IMPROVING ENERGY ACCESS MODELLING WITH GIS DATA

A CASE STUDY FOR ETHIOPIA

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ACCESS TO ELECTRICITY IN AFRICA

- SDG 7.1: By 2030, ensure universal access to affordable, reliable and modern energy services
- Very low access to electricity in Sub-Saharan Africa

Data: World Bank, 2016
ACCESS TO ELECTRICITY IN AFRICA

• SDG 7.1: By 2030, ensure universal access to affordable, reliable and modern energy services

• Very low access to electricity in Sub-Saharan Africa

• Limited grid extent

Data: World Bank, 2016
ACCESS TO ELECTRICITY IN ETHIOPIA

Electricity access:
- 92% of urban population
- 12% of rural population

Is off-grid electricity the solution?

1. GIS analysis
2. From GIS to TIAM-ECN
3. TIAM-ECN results
4. Conclusions
GIS DATA

PV

Diesel

Hydro

Estimated costs of electricity delivered by a (10kWp) off-grid PV system

- EUR / kWh
  - < 0.10
  - 0.10 - 0.15
  - 0.15 - 0.20
  - 0.20 - 0.25
  - 0.25 - 0.30
  - 0.30 - 0.35
  - 0.35 - 0.40
  - 0.40 - 0.45
  - 0.45 - 0.50
  - 0.50 - 0.60

Estimated costs of electricity delivered by a diesel generator

- EUR / kWh
  - < 0.03
  - 0.03 - 0.05
  - 0.05 - 0.10
  - 0.10 - 0.15
  - 0.15 - 0.20
  - 0.20 - 0.25
  - 0.25 - 0.30
  - 0.30 - 0.35
  - 0.35 - 0.40
  - 0.40 - 0.45
  - 0.45 - 0.50
  - 0.50 - 0.60
  - 0.60 - 1.00
  - 1.00 - 2.00
  - 2.00 - 2.50

https://europa.eu/capacity4dev/afretep/minisite/processed-gis-data
FOR EACH PIXEL...

- (Min) cost of off-grid electricity
- Distance from the grid → cost of grid electricity
- Population
- And their projection to 2050
WILLINGNESS TO PAY FOR ELECTRICITY (WTP)

\[ WTP_{2010} = 2\% \frac{GDP_{pp}}{FEC_{pp}} \]
POTENTIAL FOR ON- AND OFF-GRID ELECTRICITY

2010

2030

2050

No access

Grid only

On- or off-grid

Off-grid only
FROM GIS TO TIAM-ECN (OR OTHER IAM...)

- Demand for grid electricity

- Demand for off-grid electricity

- Constraints:
  - Max off-grid PV, hydro and diesel potential
  - Competition between on- and off-grid
OFF-GRID PROCESSES IN TIAM-ECN

![Graph showing LCOE ($/MWh) for different energy sources and years: 2010, 2020, 2030, 2040, and 2050. The energy sources include Wind stand alone (300 W), Wind mini grid (100 kW), Solar PV stand alone (300 W), Solar PV minigrid (25 kW), Hydro stand alone (300 W), Hydro minigrid (100 kW), Diesel stand alone (300 W), and Diesel mini grid (100 kW).]
ELECTRICITY GENERATION

- More detailed representation
- PV only off-grid
- Extra wind, hydro and oil
- Diesel generators lock-in?
- Grid expansion utilized less and less in time…
- … shift from base-load to peak capacity
- Function and importance of grid change over time
- Risk of underutilization
CONCLUSIONS

- Improved representation of off-grid electricity access in TIAM-ECN
- Relies on GIS data
- Critical assumption: WTP

- Off-grid technologies essential to reach universal access
- Large role of PV and wind, possible diesel generators lock-in
- Risk of underutilization of grid expansion

Next steps:
- Validate approach (sensitivity analysis, etc.)
- Extend to rest of Africa
- Include more off-grid options in TIAM-ECN