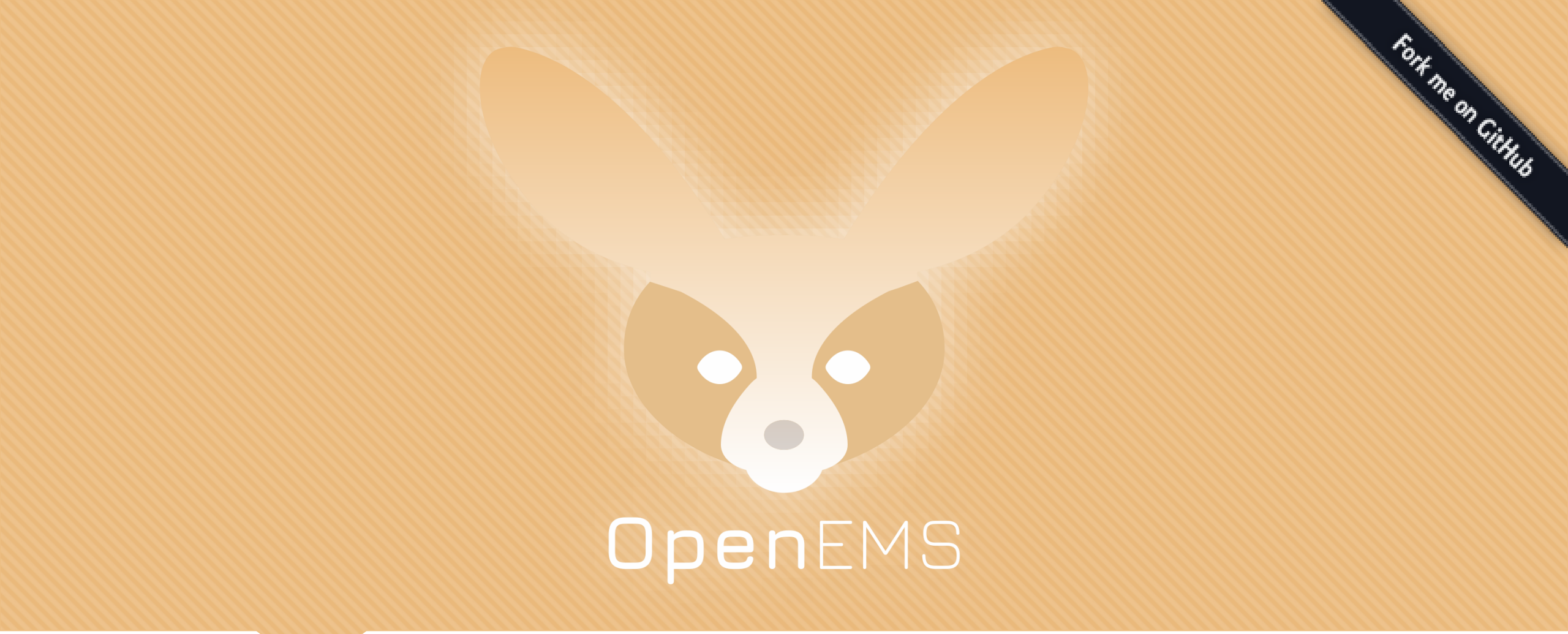
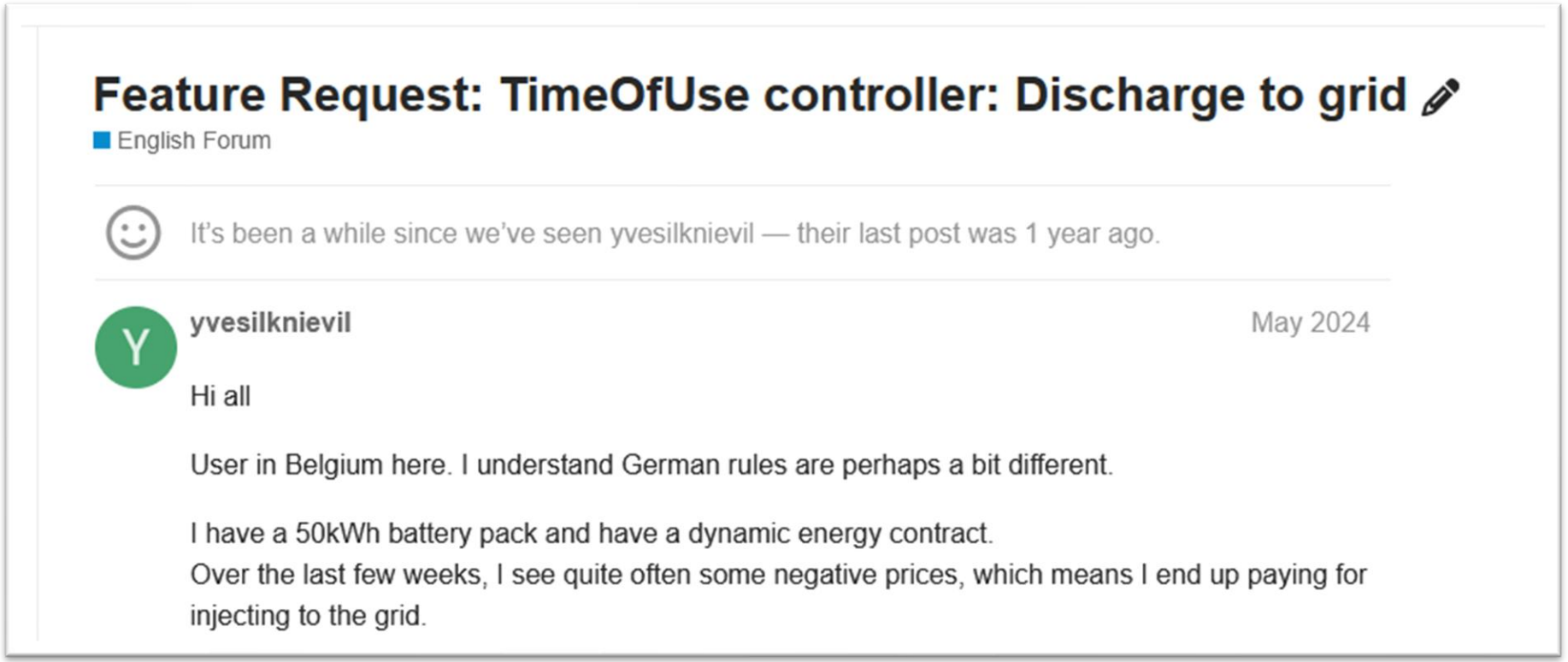


Energy Scheduler v2 & Genetic Algorithms

Networking Friday - 4th April 2025 - Stefan Feilmeier

Community engagement

Discussions in OpenEMS Community: https://community.openems.io/



Feature Request: TimeOfUse controller: Discharge to grid

English Forum

It's been a while since we've seen yvesilknievil — their last post was 1 year ago.

yvesilknievil May 2024

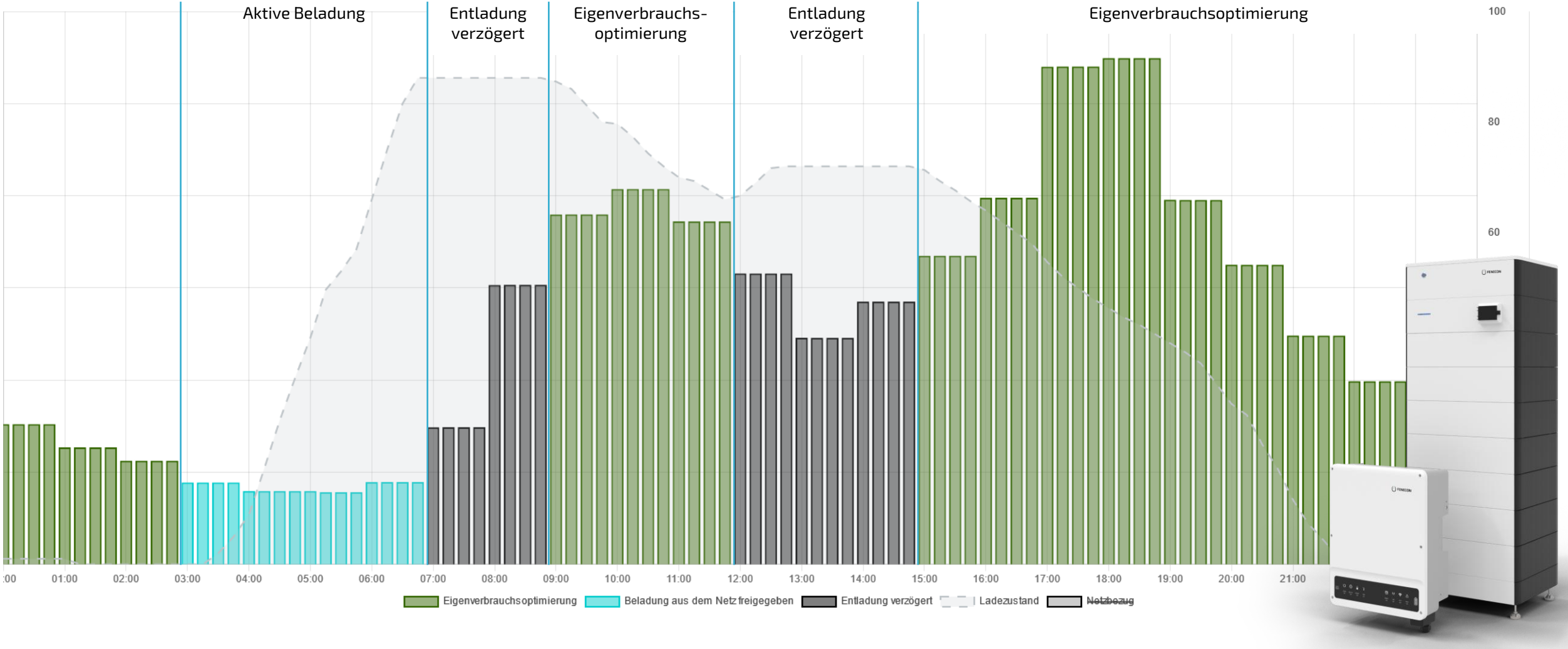
Hi all

User in Belgium here. I understand German rules are perhaps a bit different.

I have a 50kWh battery pack and have a dynamic energy contract.
Over the last few weeks, I see quite often some negative prices, which means I end up paying for injecting to the grid.

Energy-Schedule with a battery in Winter

Minimize Buy-From-Grid costs



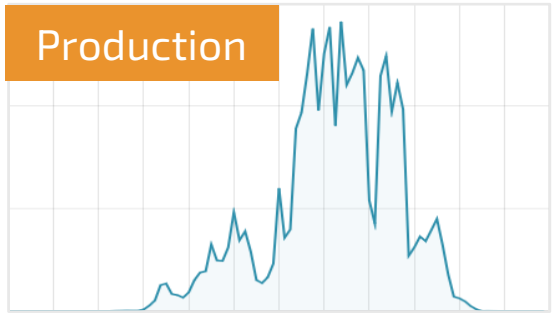
AI-based schedule management

Integrated and modular software architecture in OpenEMS

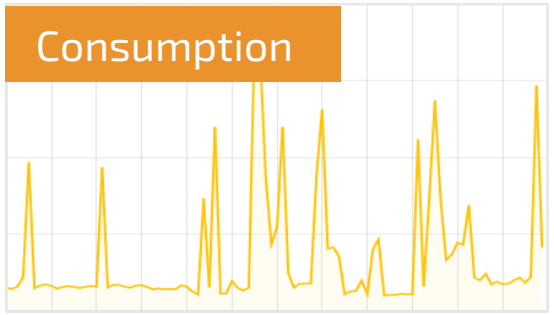
every 15 Minutes

forecast

Production



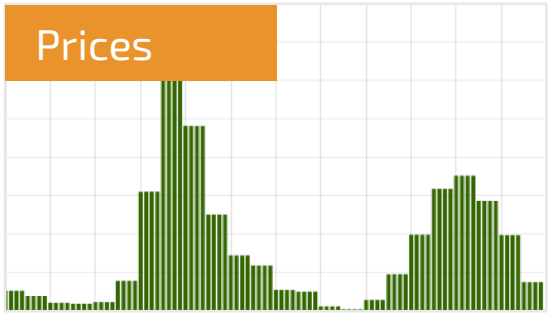
Consumption



daily

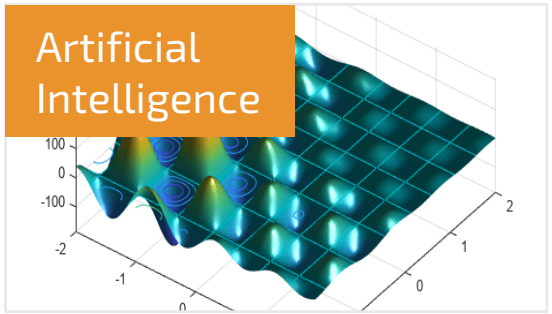
receive

Prices



optimized

Artificial Intelligence



simulieren

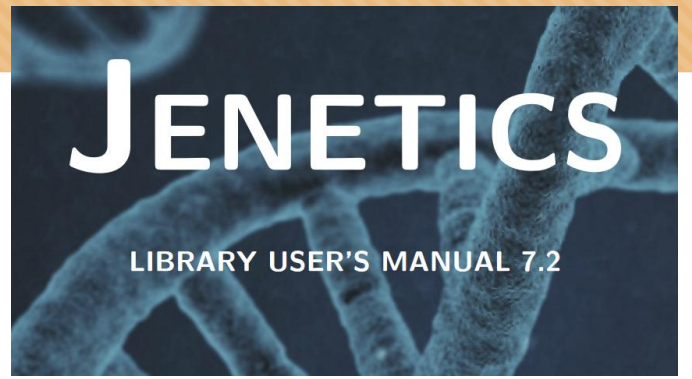
selektieren

Digital Twin

execute

Energy Schedule	
00:00 – 00:15	…
00:15 – 00:30	…
00:30 – 00:45	…
00:45 – 01:00	..
01:00 – 01:15	…
…	…

Genetic Algorithms



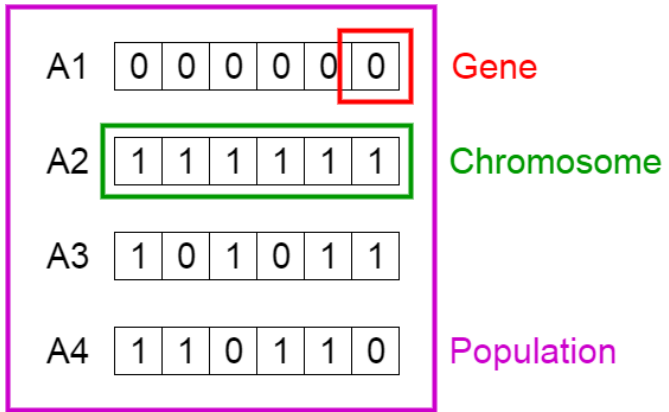
„Genetische bzw. Evolutionäre Algorithmen (EA) sind eine Klasse von stochastischen, metaheuristischen Optimierungsverfahren, deren Funktionsweise von der Evolution natürlicher Lebewesen inspiriert ist.“

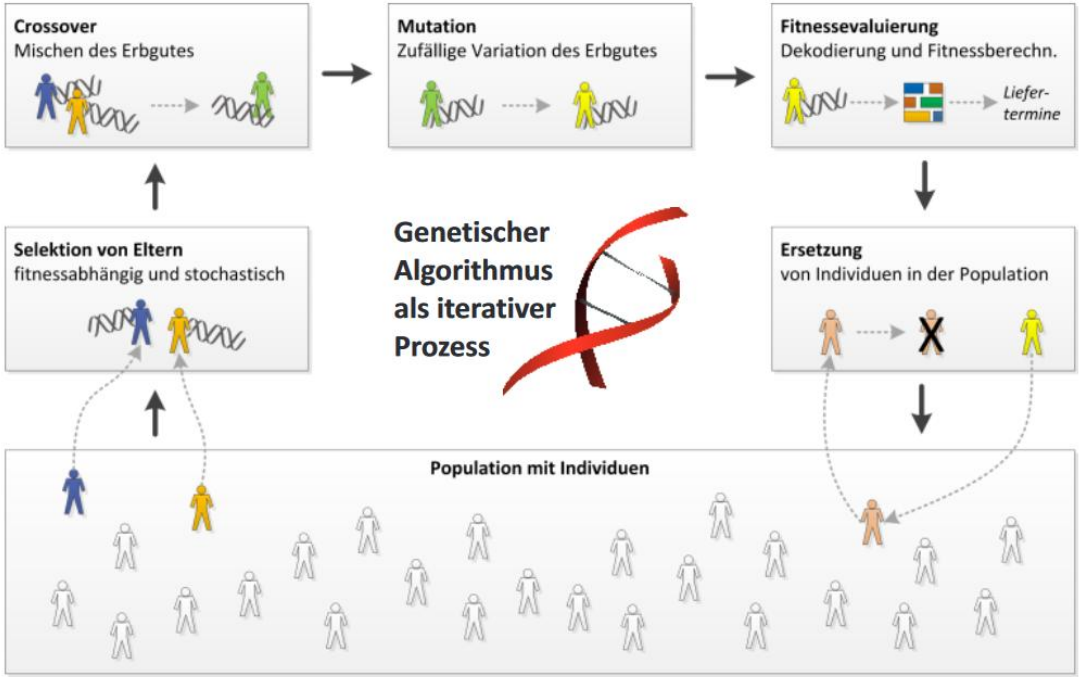
„Oft führen Aufgabenstellungen der **Künstlichen Intelligenz (KI)** zu Optimierungsproblemen. Diese werden je nach Struktur entweder mit Suchalgorithmen aus der Informatik oder, zunehmend, mit Mitteln der mathematischen Optimierung gelöst. Bekannte heuristische Suchverfahren aus dem Kontext der KI sind evolutionäre Algorithmen.“

(Wikipedia)

Genetic Algorithms

- Gene
  = Mode of a Controllers within a period
- Chromosome
  = Schedule
- Population
  = Multiple Schedules
- Fitness function
  = Calculates fitness (cost) of a Schedule





https://www.tu-chemnitz.de/wirtschaft/bwl7/optsys/framework/Brosch%C3%BCre.pdf

Energy Scheduler v1 vs v2

- In common:
  - Usage of Genetic Algorithms
  - Split real-time control from energy-schedule
- Energy Scheduler v1
  - Works only with battery
  - Simple and very fast calculations
  - Used in production on thousands of EMS
- Energy Scheduler v2
  - Universal with all kinds of devices and controllers (e.g. EV-Charging)
  - Work in progress

One Mode vs. Different Modes

- Fix-Active-Power-Controller

- Time-of-Use-Tariff Controller
- Electric Vehicle Controller

Terminology

- Schedule
- Mode
- Period
- Context
- Chromosome - Gene

https://github.com/OpenEMS/openems/blob/develop/io.openems.edge.energy/readme.adoc

OpenEMS Energy

Implementations and Services for OpenEMS Energy Schedules.

To understand the functionality and terms used in this implementation, its helpful to refer to the Jenetics manual available at https://jenetics.io/.

Terms

Following terms and relations to Jenetics are used:

Mode

The Mode refers to a predefined operation mode of a OpenEMS Controller. A Mode is represented in Jenetics as a `Gene`.

Period

The Period refers to a space in time. A Period holds one Mode per OpenEMS Controller to define its operation mode within this period of time. A Period is represented in Jenetics as an index within a `Genotype` of `Chromosome` s.

Schedule

A Schedule refers to a set of multiple Periods. A Schedule is represented in Jenetics as a `Genotype`.

Optimization

A Optimization consists of multiple Schedules that are typically simulated within a 15-minutes period. A Optimization is represented in Jenetics as a `Population`.

Context and their Scopes

Energy Scheduler uses `Context` objects that hold information that is relevant to a certain Scope of an Optimization run.

OpenEMS Controllers use delegation to `EnergyScheduleHandler` objects to handle requirements of the Energy Scheduler.

GlobalOptimizationContext (`goc`)

The GlobalOptimizationContext - commonly abbreviated as `goc` - is a Context that is valid throughout an entire Optimization. It's typically recreated once per 15-minutes.

Example data: - Prediction of Production and Consumption - List of all Energy Schedulers - Global Limits like a limited Grid power - ...

GlobalScheduleContext (`gsc`)

The GlobalScheduleContext - commonly abbreviated as `gsc` - is a Context that is valid for simulation of one Schedule. It's typically recreated multiple times per second.

Example data: - Initial Energy of an ESS at the start of a Period.

ControllerOptimizationContext (`coc`)

The ControllerOptimizationContext - commonly abbreviated as `coc` - is a Context that is valid throughout an entire Optimization for one Controller/EnergyScheduleHandler. It's typically recreated once per 15-minutes.

ControllerScheduleContext (`csc`)

The ControllerScheduleContext - commonly abbreviated as `csc` - is a Context that is valid for simulation of one Schedule of one Controller/EnergyScheduleHandler. It's typically recreated multiple times per second.

FENECON Energy Management System (FEMS)

https://www.thesmartere-award.com/hall-of-fame

Get Started

- RunOptimizerApp
  - Simulated environment
- RunOptimizerFromLogApp
  - Re-Run log from real system