energy storage system

Memo

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To:

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Subject:

Ecovat charging cycles

Goal:

The goal of this memo is to explain the Ecovat charging cycle excel model. The goal of this model is to determine the number of charging cycles of the Ecovat for a certain project, and ultimately the required storage volume of Ecovat for a 100% renewable heating supply. In this case 100% renewable is defined as if only solar thermal and heat pumps (on wind power) are available.

How to use the model?

Start on the Dashboard of the Excel model.

Only the pink/orange coloured should can be changed in the model. All other cells are formula based cells.

- First, the program of the project should be inserted: number of households, heat demand per household, etc.
- Secondly, the ratio of wind vs. solar thermal can be determined.
- Thirdly, the losses on the district heating network in the losses in the Ecovat can be determined. Then cell C28 will show the number of charging cycles and Cell C38 will give an estimation of the required storage volume.
- Finally, by altering the delta T of storage in cell C32, one can change the required storage volume (but not the required storage capacity and charging cycles). Some project might have a larger delta T than others. This will depend on the temperatures of the district heating and the heating appliances.

How does the model work?

Three profiles are important:

1. The heat demand profile --> sheet "heat demand profile";
2. The production profile --> sheet "production profile";
3. State of charge profile → sheet "Charging cycles".

The first two profiles are normalised profiles (meaning the sum of all 8760 hours is 1). See next chapter "Used data".

The state of charge (SOC) can be determined for each hour of the year by adding the heat production and subtracting the heat demand. This is done in sheet "Charging cycles". The delta between SOC_max

and SOC_min is the required storage capacity. The number of charging cycles can then be determined: Divide the amount of delivered heat by the required storage capacity.

What will increase the number of charging cycles?:

1. More wind compared to solar since wind is more available in winter (this should not be taken into extreme with 100% wind however).
2. Better insulated households since the share of hot tap water will increase. More hot tap water makes the heat demand profile come closer to heat generation.

Used data:

For the production profiles several data sources were used. The data can be found in the Excel:

1. Wind profiles from Windunie. Ecovat has contacted Windunie to provide several wind profiles so that we can determine charging cycles. The goal was to have representative wind profiles for the Netherlands. Therefore, a distinction was made in wind on land vs. wind at sea. Ecovat might have a PPA contract in the future, and thus the difference between land and sea should be known to Ecovat. Also, data of 5 years was requested so that yearly deviations were included in the model. On the request of Ecovat, Windunie has made:
    a. 5 wind profiles (2013 until 2017) of an average Lagerwey L100 2,5 MW turbine on land with an axial height of 100 meters
    b. 5 wind profiles (2013 until 2017) of an average Lagerwey L100 2,5 MW turbine at sea with an axial height of 100 meters.
2. Wind profiles from Entsoe. These were extracted from the Entsoe website after making an account. The goal was to compare these profiles with those of Windunie to see if there are any significant differences. 2 profiles:
    a. Wind production on land in 2015;
    b. Wind production at sea in 2015.
3. Solar profiles of two locations by extracting irradiation data from KNMI. The effect of changing between those locations hardly changes the charging cycles outcome. Namely, ca. 0,02 charging cycles:
    a. Irradiation in Eindhoven;
    b. Irradiation in de Bilt.

For the heat demand two data profiles were used:

1. Temperature dependent profile from NEDU for the space heating profile;
2. Temperature independent profile from NEDU for the hot tap profile.

Project example:

2 projects are shown in column J to Z. These numbers will not change anymore when the numbers in column B to H are adjusted. These 2 projects show the variety of charging cycles by changing several project characteristics, such as wind vs. solar proportions, wind on sea vs. wind on land or even wind profiles of different years. Naturally, any project can still be inserted in column B to H and the result will be shown in cell C38. As illustrated, the number of charging cycles for the project in the Hague has a variety between 1,44 and 3,40 charging cycles.

Further remarks:

1. COP is lower when 100% wind is applied (compared to 50%) since solar thermal can produce higher temperatures more efficiently than heat pumps can;
2. COP is not included in model meaning an average COP is assumed in one year;

3. Heat pumps need a heat source. For example, surface water. When no water based heat source is available, the heat pumps should be air based. This provides constraints in the built environment due to noise limits of the air outlets;
4. Ecovat should match the required volume (cell C38) as close as possible. For each project it can be decided which standard Ecovat size is applied; bigger or smaller than required.