Imperial College London

Supporting Rural Electrification in Developing Countries

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CLOVER: Modelling Minigrids for Rural Electrification

What is CLOVER?

The Grantham Institute – Climate Change and the Environment has developed a minigrid simulation and optimisation tool called CLOVER (Continuous Lifetime Optimisation of Variable Electricity Resources). It is designed to help inform governments, businesses, NGOs and researchers in making decisions about the impact of installing minigrid systems to bring reliable electricity to rural communities.

What can CLOVER do?

CLOVER has two main functions:

- Simulating minigrid systems to assess their performance and impact
- Optimising minigrid component sizes to ensure future performance

To do this it uses real-life meteorological data and simulated load data to assess the performance of a minigrid over several years at an hourly resolution. Electricity generation and supply data are calculated, along with information about periods of downtime, where communities may rely on backup energy services such as kerosene for lighting or diesel generators.

The model can provide information about a minigrid system's electricity production, expenditure and cost of electricity, reliability and environmental impact. By considering growth in electricity demand, CLOVER can calculate the sizing requirements of a future minigrid and identify the most suitable system to continue to meet the community's needs.

How does CLOVER work?

Users of CLOVER select any combination of generation sources to be used in the minigrid system:

- Solar PV
- Wind
- Battery storage
- Micro-hydropower
- Diesel generator
- Grid network

Users can also choose to include a connection to the national grid network, if available, and the reliability of grid electricity service. The system can be used to provide a variety of electricity services:

- Lighting
- Phone charging
- Televisions
- Fans
- Radios
- Refrigerators
- Industrial loads
- Commercial loads
- Home industries

Other services can also be included if necessary. The user defines the size of a system to be simulated on an hourly basis, or a range of available component sizes to select the most effective combination. CLOVER performs the calculations and gives the system performance as well as financial and environmental impact analysis, with the following example outputs:

- Component sizes
- Cost of electricity
- System reliability
- Energy supplied from each source
- Unmet demand
- CO_2 from each source
- Kerosene mitigation potential

The model can show when infrastructure investments need to be made, the lifetime environmental impact of the system, and its benefits in mitigating kerosene usage. The user can define the conditions that the system must achieve, for example a minimum level of reliability, and the selection criteria for the optimum system, for example the lowest cost. This can then inform the decision-making process about the most suitable choice for electrification.

The CLOVER User Journey

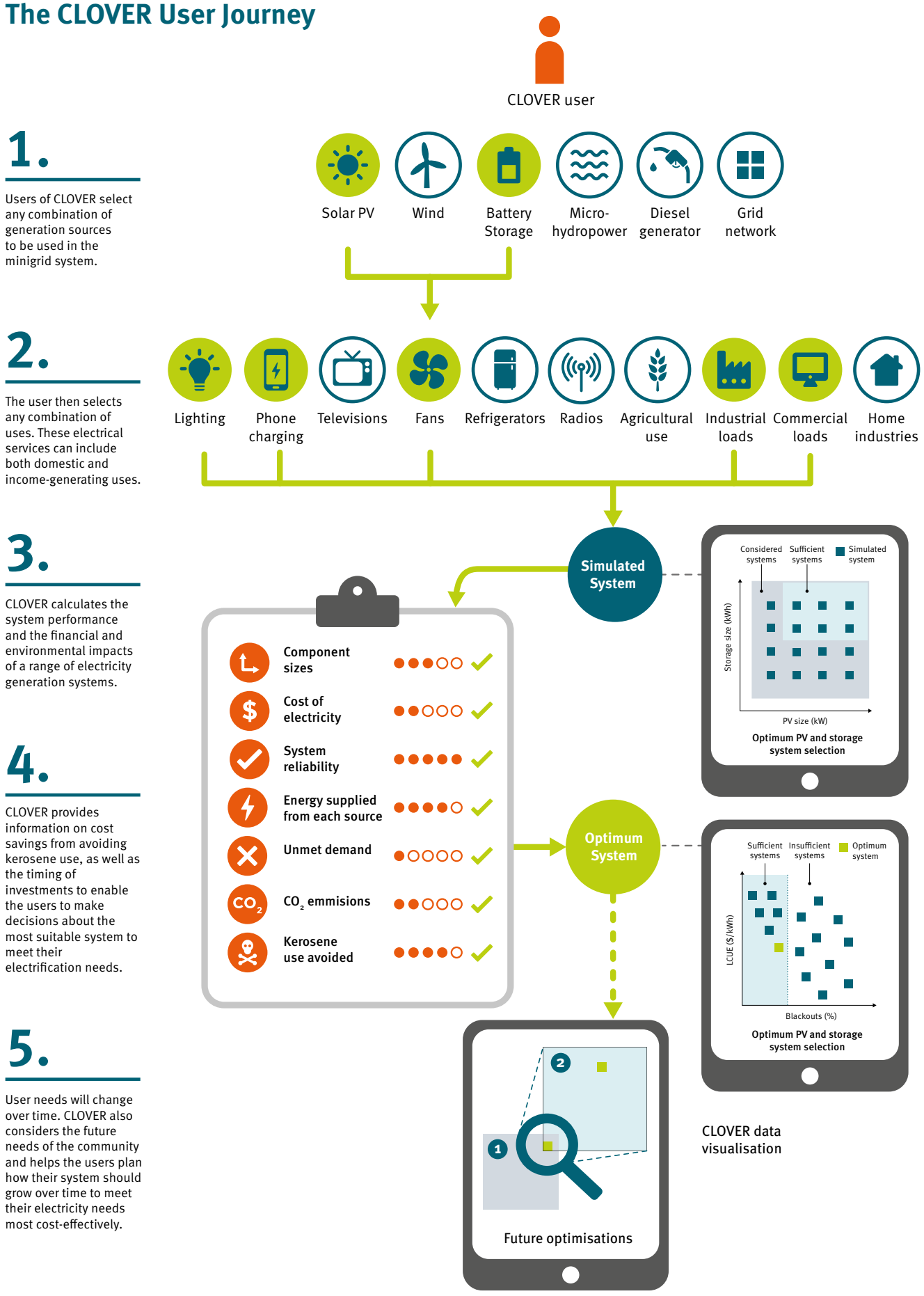

Figure 1: Clover User Journey