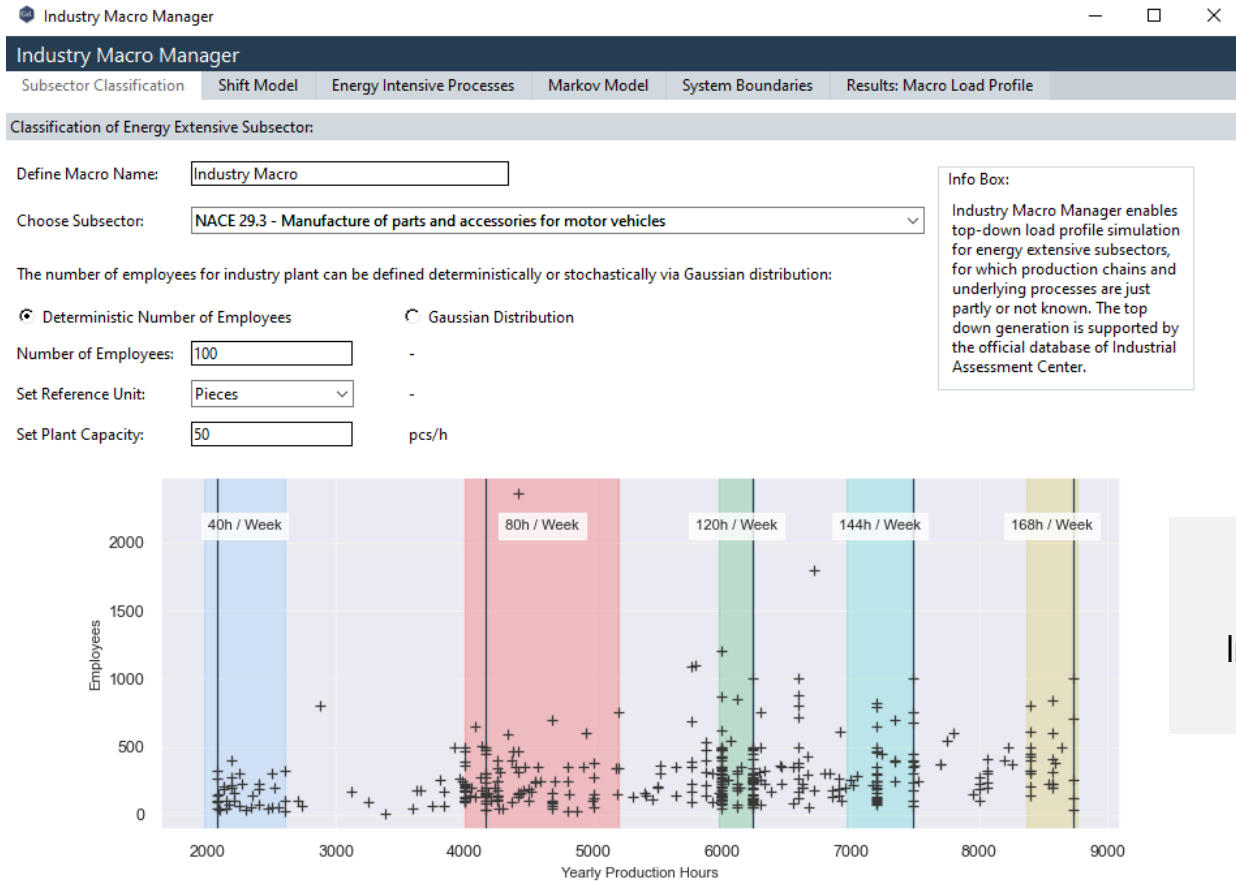


Simulation of Production Chain via Discrete Event Simulation and Generation of Load Profiles

Handling Non-Energy Intensive Subsectors Top-Down



Handling Non-Energy Intensive Subsectors Top-Down



Data from Various Industrial Databases

Cancel

Next

Handling Non-Energy Intensive Subsectors Top-Down

Investigations on
Correlations and
Development of
Stochastic Algorithms

Industry Macro Manager

Industry Macro Manager

Subsector Classification | Shift Model | Energy Intensive Processes | Markov Model | System Boundaries | Results: Macro Load Profile

Stochastic Shift Model Algorithm:

Stochastic Shift Models:
The figure on the left shows the data density of the available data on production hours and employees of anonymous industrial plants in the subsector NACE 29.3 - Manufacture of parts and accessories for motor vehicles. The introduction of the chosen number of employees shows the weekly operating hours in correspondence with shift models with the highest probability of implementation.

Operating hours with highest probability to be implemented: 120h / Week via

Shift Model Configuration:
Adapt the starting times the corresponding shifts of the chosen shift model with the sliders below.

06:00 - 14:00
14:00 - 22:00
22:00 - 06:00

Specify start of shift break and duration:

Break Start: min
Duration: min

Cancel Back Next

Handling Non-Energy Intensive Subsectors Top-Down

Generation of Load Profiles

Industry Macro Manager

Industry Macro Manager

Subsector Classification | Shift Model | Energy Intensive Processes | Markov Model | System Boundaries | Results: Macro Load Profile

Load Factor Implementation and Generated Load Profiles for Selected Industry Macro:

Load Profile Adaption:

A possible load factor for a fictitious plant in the subsector NACE 29.3 - Manufacture of parts and accessories for motor vehicles is proposed below, however, can be adapted freely. Based on this load factor, the ratio of base and peak load of the generated load profile on top of the Markov Model for energy intensive processes is calculated. The final load profile of the Industry Macro can be seen in the figure below.

Electricity:

Determined Load Factor: -

Determined Weekly Peak: kW

Direct Fuel:

Set Month of Calculation:

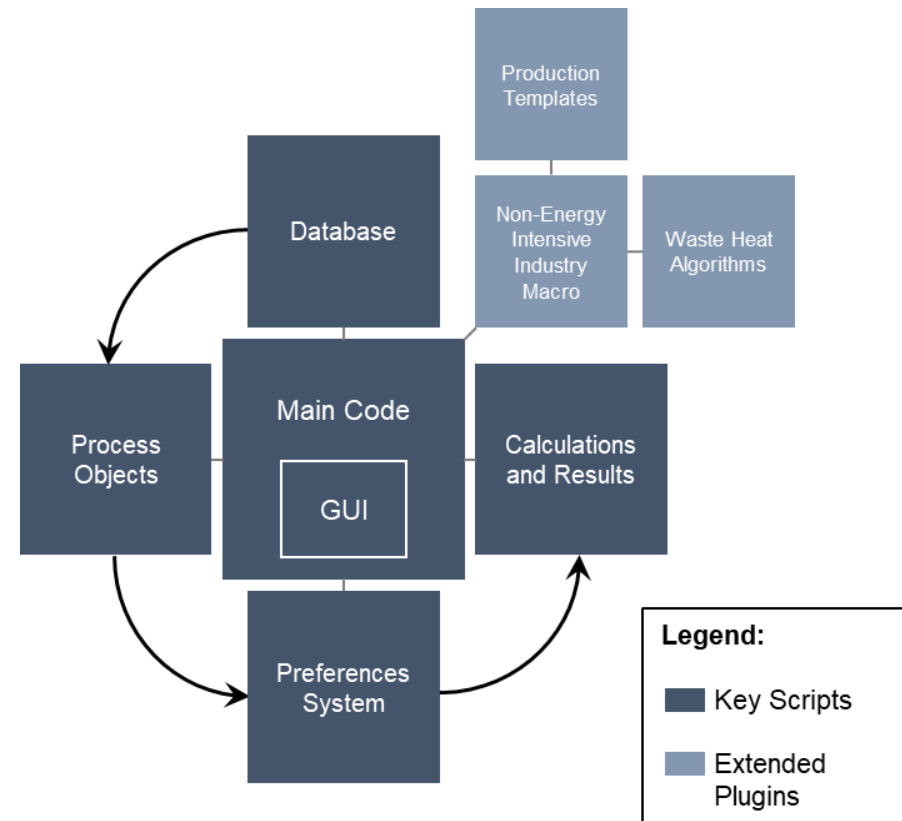
Determined Load Factor: -

Determined Weekly Peak: kW

Cancel Back Save

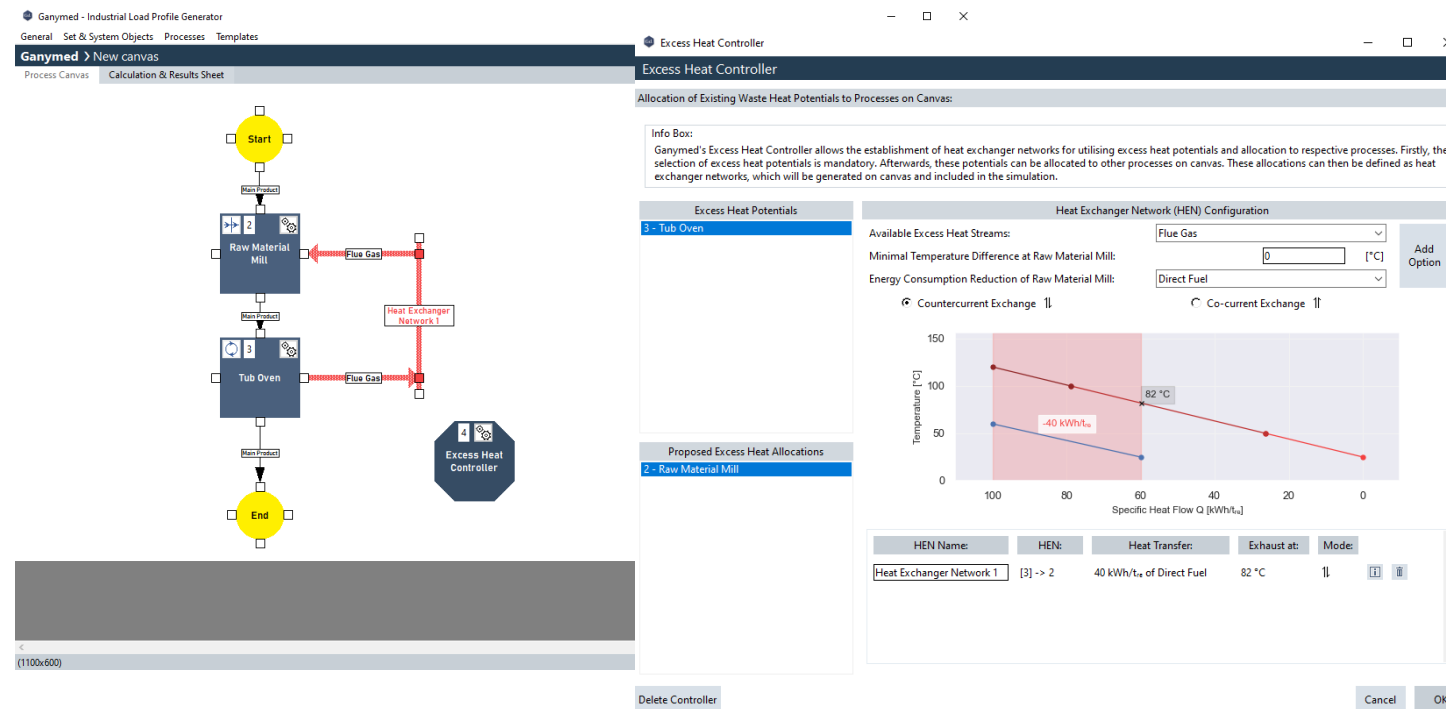
Building *Ganymed*

- *Ganymed* based upon programming language Python
- Main Code connects auxiliary scripts and is responsible for visual representation in GUI
- Processes are created via object-oriented programming logic
- Methodology for non-energy intensive subsectors and stochastic methods realised as plugins
- .exe-File including all necessary databases



Ganymed in the Future

- Methodology for calculating time resolved waste heat profiles is now implemented in *Ganymed*



Excess Heat Controller

Allocation of Existing Waste Heat Potentials to Processes on Canvas:

Info Box:
Ganymed's Excess Heat Controller allows the establishment of heat exchanger networks for utilising excess heat potentials and allocation to respective processes. Firstly, the selection of excess heat potentials is mandatory. Afterwards, these potentials can be allocated to other processes on canvas. These allocations can then be defined as heat exchanger networks, which will be generated on canvas and included in the simulation.

Excess Heat Potentials

- 3 - Tub Oven

Heat Exchanger Network (HEN) Configuration

Available Excess Heat Streams: Flue Gas

Minimal Temperature Difference at Raw Material Mill: 0 [°C]

Energy Consumption Reduction of Raw Material Mill: Direct Fuel

Counter-current Exchange | Co-current Exchange

Temperature [°C] vs. Specific Heat Flow Q [kWh/t_w]

40 kWh/t_w

82 °C

| HEN Name: | HEN: | Heat Transfer: | Exhaust at: | Mode: |
|--------------------------|----------|--------------------------------------|-------------|-------|
| Heat Exchanger Network 1 | [3] -> 2 | 40 kWh/t _w of Direct Fuel | 82 °C | |

Delete Controller

Cancel OK

- Updated software versions will be made available online as free-to-use
- Beta Website and more information at ganymed.ga

Thank you for your attention!



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