Workshop on Status and Development of Software tools for PV Hybrid and Mini-grid Systems

USERS POINT OF VIEW: Research Institutions

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Research Institutions are the main developers of tools for PV Hybrid Systems:

- Tools
  - NREL: Homer, Hybrid2, Vipor
  - NRCan: Retscreen
  - RISO: IPSYS
  - ISE
  - CIEMAT: HYSYS
- And models for components:
  - PV generator
  - Wind turbine
  - Battery
  - Inverter

But, what about R&D institutions as users?

- Analysis of systems
- Viability studies
- Design of real applications
- Academic (regular courses, MSc, PhD, etc.)

Particular aspects of PV-Hybrid and Mini-Grid Systems

- Most of the System is present in traditional only-PV Systems
  - PV generator
  - Battery
  - Power conditioning
  - Gen-set (optionally)
- Differences arise from:
  - Other forms of generation (Wind, mainly, and/or hydro)
  - Distributed users:
    - Distribution lines
    - Multiple consumers

Proposed strategy

1. Establish "Initial Conditions" for the design
2. First Energy-Balance based design
3. Selection of the best configuration
4. Detailed analysis for the selected configuration
5. Detailed design of the system

1. Establish "Initial Conditions" for the design

- Based on very simple methods, of the "worst month" type.
- Very common for PV design
- Not so spread for PV-Wind (new method)
- Useful also for technical documentation in a tender for public subsidies
- INPUT: very basic raw data
- OUTPUT: the tool provides with the optimum system (in terms of sizes of components)

2. First Energy-Balance based design

- Uses very simple equations, except for wind generation, which is more complex.
- Typical for PV-Wind-hybrid systems
- Spreadsheet based (Self designed or "free")
- Users like this level, because they "see" what's happening
- Example: Bergey's sizing method (Village Power 2000 Conference Tutorial on Small Wind Systems)
- INPUT: the Output of previous stage, and some more raw data
- OUTPUT: the tool provides with the optimum system (in terms of sizes of components and monthly production)

3. Selection of the best configuration (I)

- Requires tools that allow higher possibilities:
  - Hourly basis simulation => synthetic generation of data helps
  - Sensibility analysis
  - More detailed (but friendly) models of components
  - Databases of components – capability to create new ones
- HOMER type [Self designed (takes time and effort) or "free"]

3. Selection of the best configuration (II)

- Example: HOMER (www.nrel.gov/homer)
- INPUT: the previous stage (both output and data)
- OUTPUT: the user has to select the optimum system, among different options whose performance is characterized through hourly behaviour.

4. Detailed analysis for the selected configuration (I)

- Requires relatively complicated tools:
  - Hourly (or lower) basis simulation => synthetic generation of data helps
  - Very detailed (not always friendly) models of components => difficulty to find parameters
  - Capability to model different control strategies
  - Dynamic analysis is not usually accomplished for battery based systems
- HYBRID2 type [Self designed (takes time and effort) or "free"]

4. Detailed analysis for the selected configuration (II)

- Example: HYBRID2 (http://www.ceere.org/rerl/rerl_hybridpower.html)
- INPUT: the Output of previous stage, and more data for the models
- OUTPUT: behaviour of the selected configuration; the user has to decide whether it's as expected or not (if not, then go back to step 3)
- HOMER, more active, is coping more and more with this stage, also, as HYBRID2's evolution is slower.

5. Detailed design of the system

- Purely engineering stage:
  - Technical documentation
  - Schemes
  - Plans
- No dedicated software for this step, but programs of general use in engineering
- INPUT: the Output of previous stages
- OUTPUT: the technical documentation to implement the project

Conclusions

- Different levels in the design of PV-Hybrid Systems => different levels in the tools
- A sequential procedure is proposed as a solution in the design
- NREL's public tools nearly fulfil the described procedure for Hybrid Systems, except for some steps that can be completed with public or easily self-made tools, and other general-use software.
- But some particular aspects of PV-Hybrid and Mini-grids Systems need to be included

THE END - Thank you for your attention

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