

Where should I bake bread?

GIS-based planning of solar thermal bakeries and
the socio-cultural dimension of energy transition

Corrie Mathiak^{a,b}, Guillaume Guimbretière^a, Christophe Révillion^b, Benjamin Pillot^b

^a*LACy, UMR8105, CNRS, Univ La Réunion, Météo-France, Saint-Denis, France*

^b*UMR Espace-Dev, Univ Montpellier, IRD, Univ Antilles, Univ Guyane, Univ Réunion, Montpellier, France*



Outline

1. Why?
2. What?
3. Where?
4. How?
5. So What?



1. Why?

Why do this study?

- Overarching: Would solar-fueled bakeries match the requirements of the bread-supply chain as it is today?
- Case-Specific: Could solar thermal ovens *spatially* replace electric bakery ovens on Reunion Island?
- Output: Quantify & map potential solar bread production

Why energy?

- Thermodynamic definition: energy is the capacity for doing work
- Daily life definition: energy is a necessity – if one wants to do something, it needs energy.

Why energy *transition*?

- Energy transition
 - Simple substitution vs. transformation
 - Transition of socio-technical systems [1; 2]
 - Multi-dimensional change & paradigm shift



ZUKUNFTS-MODELL

→ Key questions: **What** are our needs, **what** energy is required to meet these (kind and quantity), **where** can we find it and **how** can we manage it?



2. What... ?

What do we need?

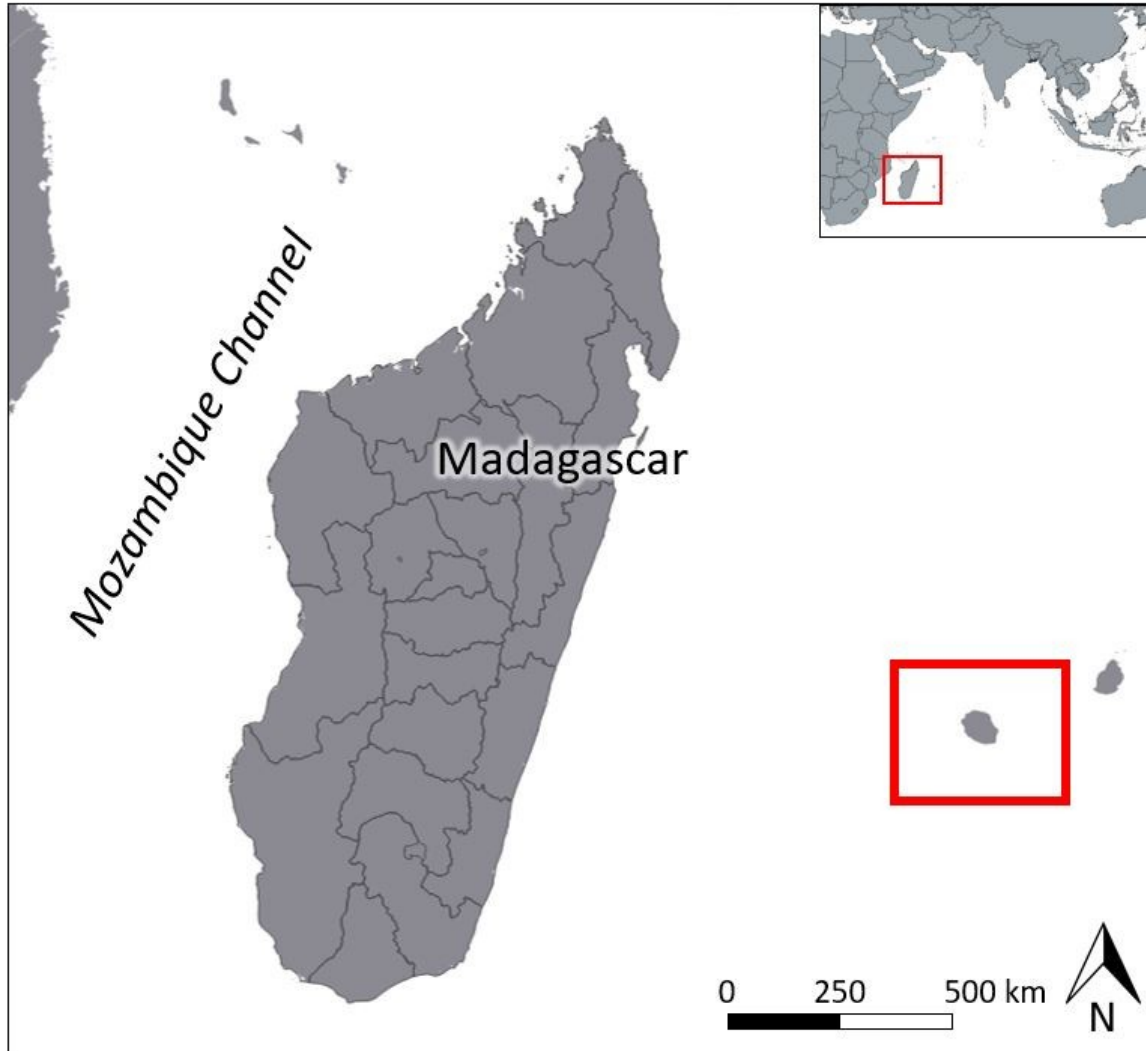
- BREAD
 - Staple food
 - Socio-cultural significance of bread [2; 3]

What energy service to we need?

- Thermal energy for baking
- Highest embedded energy in bread life cycle [4; 5; 6]
- Comparatively high temperature requirements [7]



3. Where... ?



Where is the case study located?

- Reunion Island, France
- Geo-climatic suitability [8]

Where should I bake bread?



Resource availability



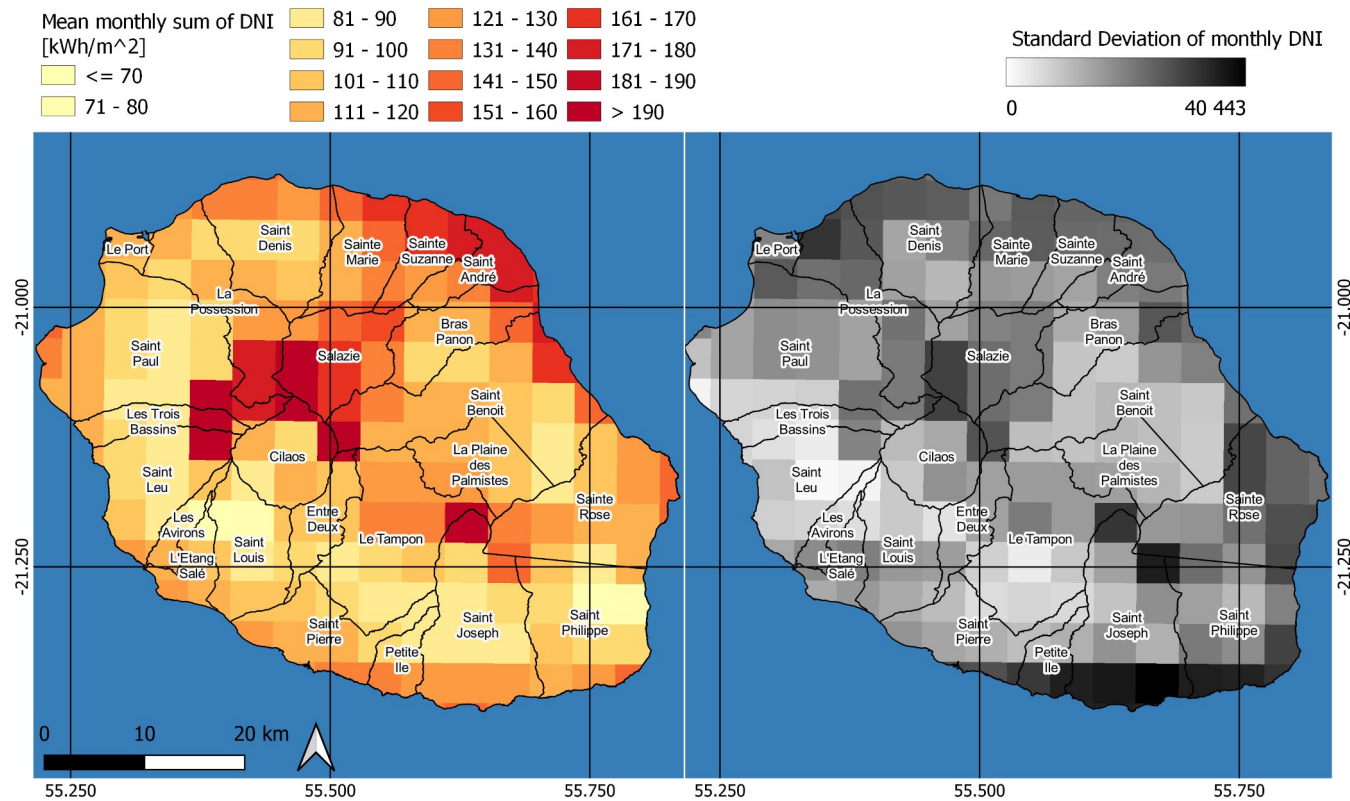
Current bakery
locations



4. How...?

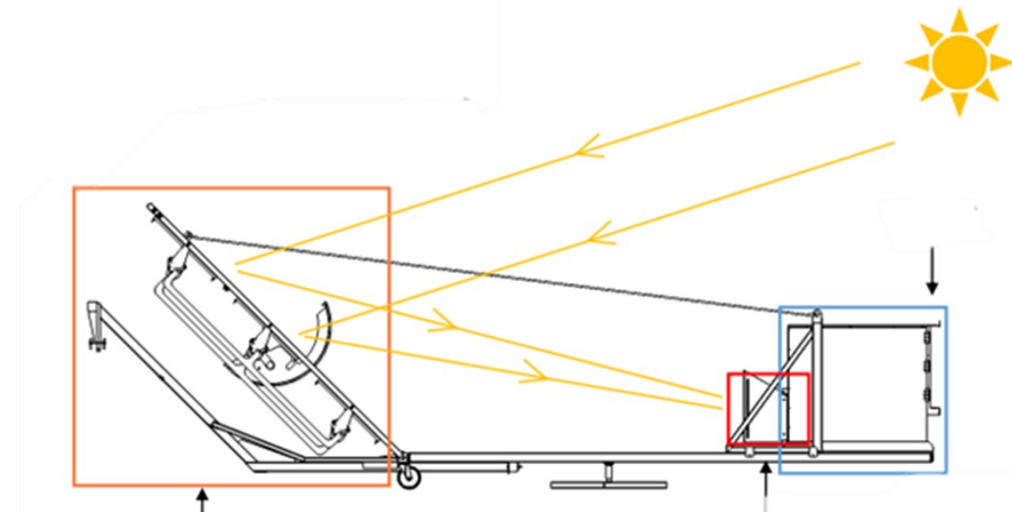
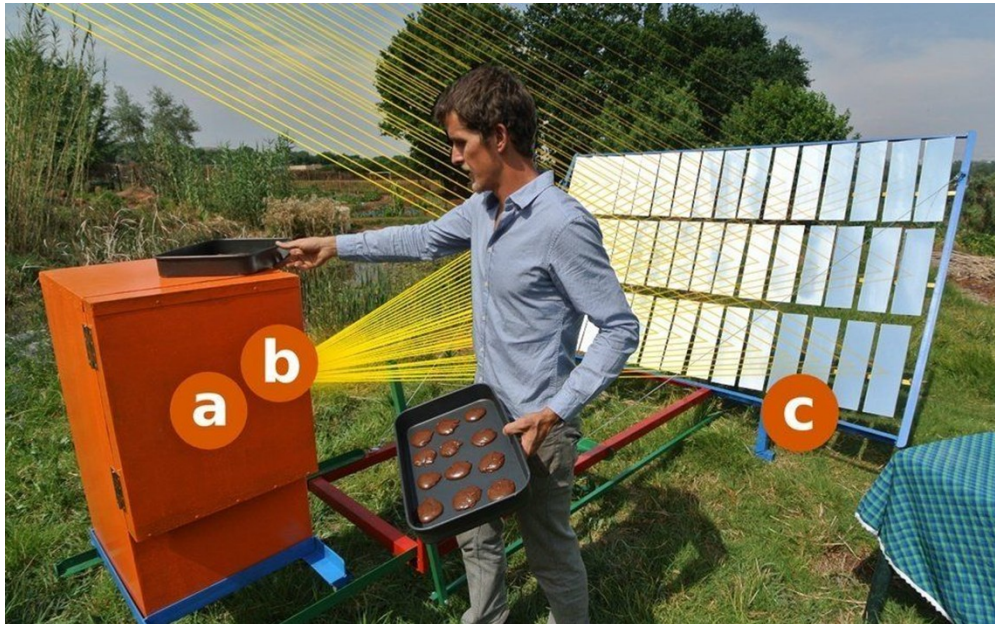
How is available solar energy distributed?

Monthly DNI 2017-2019



Data: NREL (DNI), Alkante (Limite de Commune)
CRS: WGS 84 UTM 40S (ESPG: 32740)

How does the solar oven work?



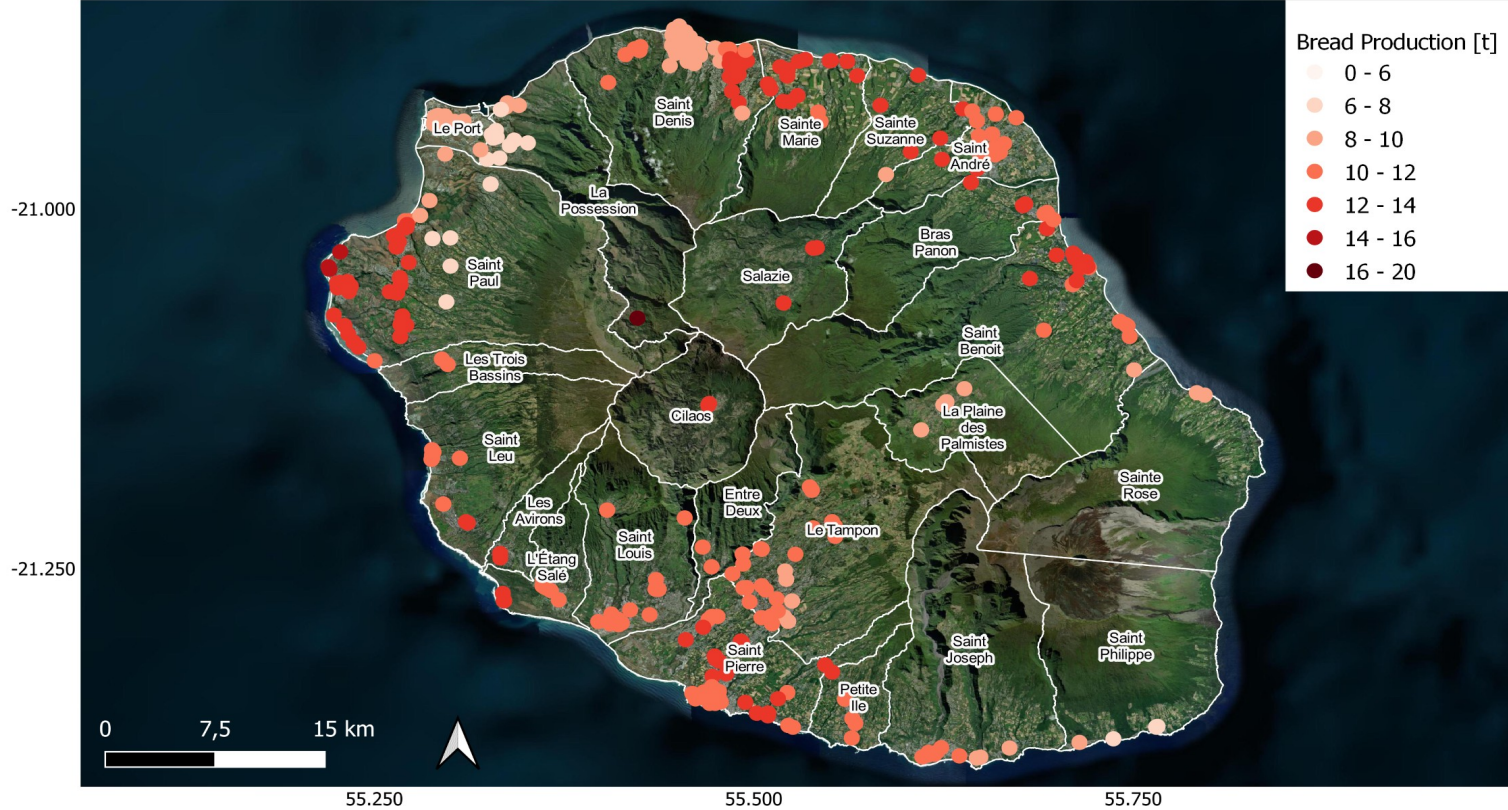
Lytefire 11 [7;9]

How does the baker work?



How much solar bread production is possible?

Potential Solar Bread Production 2019
at Current Bakery Locations



Data: NREL (DNI), Alkante (Limite de Commune),
ESRI (Satellite Imagery Background)
CRS: WGS 84 (ESPG 4326)



5. So what?

Energy transition is possible...

- ...if it considers and permeates all levels:
 - Needs: Community dietary behavior
 - Energy Service: thermal energy for baking
 - Energy production system: oven technology and baker's work
 - Energy resource supply: solar radiation

The challenges

- No sun = no bread
- Adapting baking practices
- Adapting consumption practices

3 GOOD HEALTH
AND WELL-BEING



7 AFFORDABLE AND
CLEAN ENERGY



12 RESPONSIBLE
CONSUMPTION
AND PRODUCTION

The opportunities

UN SDGs [11]

- 7: Zero emissions bread baking
- 12: Reduce input costs & food waste
- 3: Healthy bread

IT'S NOT TOO GOOD
TO BE TRUE.

References

1. Kern, F., Smith, A., 2008. Restructuring energy systems for sustainability? Energy transition policy in the Netherlands. *Energy Policy, Transition towards Sustainable Energy Systems* 36, 4093–4103. <https://doi.org/10.1016/j.enpol.2008.06.018>
2. Köhler, J., Geels, F.W., Kern, F., Markard, J., Onsongo, E., Wieczorek, A., Alkemade, F., Avelino, F., Bergek, A., Boons, F., Fünfschilling, L., Hess, D., Holtz, G., Hyysalo, S., Jenkins, K., Kivimaa, P., Martiskainen, M., McMeekin, A., Mühlemeier, M.S., Nykvist, B., Pel, B., Raven, R., Rohrachner, H., Sandén, B., Schot, J., Sovacool, B., Turnheim, B., Welch, D., Wells, P., 2019. An agenda for sustainability transitions research: State of the art and future directions. *Environmental Innovation and Societal Transitions* 31, 1–32. <https://doi.org/10.1016/j.eist.2019.01.004>
3. Scala-Riondet, N., 2005. La formation, stratégie de survie de la boulangerie artisanale. *Formation Emploi* 90, 51–64. <https://doi.org/10.3406/forem.2005.1756>
4. Denis, I., 2012. Du pain et de la pétanque à Mayotte 15.
5. Espinoza-Orias, N., Stichnothe, H., Azapagic, A., 2011. The carbon footprint of bread. *Int J Life Cycle Assess* 16, 351–365. <https://doi.org/10.1007/s11367-011-0271-0>

References

6. Kheiralipour, K., Sheikhi, N., 2021. Material and energy flow in different bread baking types. *Environ Dev Sustain* 23, 10512–10527. <https://doi.org/10.1007/s10668-020-01069-2>
7. Notarnicola, B., Tassielli, G., Renzulli, P.A., Monforti, F., 2017. Energy flows and greenhouses gases of EU (European Union) national breads using an LCA (Life Cycle Assessment) approach. *Journal of Cleaner Production* 140, 455–469. <https://doi.org/10.1016/j.jclepro.2016.05.150>
8. Moseme Forsythe, H.D., Madyira, D.M., 2019. Experimental performance assessment of a solar powered baking oven. *Procedia Manufacturing* 35, 535–540. <https://doi.org/10.1016/j.promfg.2019.05.076>
9. NeoLoco, n.d. Artisanat solaire [WWW Document]. Graines NeoLoco. URL <https://neoloco.fr> (accessed 1.21.22).
- 10.. Badosa, J., Haeffelin, M., Chepfer, H., 2013. Scales of spatial and temporal variation of solar irradiance on Reunion tropical island. *Solar Energy* 88, 42–56. <https://doi.org/10.1016/j.solener.2012.11.007>
11. United Nations, n.d. THE 17 GOALS | Sustainable Development [WWW Document]. URL <https://sdgs.un.org/goals> (accessed 8.20.22).

References for Figures

| Figure | Source |
|--------|---|
| 1. | https://www.toonpool.com/cartoons/Zukunfts-Modell_407402 (accessed 08.08.2022) |
| 2. | Authors |
| 3. | Authors |
| 4.-6. | NeoLoco, n.d. Artisanat solaire [WWW Document]. Graines NeoLoco. URL https://neoloco.fr (accessed 1.21.22). |
| 7. | Authors |
| 8. | United Nations, n.d. THE 17 GOALS Sustainable Development [WWW Document]. URL https://sdgs.un.org/goals (accessed 8.20.22). |