



HOW TO GUIDE

# Fuel producing units in energyPRO





Software for techno-economic analyses of energy projects

#### Preface

energyPRO is a Windows-based modeling software package for combined techno-economic analysis and optimisation of complex energy projects with a combined supply of electricity and thermal energy from multiple different energy producing units.

The unique programming in energyPRO optimises the operations of the plant including energy storage (heat, fuel, cold and electrical storages) against technical and financial parameters to provide a detailed specification for the provision of the defined energy demands, including heating, cooling and electricity use.

energyPRO also provides the user with a detailed financial plan in a standard format accepted by international banks and funding institutions. The software enables the user to calculate and produce a report for the emissions by the proposed project.

energyPRO is very user-friendly and is the most advanced and flexible software package for making a combined technical and economic analysis of multi-dimensional energy projects.

For further information concerning the applications of energyPRO please visit <u>www.emd.dk</u>.

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### 1. Introduction

In energyPRO it is also possible to integrate fuel producing units. Fuel producing units are able to produce output fuel other units need as input fuel and this 'How to Guide' therefore shows you how to incorporate these with point of departure in an example of an electrolysis unit producing hydrogen from electricity.

### 2. Project example

To begin with open the file "Fuel producing unit" found on <u>C:\energyPRO Data\English\Project examples</u> Press open and a similar set up as the one on Figure 1 should appear.



Figure 1. Open the file "Fuel producing unit"

It is a simple example with an electrolysis unit using electricity to produce hydrogen. The fuel hydrogen is saved in a fuel storage and consumed by an engine, which produces electricity. The electrolysis unit is operating in the night tariff, while the engine is operating in the day tariff.

## 3. Enabling fuel producing units

To enable fuel producing units in the project you need to set a checkmark in the "Project identification"-folder as shown on Figure 2.

	Advanced	
	<ul> <li>Delivery of both heat and process heat</li> <li>Starting up of production units is slow and expensive</li> <li>Fuel producing energy units in project</li> </ul>	
ŀ	Figure 2. Mark "Fuel producing energy units in project"	

#### 4. Energy conversion unit

Upon check marking the box in "Project identification" you should open the "Electrolyse"-folder in the "Energy conversion unit"-folder and a similar window as the one on Figure 3 should appear.

Electrolyse	_	_	_	_	_	-	
Name: E	lectrolyse						
Production unit ty	pe User defin	ied 🖂	Non availabi	ity periods			
Fuel input	(no fuel)	~					
Fuel output	hydrogen	~					
Powerunit		MW 🕥					
Power curves	ne (nours):			Fuel and and	11	<b>-</b>	0
Operation F	uel input	Elec. consump	Heat Consump	Fuel output	Heat	Elec. power	Coo
Linoar	0.0	2.0	0.0	1.0	0.0	0.0	
Linear	0,0	2,0	0,0	1,0	0,0	0,0	
< Add line De	elete line E	Enable formulas	# in power curve				>

Figure 3. Open the "Electrolyse"-folder

You have to change the "Production unit type" to User defined and add the Fuel output in the "Power curves".

#### 5. Fuel

Typically, the produced fuel has restrictions in the amount of offered fuel and a fuel storage. Therefore, open the Hydrogen-folder under "Fuels" in order to mark the restrictions and the size of these in the window as shown on Figure 4.

🧯 hydrogen	_	_	_	_	_
Name: hydrogen					
Unit: MW	/h		Hea	t value	1,00 MWh/MWh 🗠
Advanced					
<ul> <li>Restrictions</li> </ul>	and storage	Fuel storage,	max utilizabl	e content	10,00 MWh
Offered fuel a	as time series				
Unit	MW				
<u>#</u> [	Date 🛛 🕹	[MW]		Copy all	
1 0	01-01-2012 00:00:00		0,0000	Copy selected	
				Dente	

Figure 4. Add restrictions and fuel storage to the fuel

#### 6. User defined operation strategy - only

When working with fuel producing units the "Operation strategy" has to be user defined. It is important to notice that working with fuel producing units also allows for change in the "Fuel Production Strategy" as shown on Figure 5.

Operation Strategy		
O Minimizing Net Production Co	st (NPC)	
User Defined Operation Strate	91	

Figure 5. A new tab emerges when working with fuel producing units

The operation strategy in a fuel producing case is specified by both the settings in the "Production strategy" tab and the "Fuel production strategy" tab.

#### 6.1 Production strategy

The production strategy is specified as in other projects. In the figure below this means that the highest priority is "Electrolyse" in Night tariff, followed by "CHP" in Day tariff, CHP" in Night tariff and finally "Electrolyse" in Day tariff.

🧿 Operation strategy		_ • ×				
Operation Strategy						
Minimizing Net Producti	Minimizing Net Production Cost (NPC)					
Ser Delined Operation	Strategy					
Production Strategy Fuel Prod	uction Strategy Energy Unit Se	tup				
Priority of productions	Day	Night				
Electrolyse	4	1				
CHP	2	3				

Figure 6. Production strategy

#### 6.2 Fuel production strategy - Max allowed priority number

When selecting "Fuel Production Strategy" you have the option of setting the max allowed priority number of fuel producing units as shown below.

🤁 Operation strategy		_ 🗆 🔀
Operation Strategy		
O Minimizing Net Production		
Over Defined Operation St		
Production Strategy Fuel Produc	tion Strategy Energy Unit Se	tup
Max allowed priority number of fuel producing units	Day	Night
CHP	3	0

Figure 7. Selecting the "Fuel Production Strategy"

You have to define the max allowed priority number of fuel producing unit, which is the highest priority number in the "Fuel Production Strategy" the CHP will allow the fuel producing unit to run at.

In this case the CHP needs fuel produced from the fuel producing unit (here electrolysis).

If the CHP is to produce in the day tariff, it will try to start the electrolysis if the priority number of the electrolysis is equal to or below 3 and in night tariff equal to or lower than 0.

Comparing Figure 6 and Figure 7 shows that the electrolysis can only operate in Night tariff. The CHP request a fuel producing unit "electrolyse", with a priority equal to or below 3, this is only possible for "Electrolyse" in Night tariff. In the night tariff the CHP request a fuel producing unit "electrolyse", with a priority equal to or below 0. This is never the case. Hence, the "electrolyse" can only operate in Night tariff and the CHP in Day tariff.

If no fuel storage was present in the model, there would be no production at all.

# 7. Production, graphic

Under "Reports" it is possible to collect reports of the project. In the "Production, graphic" similar figures as the one on Figure 8 can be seen.



Figure 8. "Production, graphic"-report of the project

The CHP operates in Day time emptying the hydrogen store. In the Night time the electrolysis operates and charge the store.

#### 8. Energy conversion, annual

It is also possible to collect other reports such as the "Energy conversion, annual"-report which indicates that the fuel section has changed as seen on Figure 9.

Fuels: Byfuel				
hydrogen	Fuelconsumption 2.604,0 MWh	Fuelproduction 2.604,00 MWh	Offereduel 0,00 MWh	FueInotused 0,00 MWh
Byenergyunit				
Electrolyse	0,0 MWh	2.604,0 MWh		
CHP	2.604,0 MWh	0,0 MWh		
Total	2.604,0 MWh	2.604,0 MWh		
Byenergyunit(inorigin	alfuelunits)			
Electrolyse	0.0	2.604.0 MWh		
CHP	2.604,0 MWh	0,0		

