

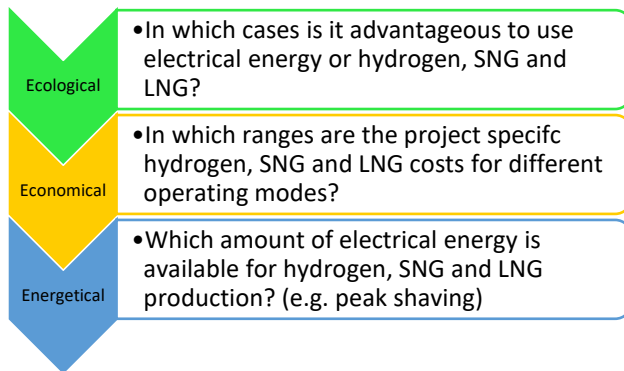
# EnergieSynergie

## PtG Tool

Simulation tool for ecological, economic and energetic analysis for production prediction of hydrogen / SNG<sup>1</sup> and LNG<sup>2</sup> in combination with renewable energies (wind / PV / hydropower / biomass).

With EnergieSynergie PtG Tool project specific parameters for hydrogen - SNG - LNG production in combination with renewables could be analysed.

PtG Tool target:



The entire value chain from renewables to electrolysis to methanation (SNG) to liquefaction (LNG) for any project-specific location can be automatically simulated.

The PtG simulation focuses on calculation of levelized costs of hydrogen - SNG - LNG, the analysis of economic efficiency and CO<sub>2</sub> reduction potentials.

Furthermore, key performance indicators (KPIs) used to identify sensitivities and scenarios for project-specific requirements.

Also, the evaluation for hydrogen - SNG - LNG production with non-feedable electrical energy (feed-in management - EinsMan) is possible.

The simulation based on project-specific 10-minute SCADA feed-in data (wind energy, photovoltaic, hydropower, biomass).

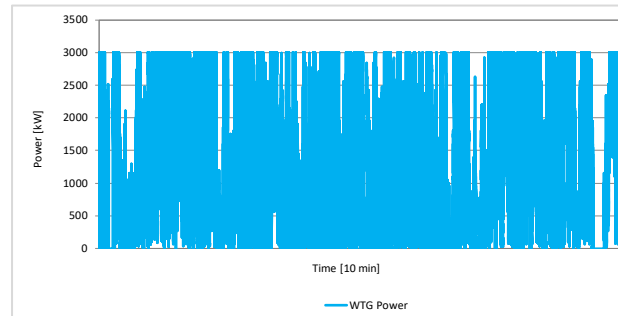


Figure 1: Evaluation of the annual feed-in of a 3 MW wind turbine

If 10-minute SCADA data are not available, local wind speed or solar radiation data from weather services used as input for the calculations. In the next step e.g. local wind speeds in combination

with project-specific wind turbine power curves used to determine feed-in data.

A lot of wind turbines power curves from Vestas, Siemens, Enercon, GE, etc. are available in the PtG Tool.

Eventlogs for determining EinsMan events can also be automatically integrated for a specific project.

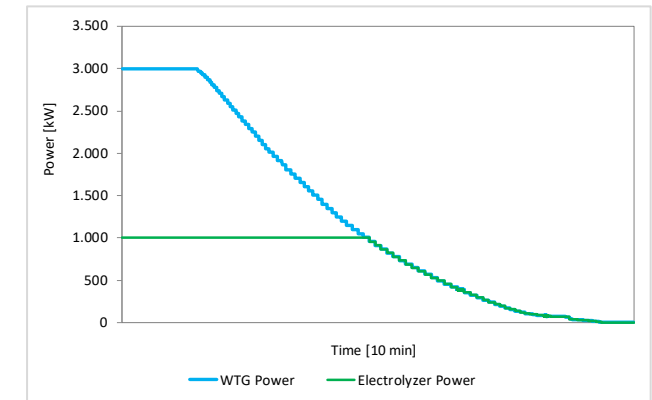


Figure 2: Annual load duration curve of a 3 MW wind turbine (blue) coupled with 1 MW electrolyzer (green).

In the PtG tool project-specific frame conditions could be defined like power purchase options (e.g. self-supply or power purchase from third parties) or different operation modes (e.g. base load or peak shaving).



<sup>1</sup> SNG = synthetic Natural Gas based on renewables

<sup>2</sup> LNG = liquefied SNG

## What is the purpose of the PtG Tool?



### 1. Renewable energy

- Preparation of 10-minute SCADA data. In a first processing, missing data records are determined, replaced and the data quality is calculated.
- If SCADA data is not available, weather data (wind speed, solar radiation) used to calculate the feed-in based on specific power curves.
- Optional: integration of EinsMan.
- Calculation of the levelized cost of energy and earnings.
- Calculation CO<sub>2</sub> emission reduction potential in mobility and heating sector compared to direct use of electrical energy.

### 2. Hydrogen



- All calculations based on project specific wind-, solar-, hydropower or biomass data (point 1).
- Calculation of hydrogen quantities in Nm<sup>3</sup> and kg in 10 min steps (52,560-time stamps per year.)
- Calculation of CO<sub>2</sub> emission reduction potential for the mobility and heating sector.
- Calculation of the range of H<sub>2</sub> cars with amount of produced hydrogen.
- Calculation of sensitivities and/or scenarios to figure KPIs for different boundary conditions.
- Calculation of hydrogen production costs and earnings for selected cases:

- Minimal hydrogen costs based on base load.
  - Minimal hydrogen costs based on peak shaving.
  - Minimum production costs for a defined amount of hydrogen (base load).
  - Minimum production costs for a defined amount of hydrogen (peak shaving).
- Calculation of electrolyzer load.

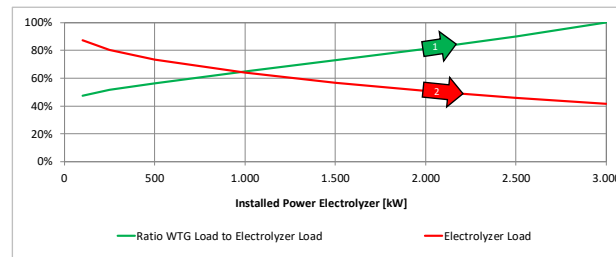


Figure 3: Example, specific and relative electrolyzer and wind turbine load

### 3. SNG and LNG



Calculation of SNG and LNG quantities based on project-specific hydrogen scenarios (point 2).

### 4. Outlook - Look Forward Tool



The look forward simulation tool forecasts your hydrogen - SNG - LNG production for the next days based on weather forecasts.

## 5. Benchmarking the CO<sub>2</sub> emission reduction potential



The calculated specific CO<sub>2</sub> emissions are compared to hydrogen colouring, e.g. green, turquoise, blue, grey hydrogen.

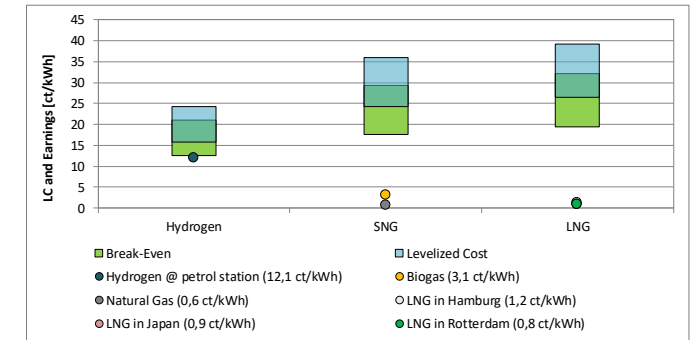


Figure 4: Example, production costs of hydrogen, SNG and LNG, as well as earnings estimations

Please contact us for an individual offer.

EnergieSynergie

Garveshellmer 1

26939 Ovelgönne

info@energiesynergie.de

www.energiesynergie.de

T +49 (0) 4480 233 125

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