# Optimal Placement and Design of Renewable Microgrids to Support Electrification Based on Satellite and Mobile Phone Data

## *Introduction*

- This work investigates the value of satellite and mobile phone data to facilitate electrification planning in developing countries, i.e., based on optimised location and design of microgrids (**MGs**).
- A Socio-techno-economic framework is developed to optimise investment decisions based on the:
  - technical feasibility of grid extensions and installation of diesel and photovoltaic (**PV**) MGs;
  - economic attractiveness of the different options and
  - potential to improve access to education and health facilities
- The methodology is demonstrated with applications to Senegal where basic energy information for electrification planning and access to electricity are limited (see Fig. 1), while most of the population use mobile phones and electrification of health, education and other vital facilities are apriority.

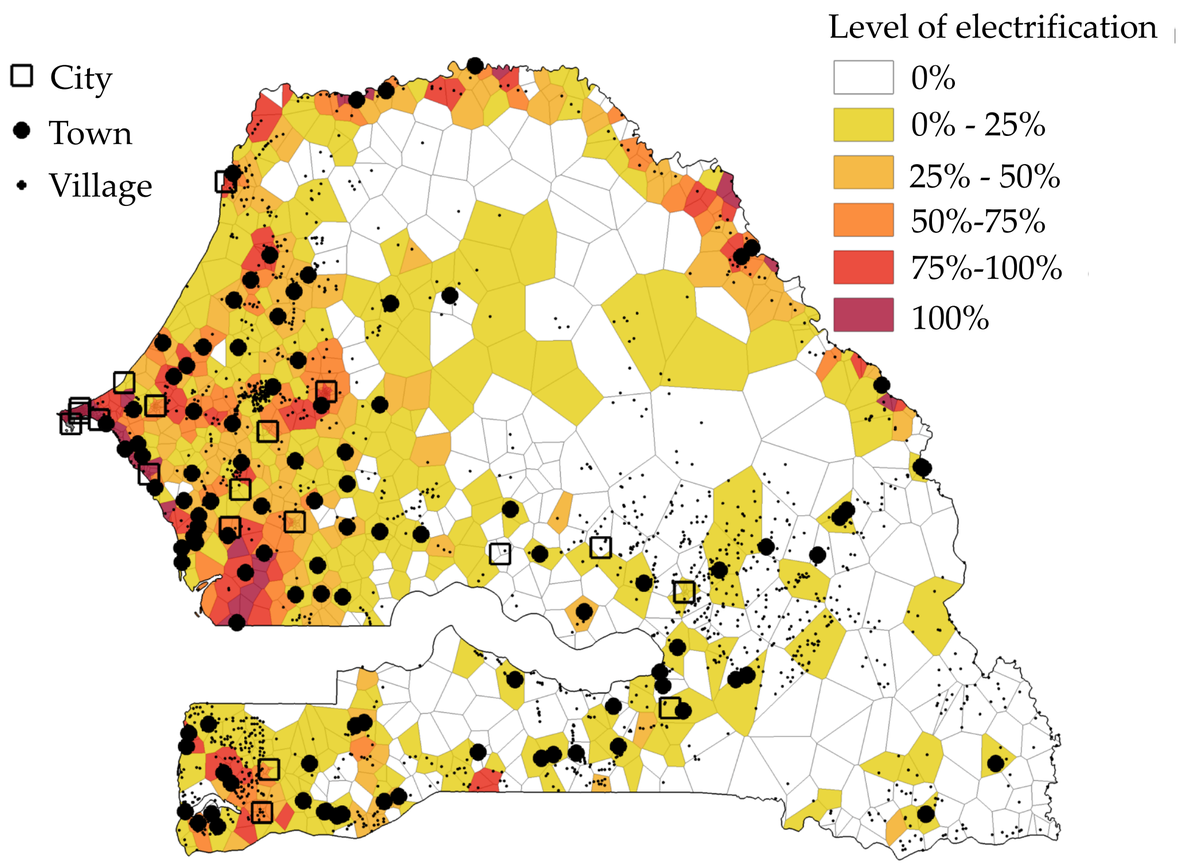


**Fig. 1: Electrification levels in Senegal.**

## *Socio-techno-economic framework*

- The proposed socio-techno-economic electrification planning framework brings together satellite and mobile phone, socio-economic and geo-referenced data analysis, and novel energy infrastructure planning optimisation techniques that can quantify the techno-economic feasibility of different electrification options.
- Available electrification, health, and education data, and the location and size of communities in rural areas were obtained from the local electricity company (Senelec), census and existing literature. This information, was combined with satellite (night light) and mobile phone (mobility) data from Orange.

## *Case study*

- The proposed methodology was used to build an electrification map of Senegal, which highlights zones where (i) extending the grid, (ii) installing diesel MGs or (iii) building PV MGs are the preferred options (see Fig. 2).
- The recommendations can be adjusted based on different combinations of socio-techno-economic options, e.g., from the cheapest alternatives to the most resilient electrification of health infrastructure.

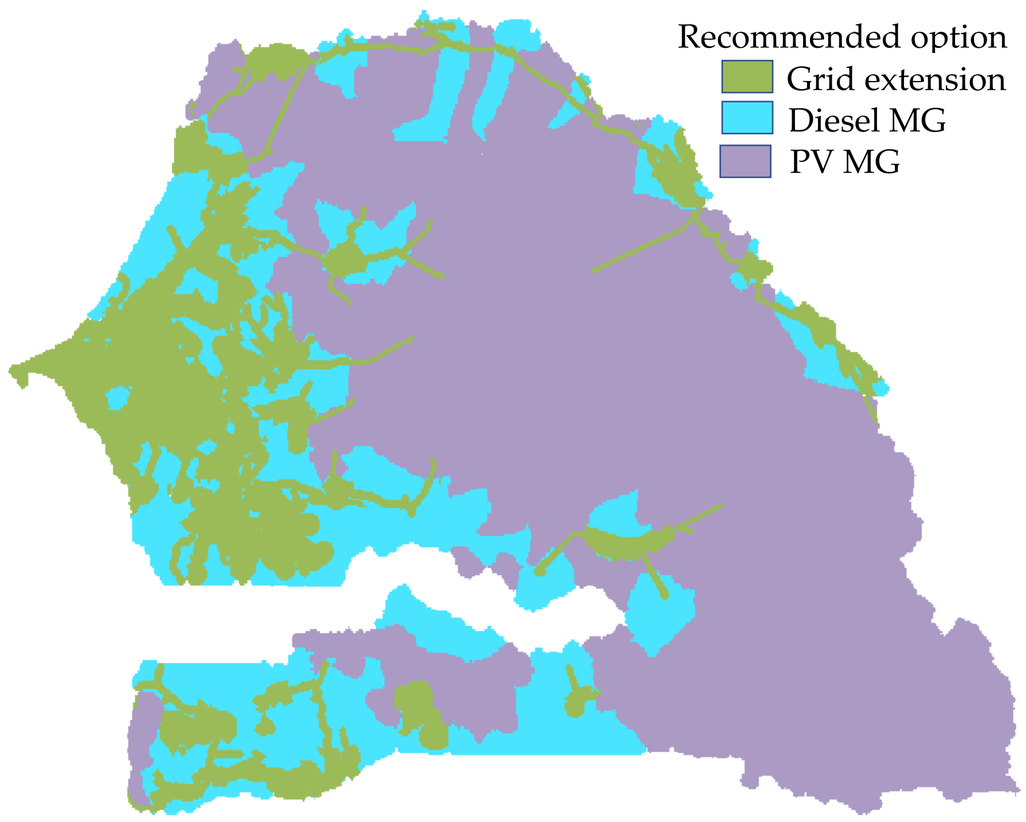


**Fig. 2: Electrification recommendations map.**

## *Conclusion*

- The combined mobile phone and satellite data proved to facilitate accurate estimations of the location of population centres (compared with data from census).
- This information allowed detailed electrification planning throughout the country. Based on the results, the following observations were made:
  - Electricity grid extensions are generally more economically effective for zones with high potential population growth due to potential migration in the vicinity of the grid.
  - Diesel engine-based community level MGs become the preferred technology for most zones located far from the grid, particularly large villages or areas with significant potential population growth due to migration.
  - PV MGs tend to be the most convenient option for villages; particularly when only electrifying for basic needs, such as, lighting and mobile phone charging.


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