Shifting intraday electricity usage through time-of-use tariffs

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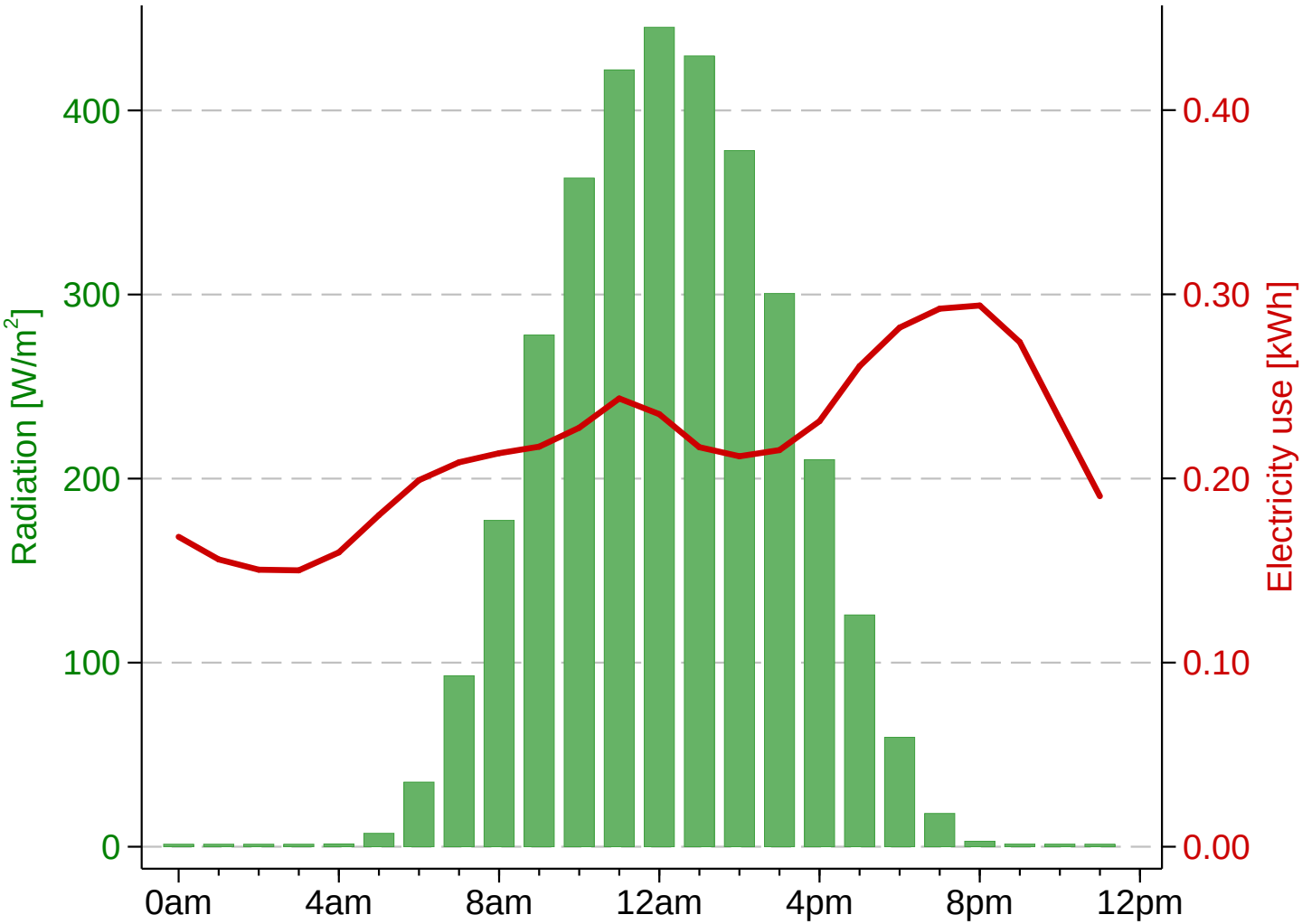
Motivation

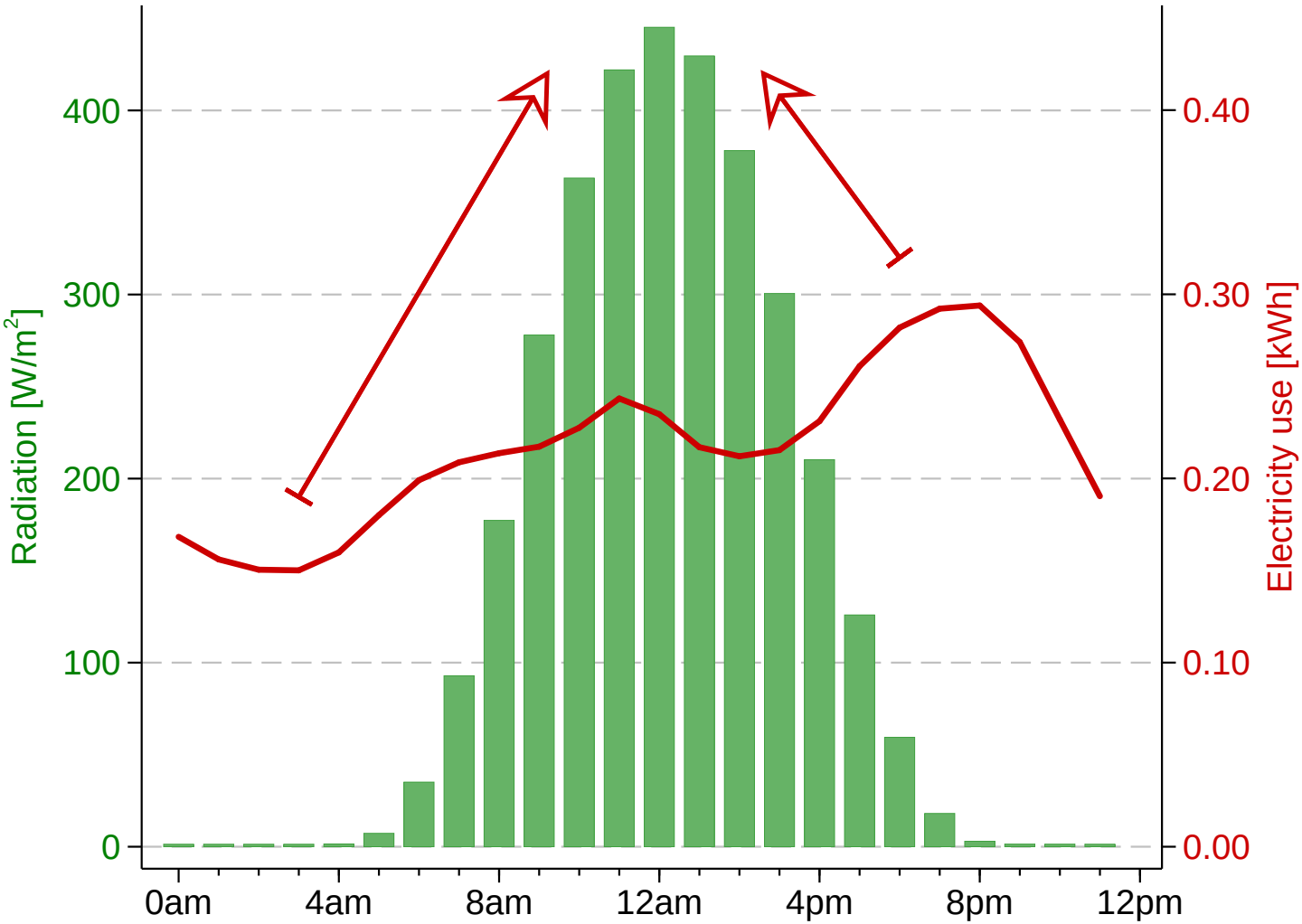


Average solar radiation per hour in CDF/DEM/FAH in 2013-2016. Data source: *MeteoSwiss*.
Average electricity used per hour by 498 HH in 2013-2016. Data source: *La Goule*.

Related literature and potential solutions

- Engineering
  - Large literature, see review by Kondziella & Bruckner, *RSER* 2016)
  - Solutions investigated: grid expansion and storage (supply-side)
- Economics
  - Focus on electricity conservation and peak reduction (demand-side)
  - Recent evidence based on high-frequency meter data: Bartusch et al. (*EP* 2011), Degen et al. (*SFOE report* 2013), Di Cosmo et al. (*EJ* 2014), Jessoe & Rapson (*AER* 2014), Ito et al. (*NBER* 2015)

Our objective: load shifting



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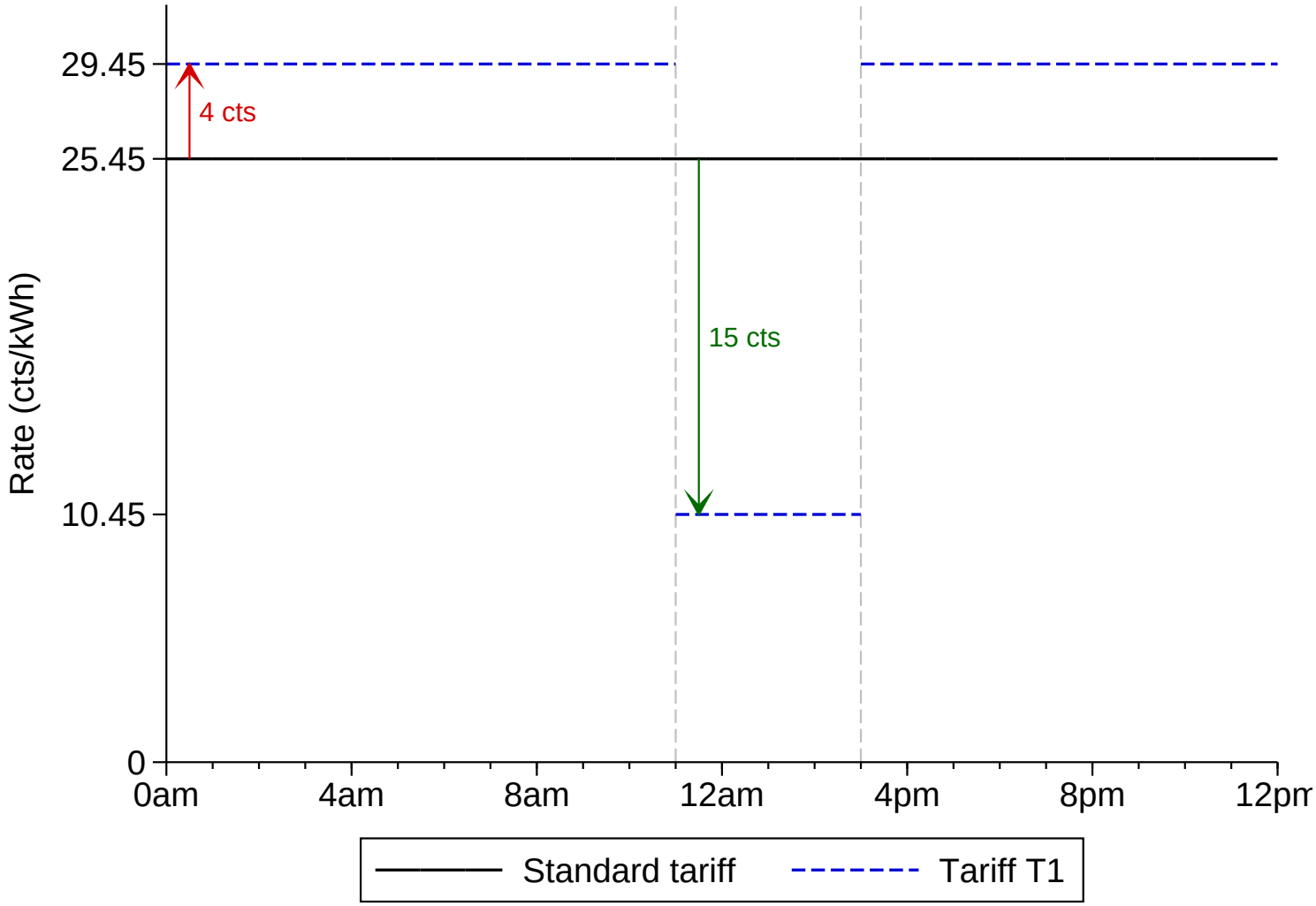
The experiment

- Collaboration with a utility active in northern Switzerland (Jura/Bern) with 8,000 customers
  - Meters record electricity usage in 15- or 60-minute intervals since 2013
- Eligible households:
  - Flat electricity tariff, no PV, primary residence
- Participants:
  - Answered preexperiment survey
  - Randomly selected
- Random allocation:
  - Control
  - Treatment 1
  - Treatment 2

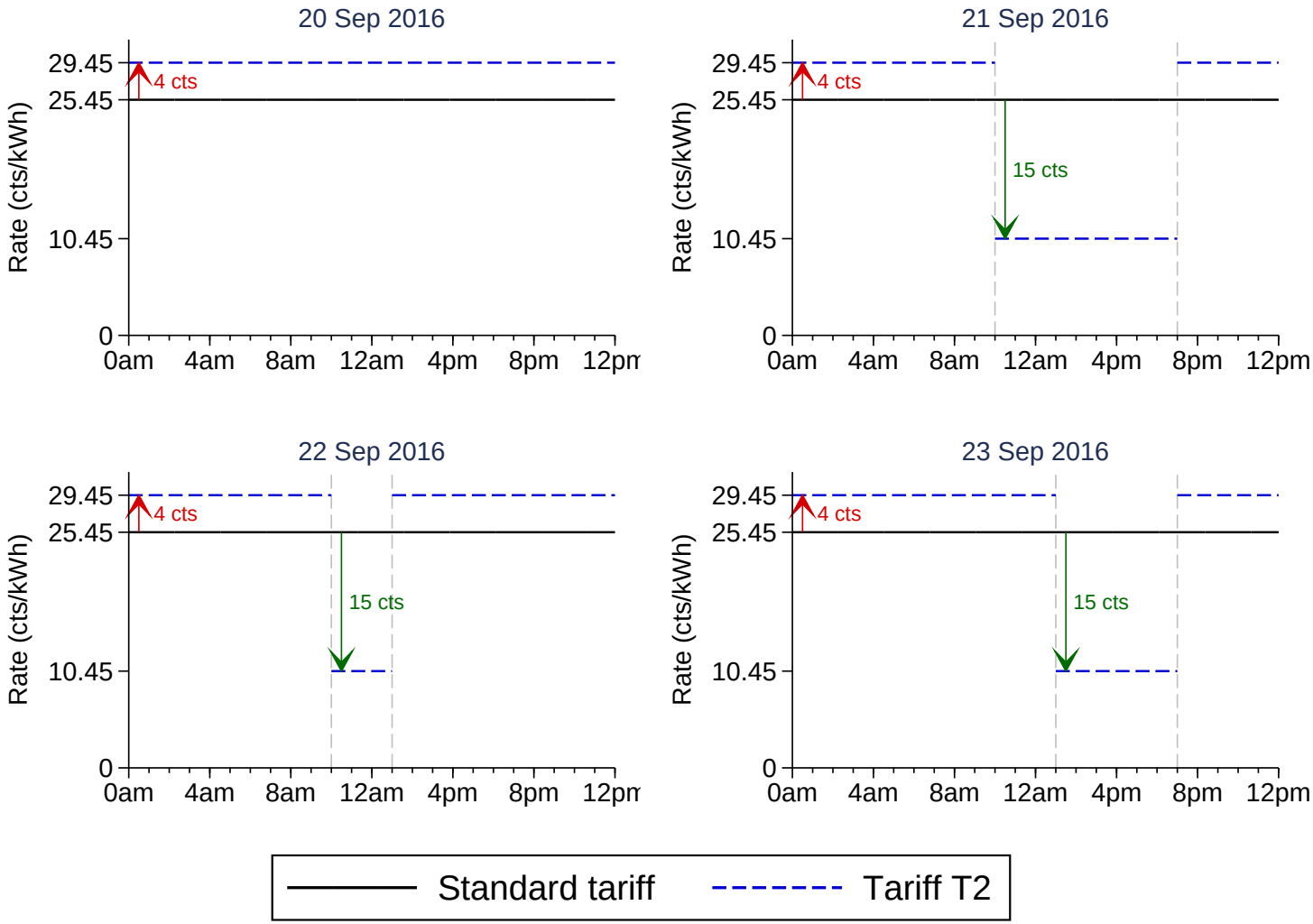
Treatment 1

With respect to standard tariff, rate is decreased between 11am-3pm and increased for other hours

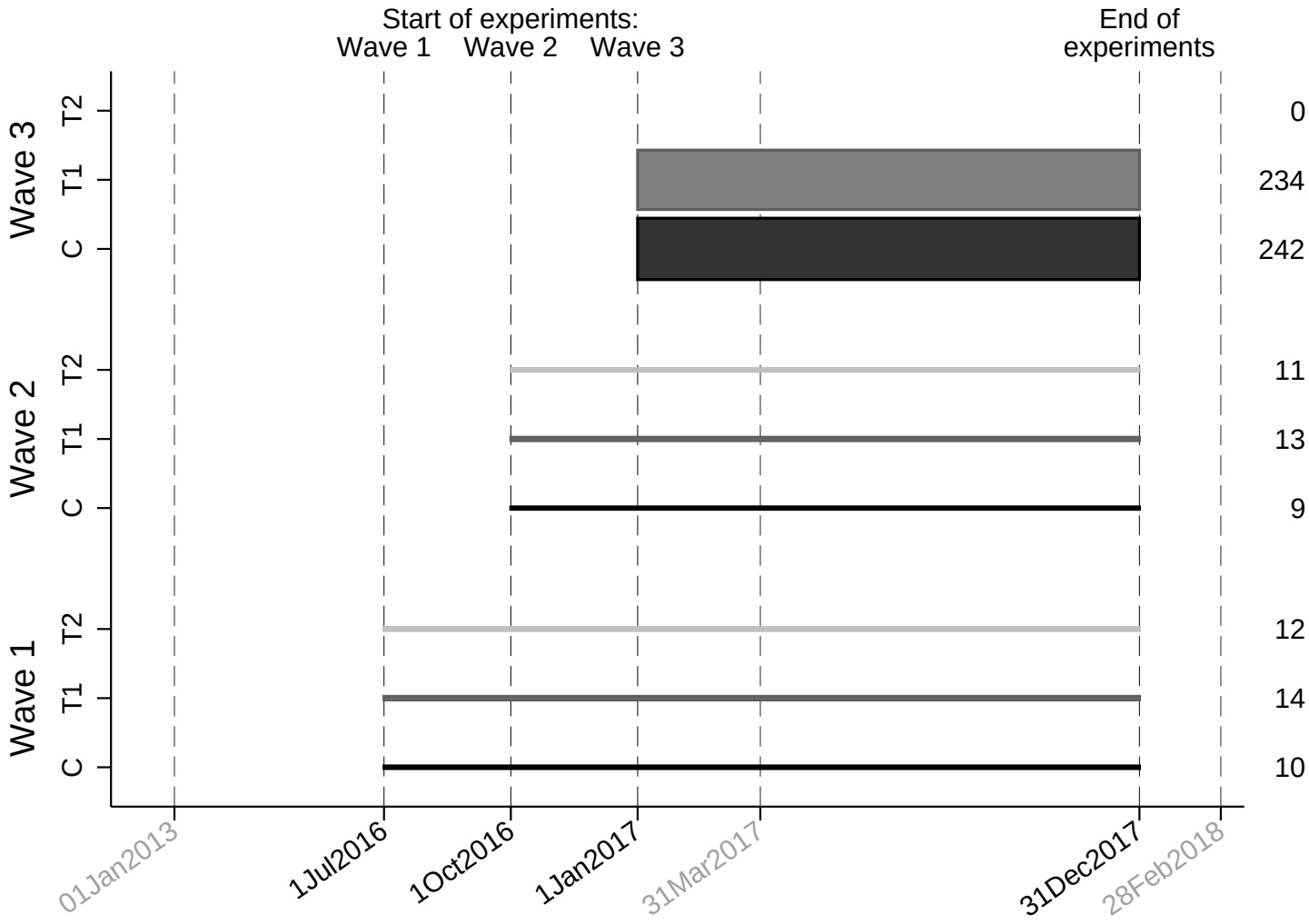


Treatment 2

At 5pm every day, a text message (SMS) indicates the timing of low/high rates for the following day (based on weather forecast)



Waves and number of households



Note: size of line proportional to number of households in each wave-group.

Difference-in-differences estimations

- Estimated equation for Treatment 1:

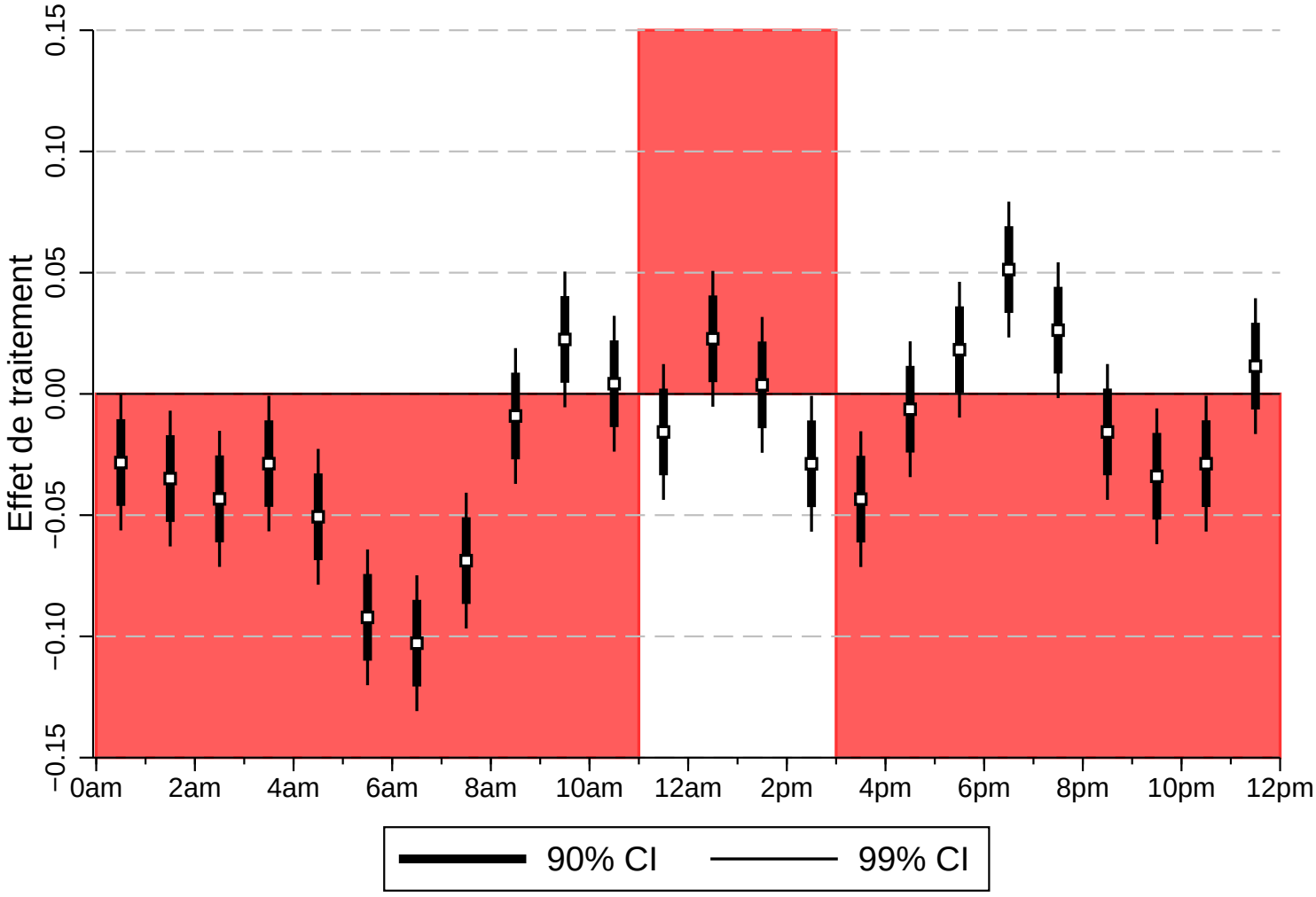
$$\ln(kwh_{iht}) = \sum_{h=1}^{24} \beta_h T_{ght} + \delta_t + \alpha_g + \lambda_h + \varepsilon_{iht} \quad (1)$$

- Estimated equation for Treatment 2:

$$\ln(kwh_{iht}) = \sum_{h=1}^{24} \beta_h TH_{ght} + \sum_{h=11}^{19} \beta_{gh} TL_{ght} + \delta_t + \alpha_g + \lambda_h + \varepsilon_{iht} \quad (2)$$

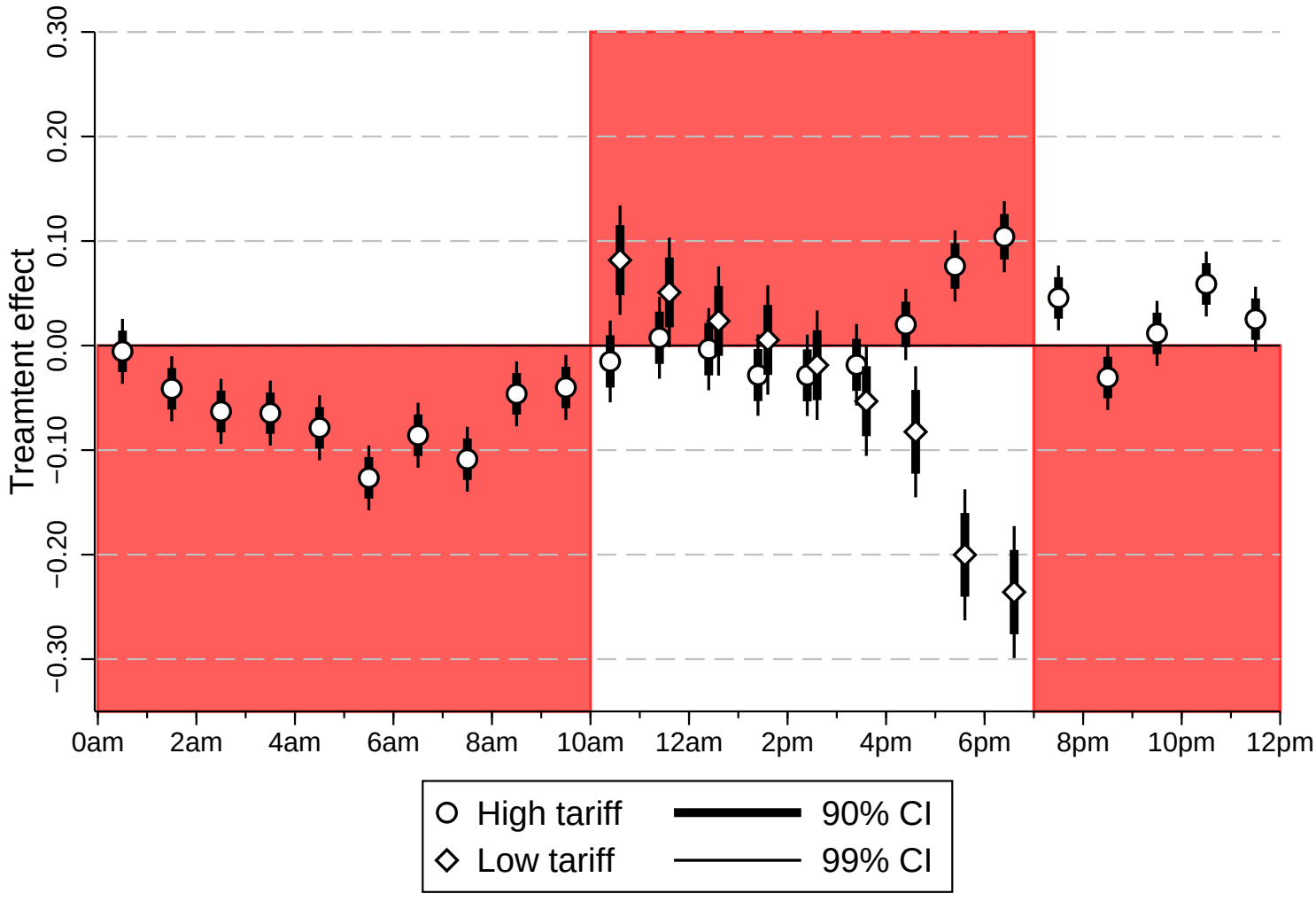
  - kwh_{iht}: electricity usage by household i in hour h of day t
  - T_{ht}: 1 if household $i \in$ treatment group g, day $t \in$ treatment period, and hour is h
  - TH_{ht}: 1 if household $i \in$ treatment group g, day $t \in$ treatment period, and hour h is a high tariff hour
  - TL_{ht}: 1 if household $i \in$ treatment group g, day $t \in$ treatment period, and hour h is a low tariff hour
  - δ_t: time fixed effect
  - α_g: group fixed effects
  - λ_h: hour fixed effect

(Very) preliminary results: Treatment 1 (11am-3pm)



Results based on 43 households of waves 1 + 2, groups C0 + T1.

(Very) preliminary results: Treatment 2 (sunny hours)



Results are based on 38 households of waves 1 + 2, groups C0 + T2.

Conclusion

- To be continued...
- This experiment constitutes one step forward...
  - to investigate whether/how households adapt to time-of-use tariffs
  - to explore potential solution to temporal mismatch between electricity consumption and solar production
- ... but another step is to make the alternative tariff binding for the customers
  - Under discussion

Thank you for your attention