Accurate tool to help estimate the economic profitability of a PV installation / Group-it project

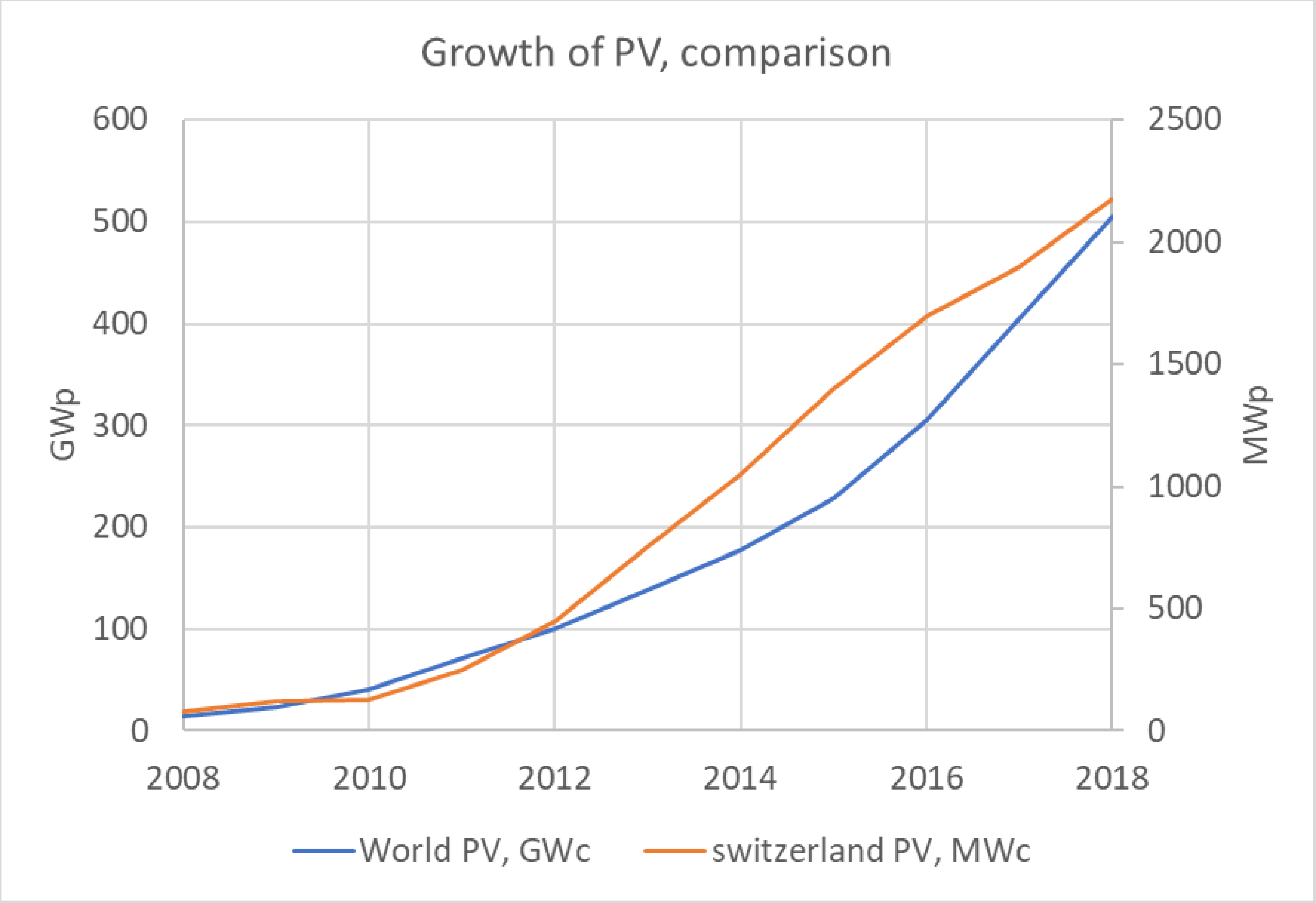
Outil précis d'estimation de la rentabilité économique d'une installation PV / Projet Group-it

Alan Lauraux
HES-SO Valais-Wallis

Energy communities for collective self-consumption: frameworks, practices and tools
Session 3 – June 16, 2020
Which skills and tools to support energy communities?

Actual situation in Switzerland

- PV evolution in Switzerland
- Energy strategy 2050
- Main obstacles
    - Complexity of the process for new installations
    - Geographical disparity



Data source : SwissSolar

What’s Group-it ?

The three main disincentives to PV installation are :

- Lack of knowledge,
- Lack of financial resources and
- The fact that they didn't know who to talk to.

Group-it :

- Offer a free pre-study
- Visite of the house
- Issue a request for proposal
- Sort the best 2 offers
- Answer questions
- *Session 7, 9.8.20, Group-it*

The algorithm’s goal

- Estimate the optimal number of panels

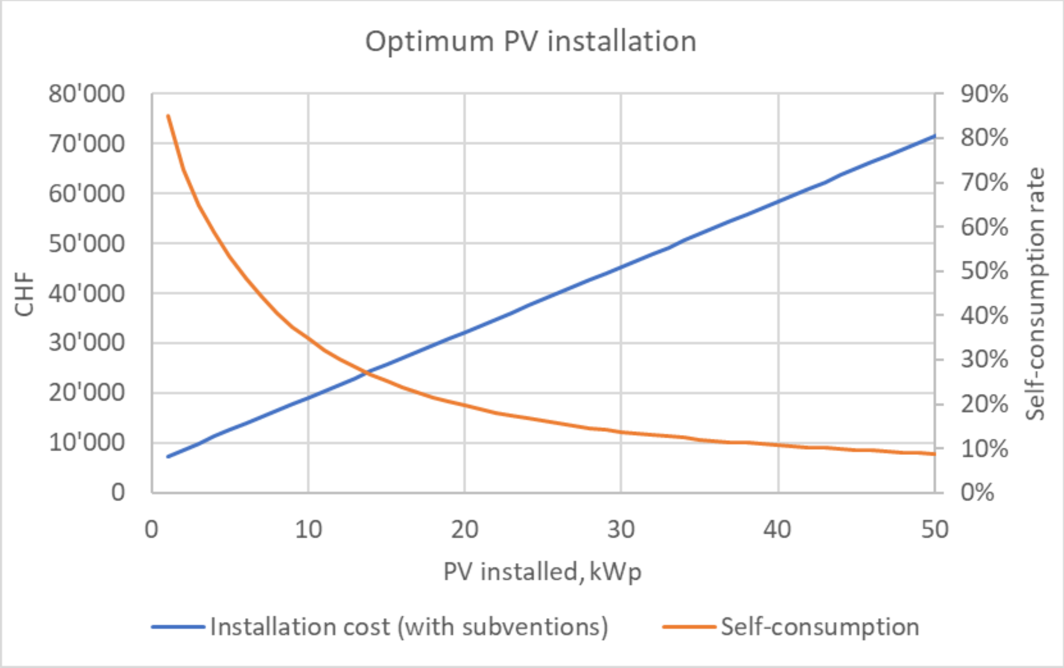
- 2 simulations
  - Best economical return
  - Production matching consumption

- Key economic parameters
  - Price of electricity consumed
  - Feed-in tariff
  - Self-consumption
  - Panel installation cost
  - Subventions, maintenance and taxes

- No production cost calculation

Roof section’s solar efficiency
Annual consumption
-> Self-consumption rate
(Hourly data over one year)

The economic optimum

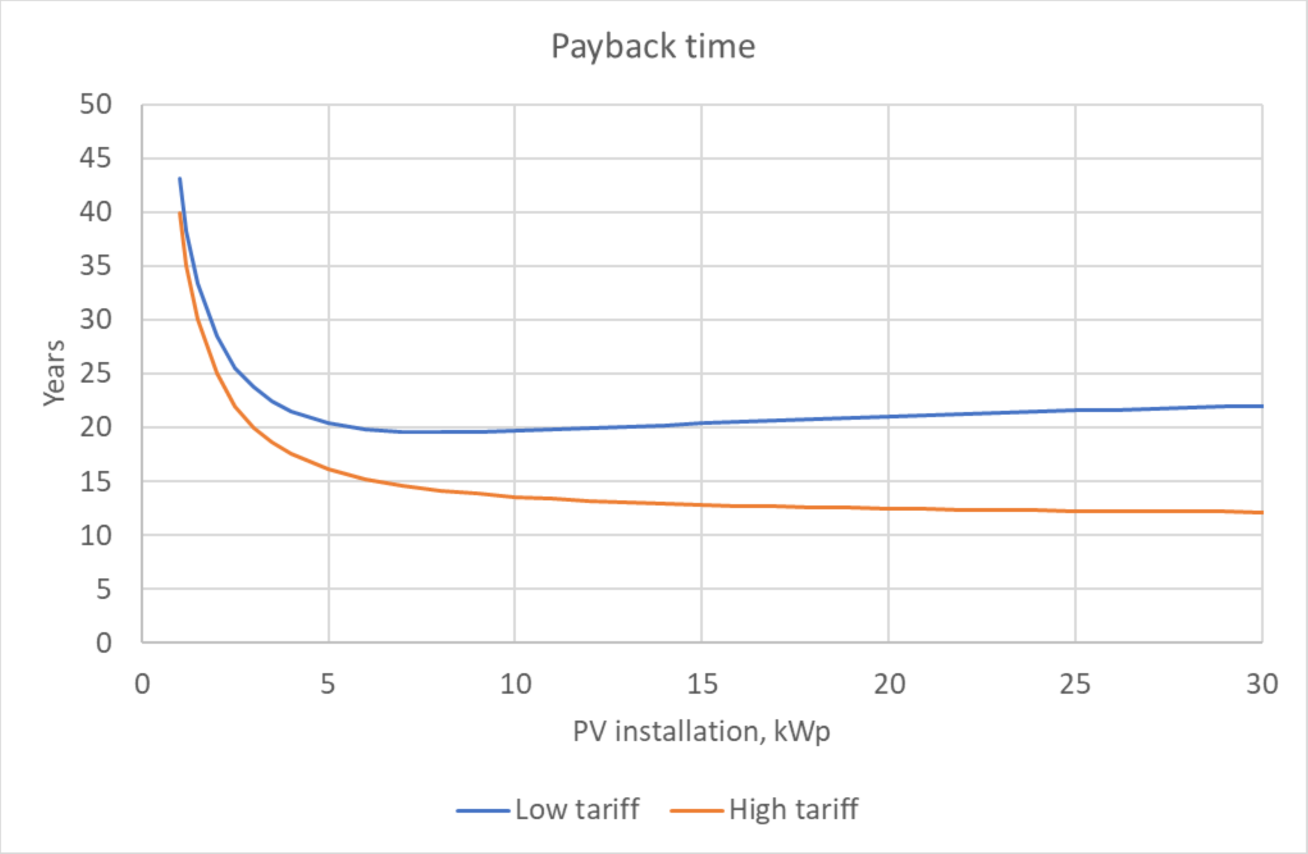


Installation cost :
7025 CHF + 1650 CHF/kWp

- Scaffolding
- Cabling
- Cost of moving

Distribution grid operators (purchase/feed in) :

Leuk 19.2 / 5.4 cts/kWh
Geneva 19.6 / 12.2 cts/kWh



Data source

Survey

- Address
- Annual electrical consumption
- Type of heating and domestic hot water (DHW)
- Number of adult and children
- Occupancy (all year, only during summer..)
- Electric car (owned or wanted)
- Family status and taxable income

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- Slope and azimuth of all roof sections
- Roof section’s solar efficiency (average solar radiation per year)
  - Snow
  - Near (trees, other building) and far (mountains) horizon

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- Maximal number of panel per section
- Drawing of the panel

PVGIS

- Far horizon
- Altitude

Not asked

- Building age, isolation for the heating modelling

Specific information for the calculation

Apartment building

- Number of appartments and rooms

Company

- Schedule (office time, 24/24 or specific)

General information

- Supplier of electricity with prices (buy and sell)
- Taxes information depending on the commune

General parameters

- System performance (15%)
- Cost of the installation
- Actualization rate (2%)
- State subvention
- Replacement on the inverter after 15 years
- Maintenance (0.3% of the initial investment)
- Loss of performance of the panels (20% after 30 years)
- Sun’s elevation and azimuth in central Switzerland

Main output of the pre-study

2 different scenarios

1. Optimizing the NPV (Net Present Value)
2. Power installed matching the annual consumption

Main output

- Installed PV on which roof section
- Self-consumption rate
- NPV and IRR (Internal Rate of Return)
- Investments and deductions
- Runback time
- Production in kWh and CHF for the first year

Optimizing NPV

- Finding which number of panels on which roof section gives the best NPV

Matching the annual consumption

- Finding which number of panels on which roof section gives the highest self-consumption rate
- With the constraint that the annual production must match the annual consumption

Explanation of the production simulation

1. 9 slope and 7 azimuth profiles are possible
2. 63 pre-calculated profile
3. Modified to consider the far horizon
4. And the snow
5. Weighted to match the solar efficiency
6. Profile of 8760 lines per x column (number of roof section), for 1 kWp

Far horizon

- When the sun is under the far horizon, attenuation of 95%

Snow

- Approximation
  - Slope and roof orientation
  - Roof’s isolation
  - Roof’s access
- Using altitude and far horizon
- Reduce step by step the production rate
  - Less that 1000 meters : 0 week
  - Zermatt : 10 weeks
  - Montana : 5 weeks

Explanation of the consumption simulation

Annual total

1. DHW based on the number of people (840 kWh per adult) and heating type :
   1. Electric boiler : 1
   2. Heat pump : 0.4
   3. Other (gas…) : 0
2. Heating based on the system's type and the annual electric consumption :
   1. Electric heating : 0.5
   2. Heat pump heating : 0.34
   3. Other (gas…) : 0
3. Electric car : 2020 kWh
4. Base : the remaining (with a loop to avoid negative result)

Repartition over a year

1. DHW is distributed evenly during each day
   1. Morning, 6 to 8 o'clock
   2. Noon, 12 o'clock
   3. Evening, 21 to 23 o'clock
2. Heating is distributed depending on the outside temperature
3. Electric car distribution :
   1. Weekday : 17 to 22 o'clock
   2. Weekend : 9 to 16 o'clock
4. Base : real consumption data of a typical apartment
5. Occupancy (all, all except winter, weekend and holydays, only summer)

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Explanation of the consumption simulation

Apartment building

1. DHW based on the number of average people in a specified number of room
2. Heating based on the average surface of an apartment with a specified number of room and the average heating consumption (70 kWh/m2)

Company

1. Heating and DHW not simulated
2. Consumption distributed evenly, based on an «office hours» or «24/24» type.
3. Or «other» type, with specified consumption profile

Details of the output

The algorithm, written in python, uses scipy.optimize to find a solution

Highest self-consumption rate

- Problem if any roof section can be used
- Solar radiation minimum : 1000 kWh/m2
- Information easy to understand

Optimizing NPV

- Result could be 0 m2
- Often the whole surface should be covered
- Information that can be complex

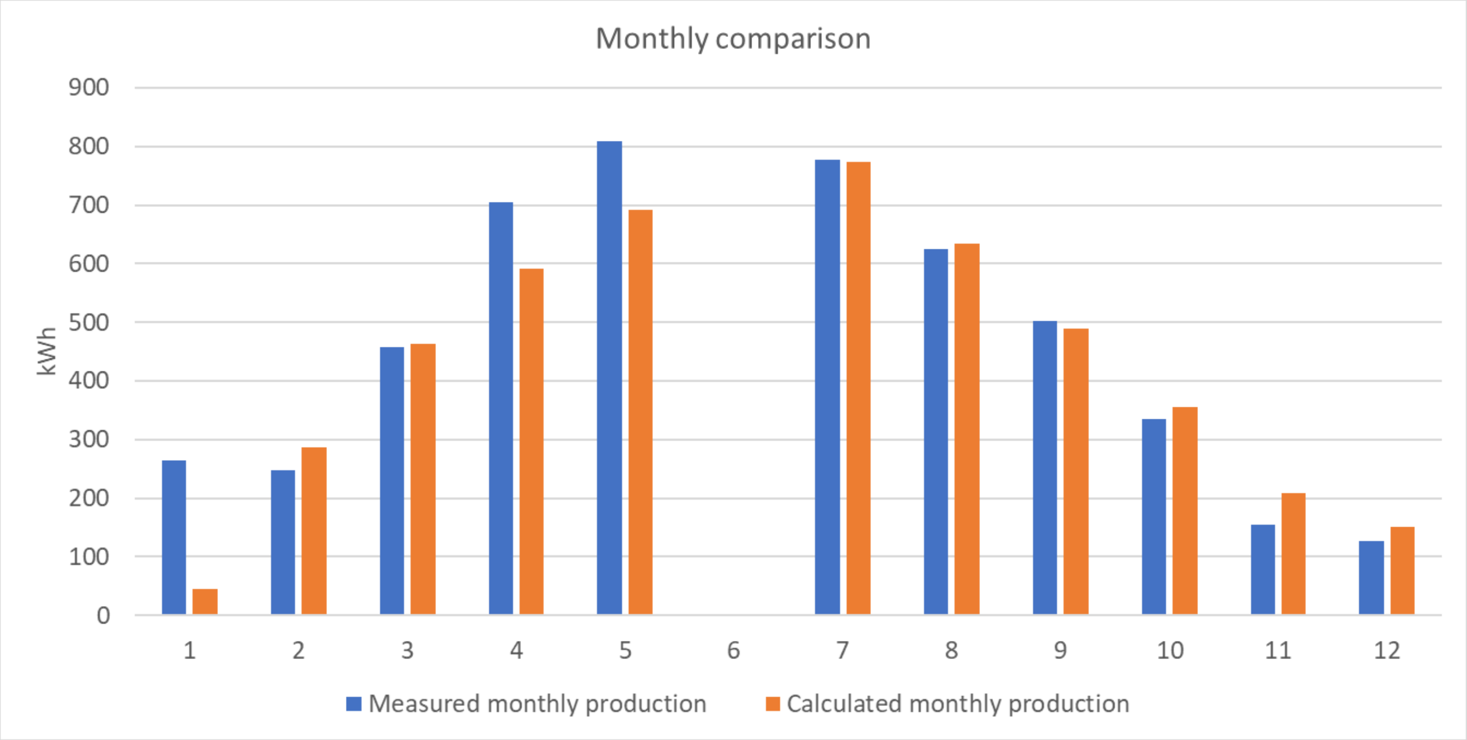
NPV

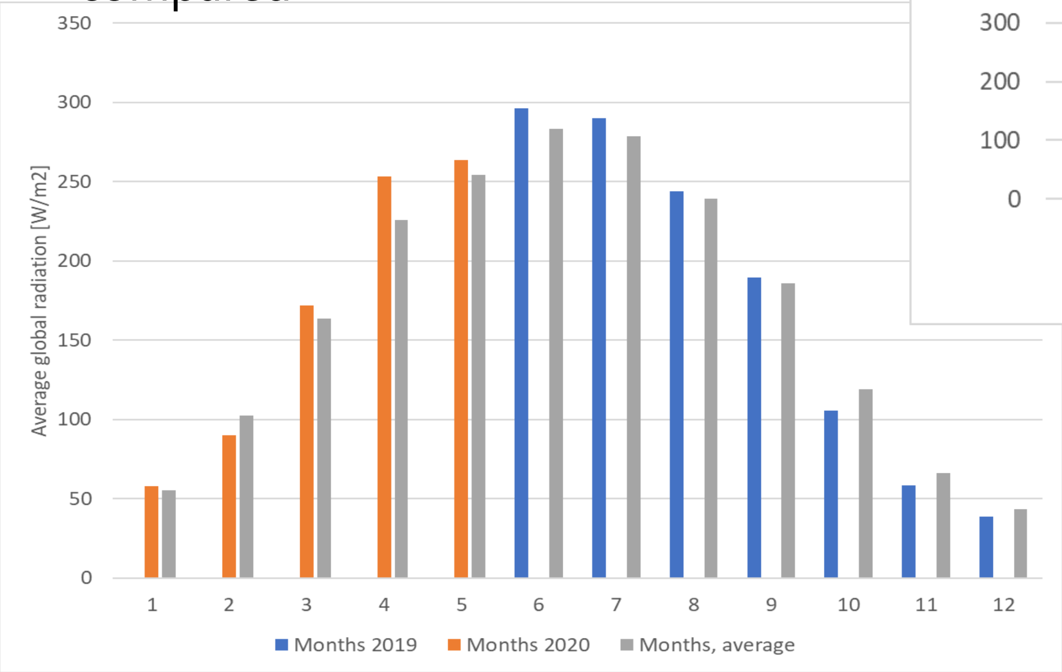
- Cashflow of 30 years
- Investments on the first year, minus subvention and possible tax rebate
- Additional costs on the 15th year for the inverter
- Earnings with the energy saved and the energy resold (no price changes during the period)
- Earnings reduced up to 20% after 30 years (for simplification)
- Earnings reduced for the maintenance cost

Is this an accurate simulation ?

Impossible to verify the theory and the reality

- Real optimization ?
- Weather is stochastic
- Self-consumption data
- Only production and consumption can be compared



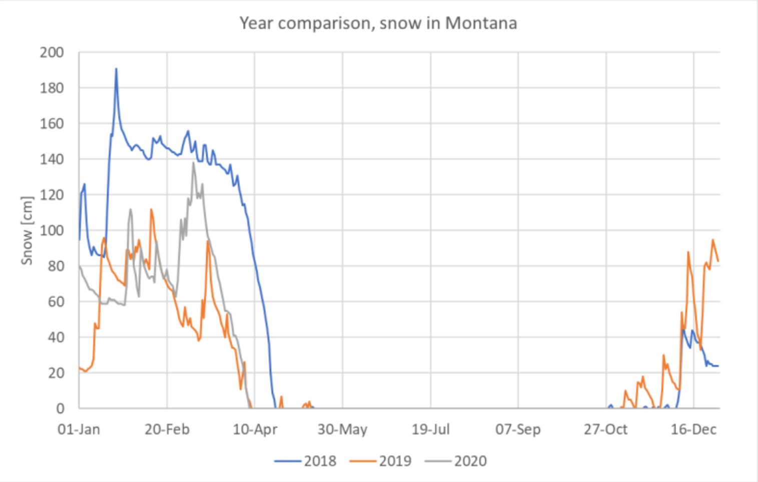


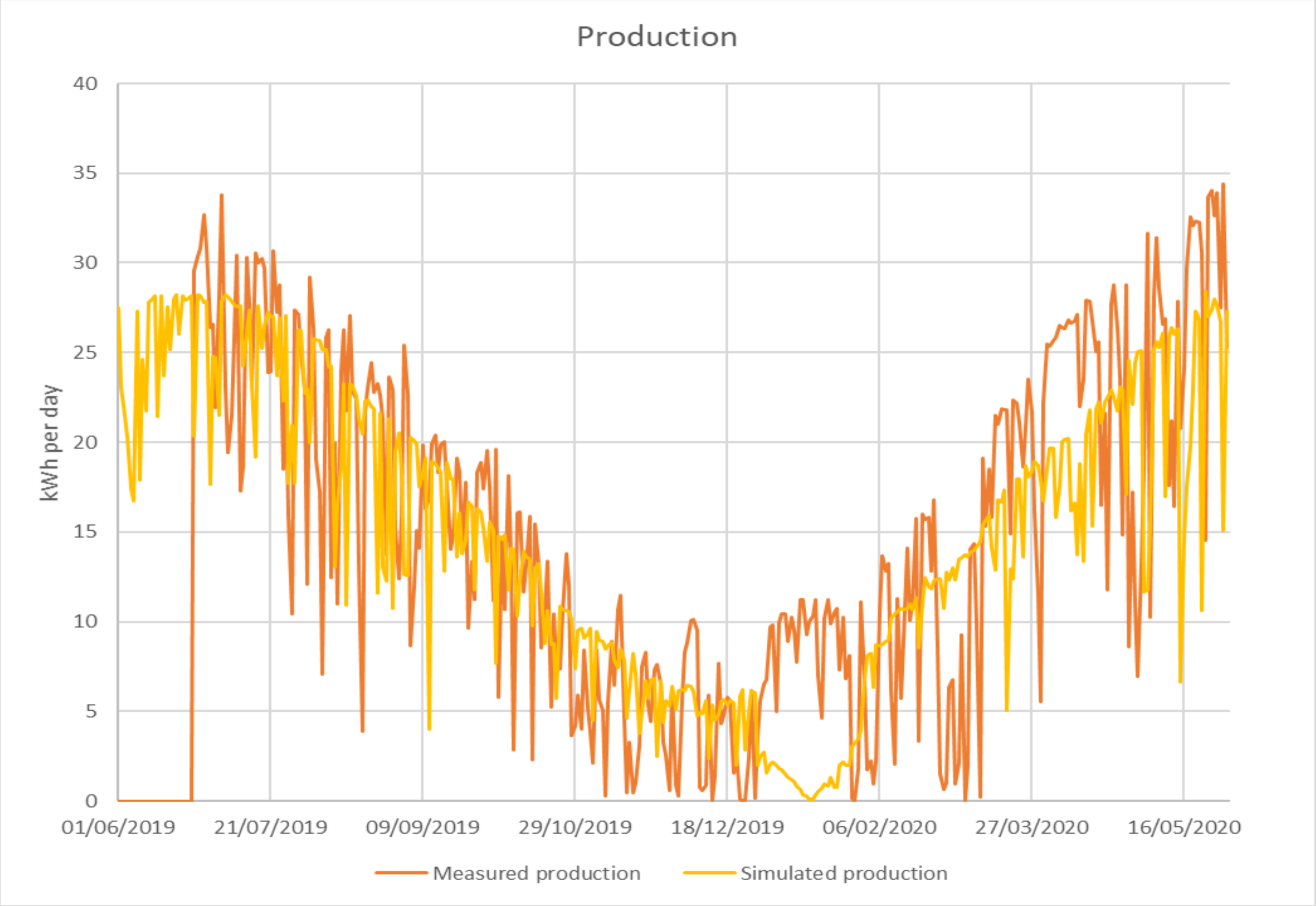
Production

St-Martin, alt. 1600m

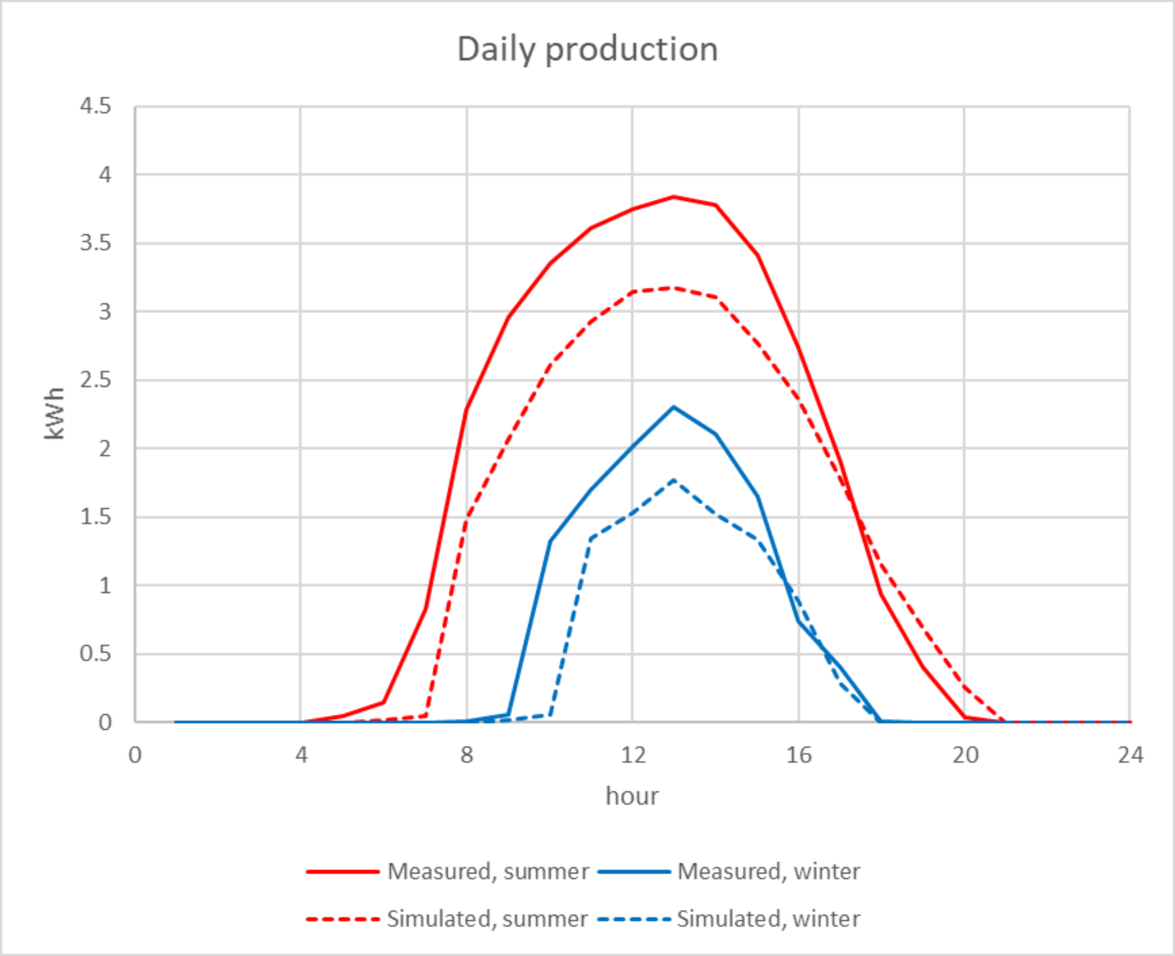
- Snow

	Data	Simulation	
Efficiency	15.9%	15.0%	
Total production	5769	5443	kWh
Difference production	6.0%		
Difference sun radiation	2.1%		





Daily production

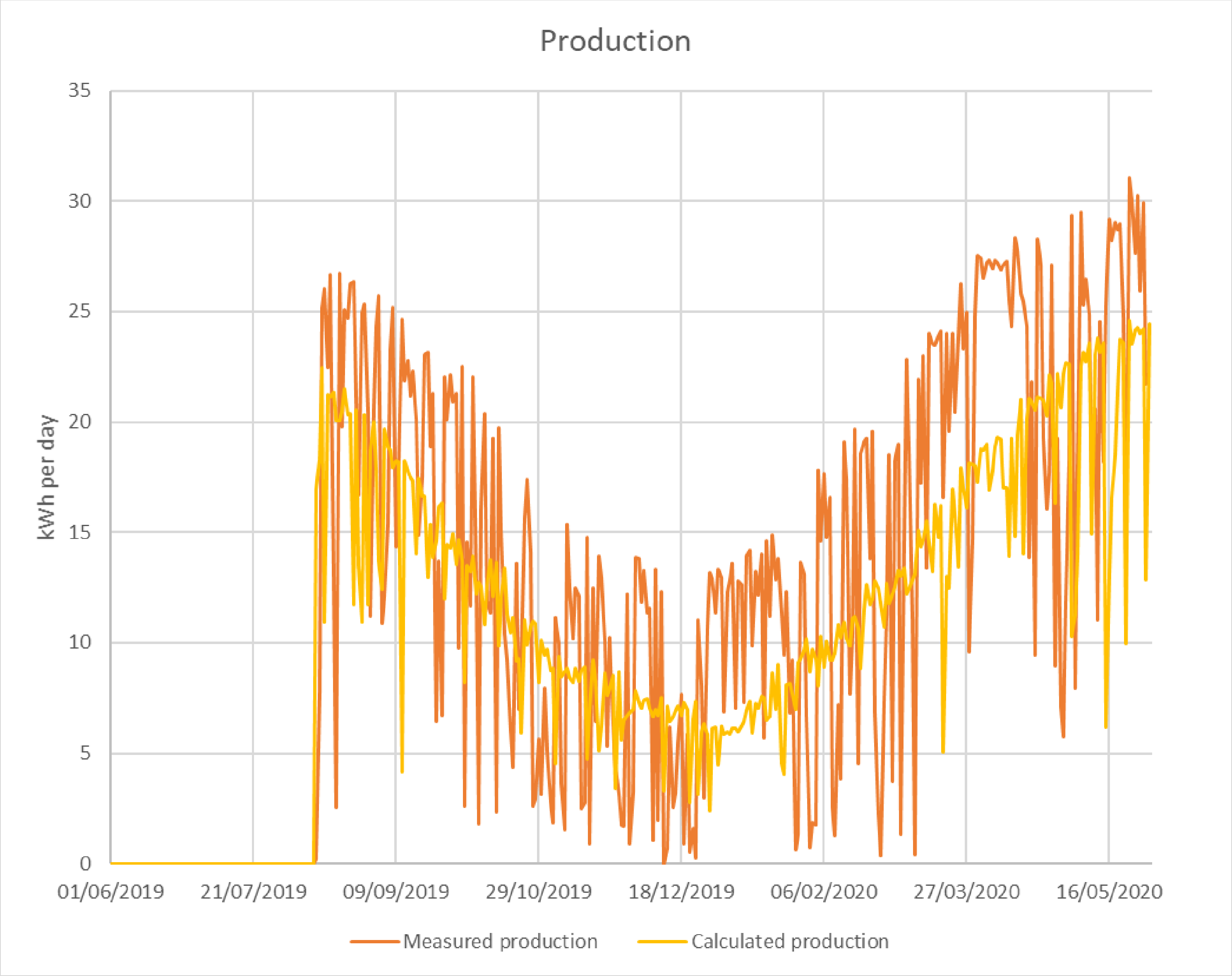


Production

Sierre, alt. 600m

- Average radiation data

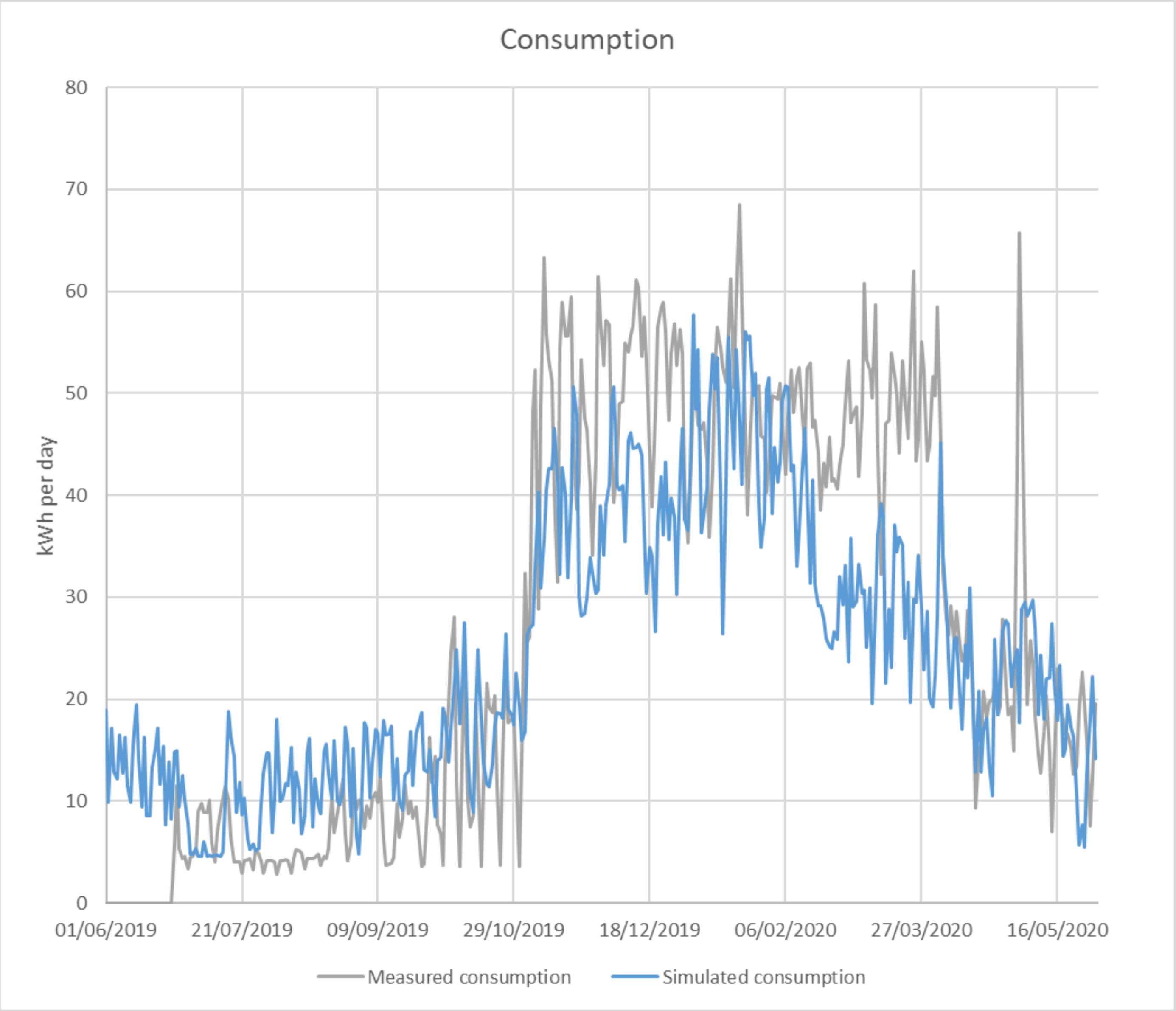
	Data	Simulation	
Efficiency	16.1%	15.0%	
Total production	5757	5361	kWh
Difference production	7.4%		
Difference sun radiation	2.1%		



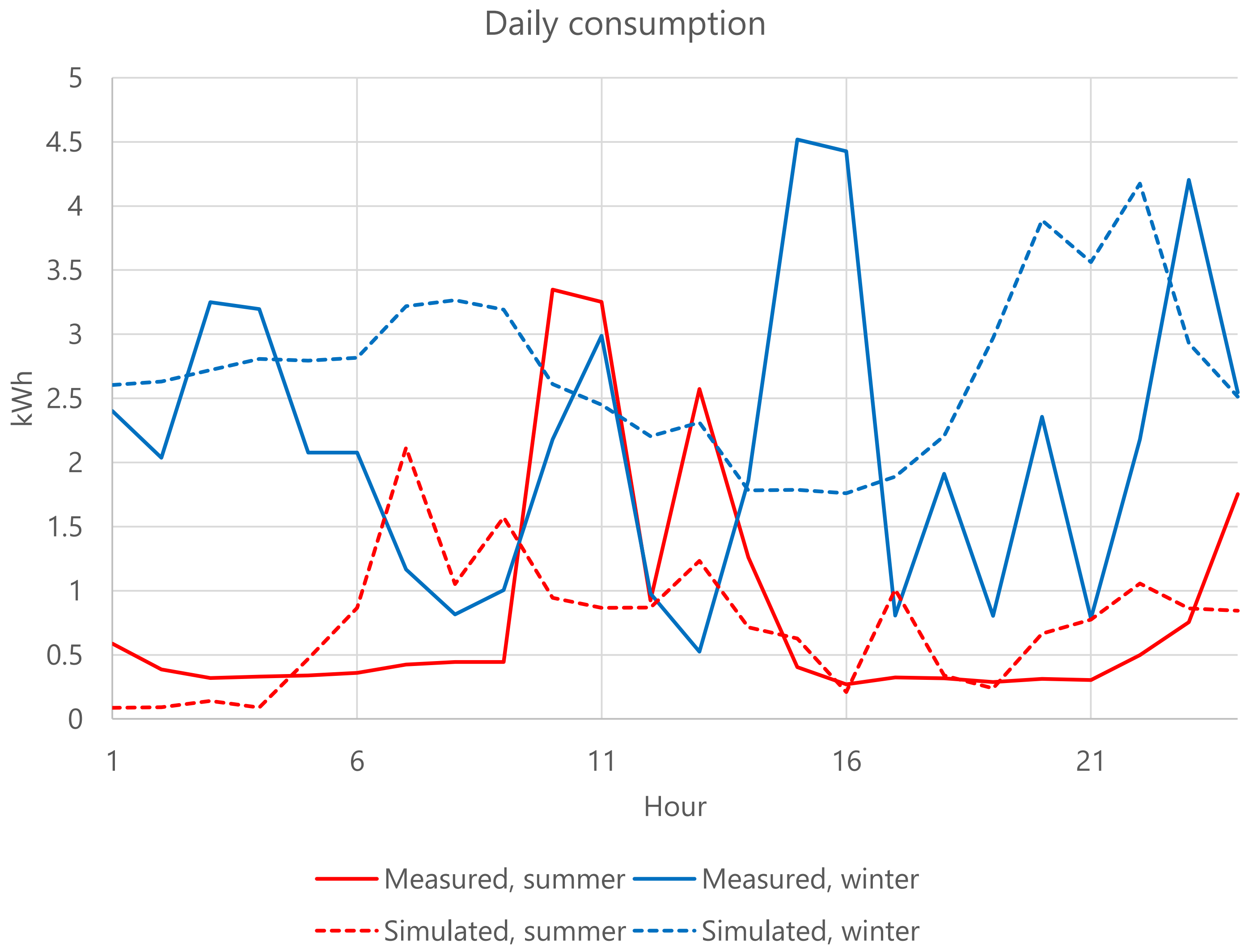
Consumption

Electric heating
Occupancy : hollydays

Heating	Difference
Electric	15%
Electric	14%
Other	-34%



Daily consumption



Perspective

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Develop a tool for self-consumption cooperatives

- Load curves (with or without PV)
- Cost of the electric network
- Find the optimum PV power (individual or collective)
- Get the production profiles of already installed PV
- Calculate the self-consumption rate (individual or collective)
- Integrate collective energy purchase
- Calculate the profitability (individual or collective)

Conclusion

Validity

- All parameters are under control and can be modified
- The results are not unrealistically optimistic, and are neutral
- The algorithm needs special input for company type building

Improvements

- More comparison with real data
  - Use electricity bills to calculate the self-consumption rate
  - Is the year of the survey a typical year ?
  - Is the PV efficiency at 16% ?
  - Electric heating during winter
- More accurate «snow» simulation
- More complex tax rebate, using the state calculator
- Measure the impact of pre-studies on individuals and professional PV installer

Thank you for your attention

Any questions ?