Determining the true value of energy efficiency improvements and demand flexibility services

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Examples

- Energy efficiency improvements
  - Retrofitting insulation in a house
  - Replacing resistive heaters with heat pumps
  - Looking at both residential and large buildings
  - Any intervention that aims to reduce total energy demand over a long period

- Demand flexibility services
  - Short term reduction of net demand
  - Can be industrial, commercial, or residential loads

Energy efficiency and demand flexibility are vital for cost-effective decarbonisation

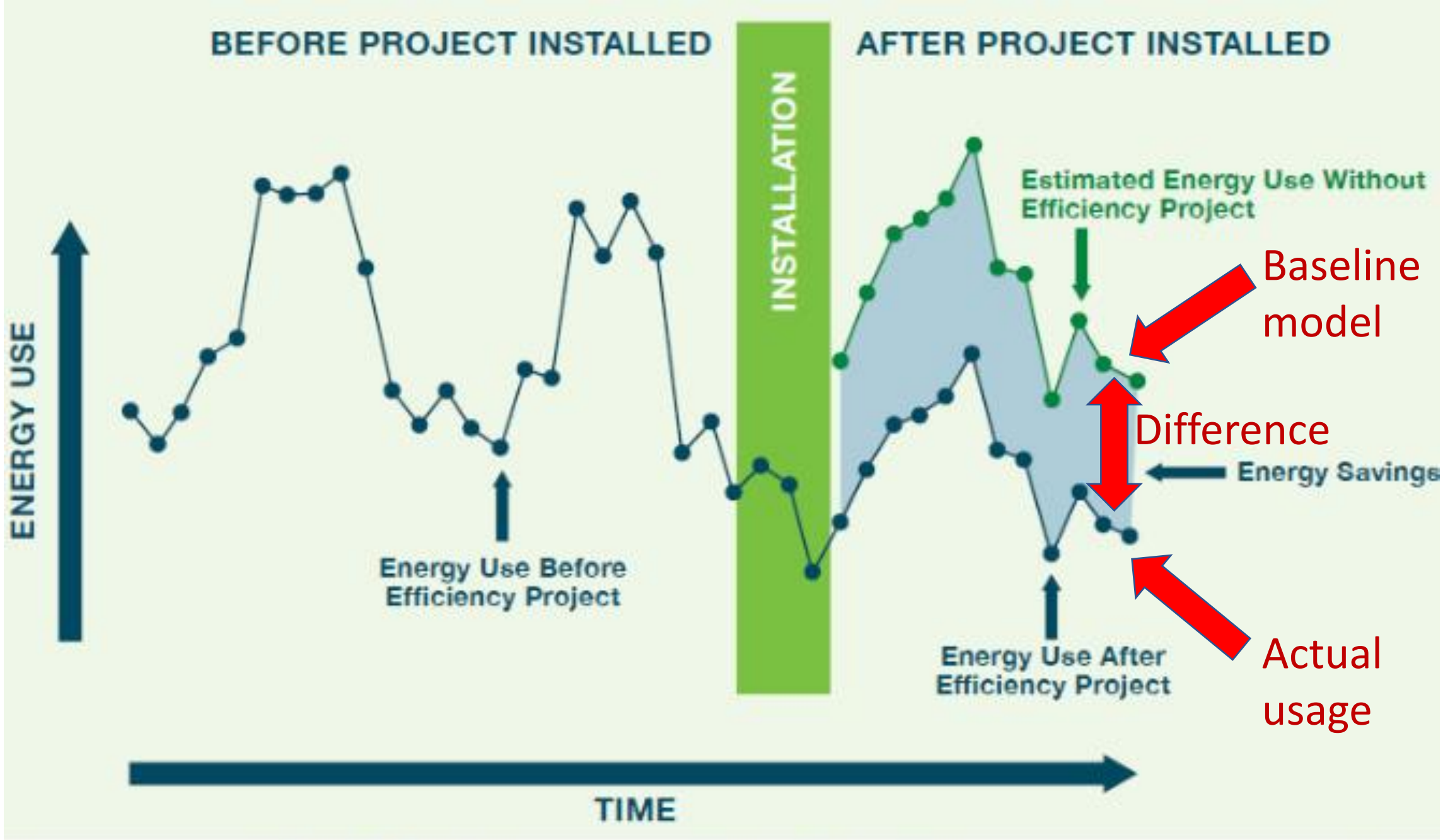
- System cost depends on demand peak
- Could greatly reduce winter peak
  - E.g. better insulated houses
- Reduced infrastructure costs
- Increasingly important as sectors transition to electricity
- Co-benefits
  - E.g. large scale insulation retrofits needed for healthy houses

Measurement and verification

- Energy efficiency improvements are often carried out in the hope of future $ savings
- We can go back afterwards and work out how much energy was actually saved i.e. ‘measurement and verification’
- We can also work out when these savings occurred (by half-hour)

Why is it important to measure the actual impact of energy efficiency and demand flexibility?

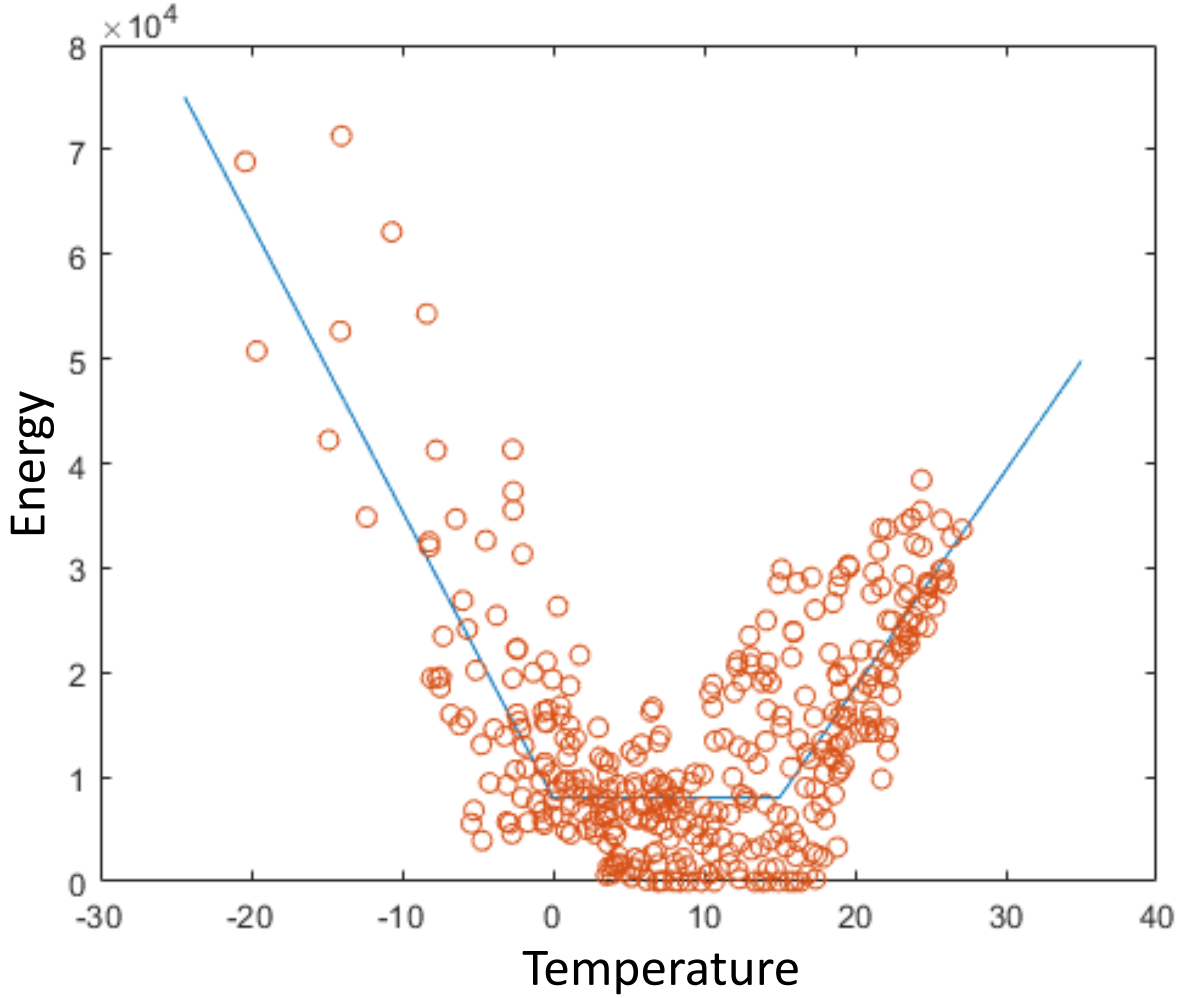
- Verification
- Attract investment, encouraging much higher uptake
- Energy savings during peak periods are more valuable
  - We want to know what time of day and what time of year savings occur
- Pay-for-performance programs
  - Pay implementers based on the actual performance of the project



State and Local Energy efficiency Action Network. 2012. *Energy Efficiency Program Impact Evaluation Guide*. Prepared by Steven R. Schiller, Schiller Consul ting, Inc., www.seeac on.energy.gov.

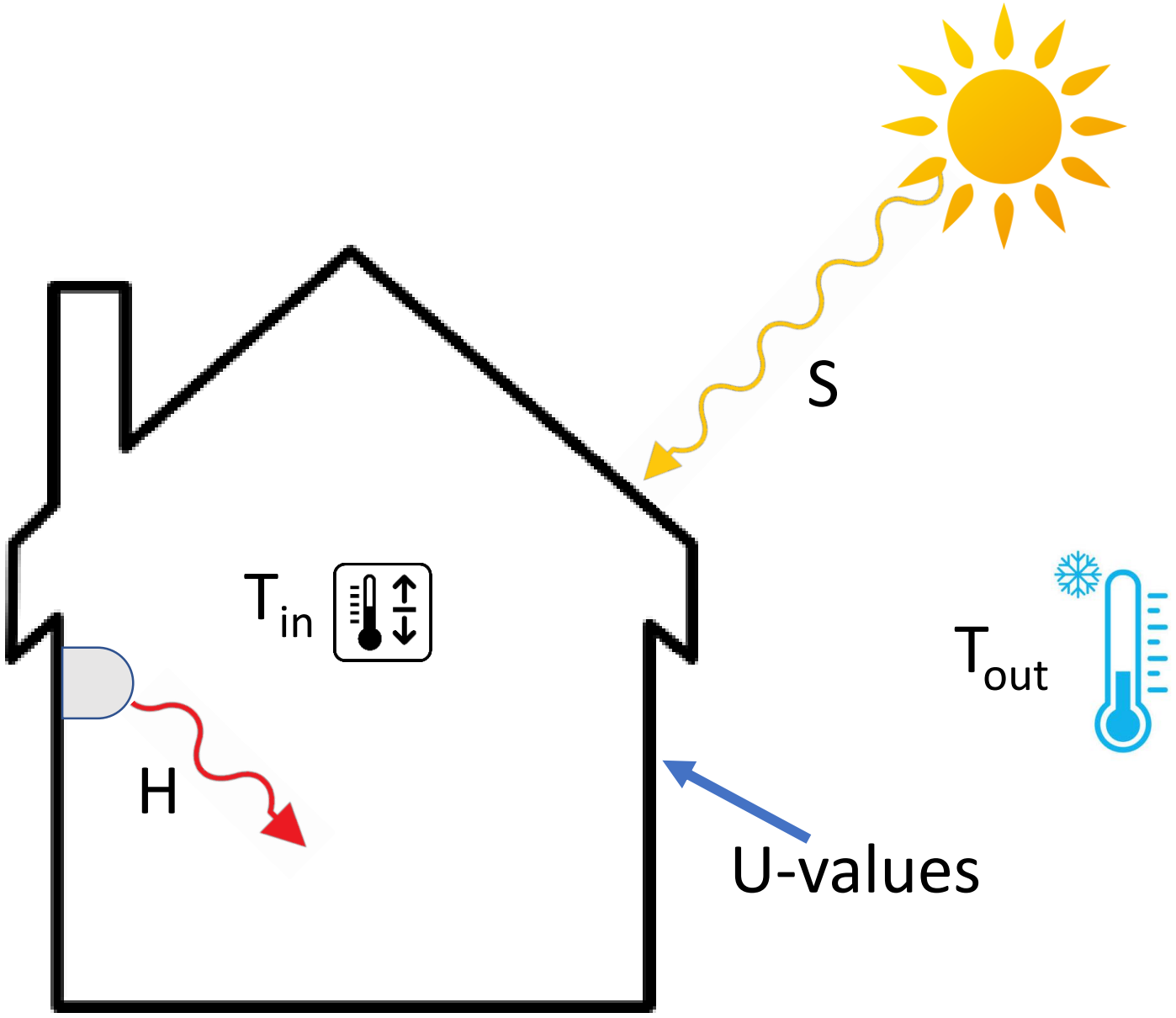
Baseline models

- Aims to predict the energy consumption of a site
- Individual model for each site
- Often use external temperature and time of day as explanatory variables
- Linear regression
- We aim to make improvements to the existing industry standard baseline models



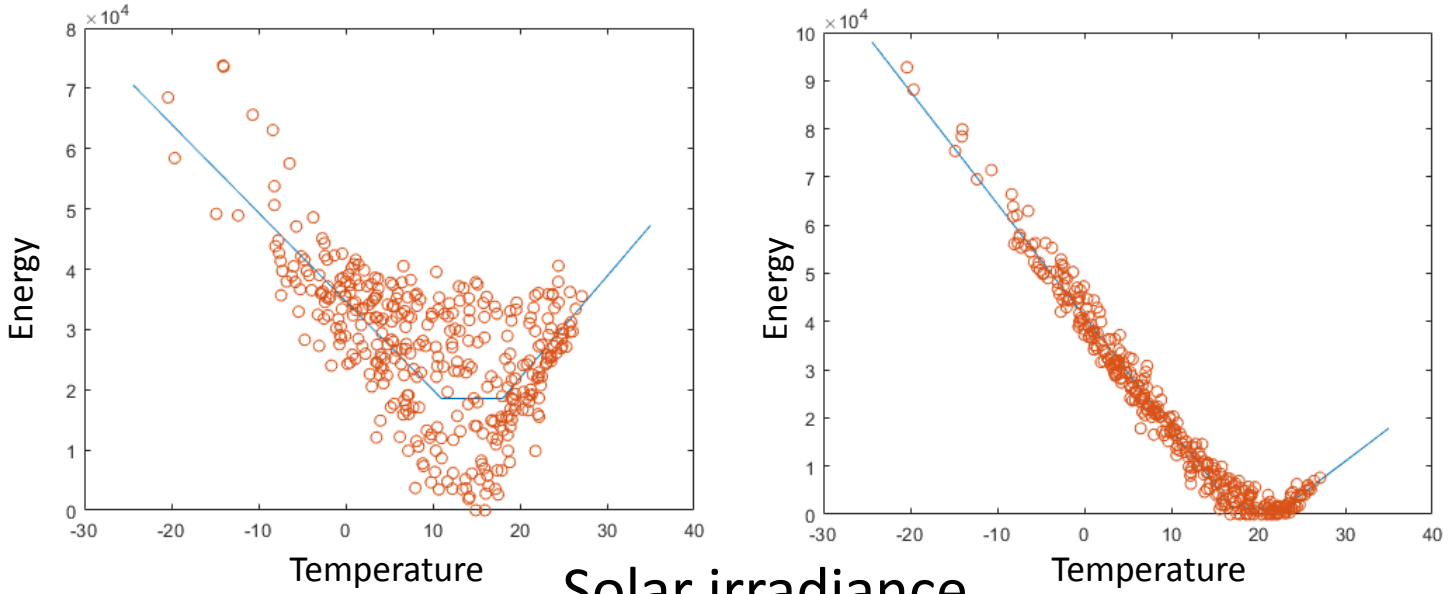
Building simulation

- Inputs
  - Dimensions
  - U-values (insulation)
  - Scheduling
  - Set-point temperatures
  - Outdoor temperature
  - Solar irradiance
- Outputs
  - Hourly energy consumption
  - Indoor temperatures
- Added benefit of knowing all parameters behind the data, useful for model validation

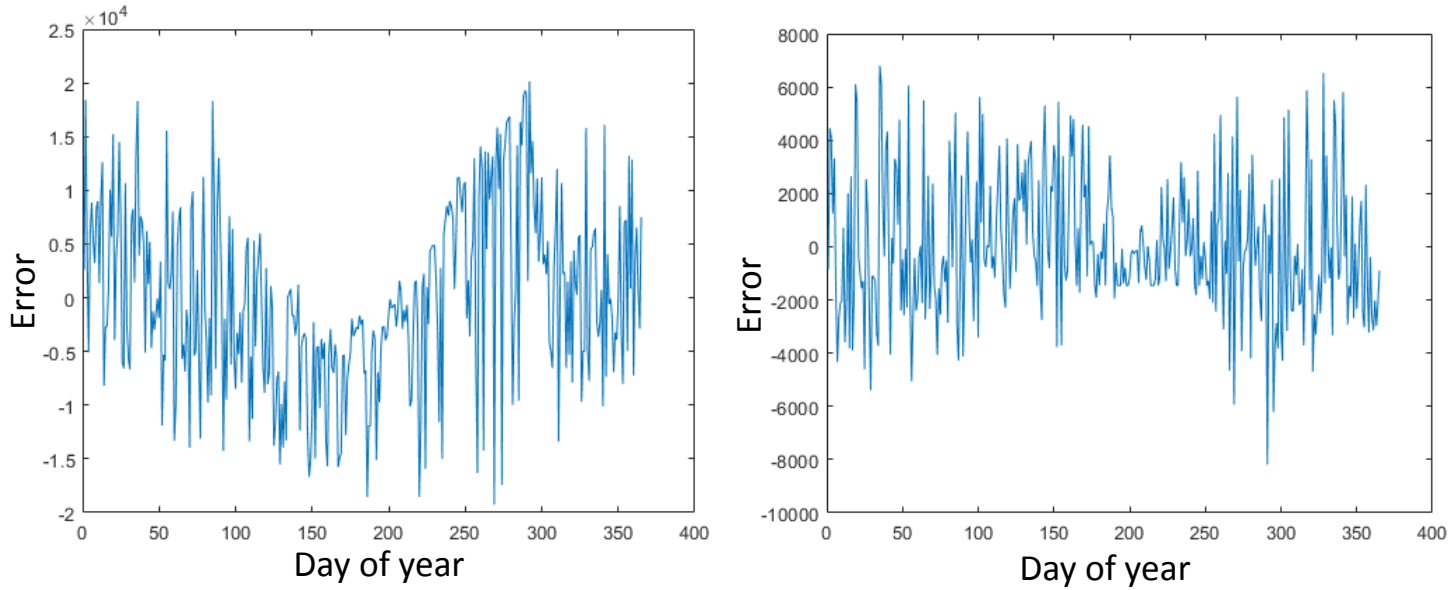


Preliminary results

- Turning down solar irradiance in the building simulation's weather inputs reduced hourly and seasonal variation
- Suggests that a solar gain term in the model could help account for the variation



Solar irradiance reduced by 80%



Summary

- We can build a model to estimate what the energy demand would have been without a demand-side intervention
- This can be used to inform the payment of demand-side services
- Potentially significant for enabling large scale uptake of energy efficiency improvements and demand flexibility

Future directions

- Improve the baseline models to improve the accuracy of savings estimation
- Methods to report the uncertainty of estimates
- Develop methods to infer indoor temperatures from smart meter data before and after an intervention
  - Useful for quantifying co-benefits