Abstract: This study aims to assess the connection between an energy producing (and consuming) building coupled with an electric vehicle and a stationary electricity storage. The building is equipped with photovoltaic panels used principally for on-site consumption but still grid connected. Using a set of data including meteorological information, electric household appliances consumptions profiles, and different scenarios of transport, the system is simulated using TRNSYS 16 on one year. Priority will be given to household consumption and electric vehicle recharge, directly or via storage. Electric grid is only used if necessary to re-inject electricity left over or as a support. The possibility to recharge the electric vehicle at work, with a photovoltaic production, is also considered. Main purposes of this study are to prove viability and benefits of electric vehicle in such a system, optimize dimensioning of the local electricity production and storage, and estimate possible autonomy level.

Purposes & Assumptions

• Take into account buildings & vehicles for a better global efficiency
• Rationalize photovoltaic production
• Minimize electric grid impact of:
  - Photovoltaic (PV) production
  - Electric vehicle (EV) recharge
• Guarantee quasi-zero emission transport
• No correlation in time between PV production and EV recharge places

Tested solutions:
- Stationary storage
- Recharge EV at work
  - ...

Hypothesis:
- EV specifications: 30 kWh ; 150 Wh/km ; (= Bolloré BlueCar performances)
- Distance between home & workplace = French median distance (8 km)
- Very simple battery model (Power as an input)
- Household electric profile consumption from 1 year IEA statements

Methodology

- Dynamic simulation with TRNSYS 16
  - One year of simulations
  - Daily household consumption
  - Meteorological data
  - Two EV's use profiles (working days & week-end)
- Different priorities for electricity flows
  - Priority for household electric consumption & EV
  - Electric grid as a support

Followings

- Test more specific scenarios
- Optimize sizing of PV power plant and storage capacity in order to meet total electric needs
- Integrate economic factor

Interrogations:
- Modelling more precisely batteries (for EV & stationary storage)?
- Interest for a large scale application?
- The other possible EV uses: → V2G – V2H

First results

- Example of different scenarios*

<table>
<thead>
<tr>
<th>PV at Home (30 m² - 3.6 kWc)</th>
<th>Without Storage</th>
<th>With Storage (38 kWh - autonomy = 2 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building &amp; Transport:</td>
<td>Building &amp; Transport: Electric system</td>
<td>Electric system</td>
</tr>
<tr>
<td>Photovoltaic (PV) production</td>
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<tr>
<td>PV production:</td>
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<tr>
<td>Different case</td>
<td>Different case</td>
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<tr>
<td>On 1 year, independent 35.4 % of time</td>
<td>On 1 year, independent 83.4 % of time</td>
<td>On 1 year, independent 31.9 % of time</td>
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</tbody>
</table>

<table>
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<tr>
<th>PV at Home (22 m² - 2.6 kWc) &amp; at Work (8m² - 1 kWc)</th>
<th>Without Storage</th>
<th>With Storage (58 kWh - autonomy = 2 days)</th>
</tr>
</thead>
<tbody>
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<td>On 1 year, independent 78.5 % of time</td>
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</table>

Observations

• Stationary storage:
  - Used to extend global autonomy of the system
  - Needs to be more interesting for household electric consumption
  - BUT expensive & lifetime limited

• Recharge at work:
  - No additional cost
  - Permit to extend EV autonomy regarding electric grid
  - BUT global efficiency not very significant (in this case)

Monthly energetic needs & production on 1 year, with and without PV production at work

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