# Zero net carbon model for Victorian houses

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# Why we developed the ZNC modelling tool

> Developed for SV by Energy Efficient Strategies & IT Power Renewable Consulting

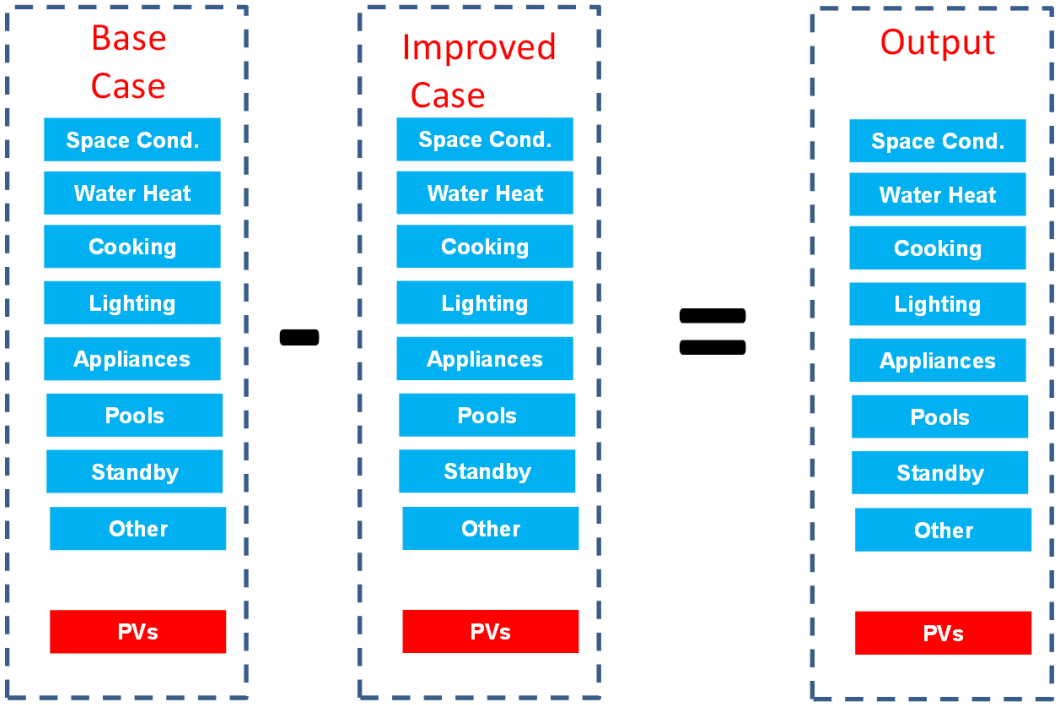
> "Zero net carbon" status is achieved if the modelled house has zero net greenhouse emissions over a typical year based on energy used by appliances and lighting, and electricity generated by rooftop PVs

> Scenario modelling tool that allows the practicality, costs and benefits of ZNC houses to be explored for new and existing Victorian houses

> Key questions to answer:

- What improvements (building shell, appliances, PV) are required for standard new and existing houses to achieve ZNC status?
- What does it cost to achieve ZNC status?
- What are the benefits – energy, energy bill and greenhouse gas savings?
- How do the economics stack up? What if battery storage is included?
- What impact does it have on the daily energy demand profile?

# Overview of the ZNC modelling tool




Model allows a “base” and “improved” case house to be defined, and then modelled for each hour over a typical year – these are compared to assess the impact.

Both the Heating & Cooling Loads and PV output are based on AccuRate weather data files.

Model calculates %ZNC status achieved and how much PV required to achieve 100%.

# Pre-loaded options for base and improved house

- **House size** – small (113m$^2$), medium (188m$^2$), large (265m$^2$)
- **Number of occupants** – defaults for house size, or specify the number
- **Climate zone** – Mild (Moorabbin), cold (Ballarat) or hot (Mildura)
- **Occupancy profile** – "home all day" or "work day" profiles
- **Scope of the ZNC calculation** – all energy, just fixed appliances, or tailor scope
- **Building shell efficiency** – House Energy Rating of 2, 5, 6, 7 or 8 Stars
- **Fuel choice** – mixed gas and electric, all electric, or specify for each appliance
- **Appliances** – end uses, number, type and efficiency level
- **Rooftop PVs** – none, 1 to 10 kW in 1 kW increments, or specify + technical parameters
- **Battery storage** – none, or 2 kWh to 20 kWh in 2 kWh increments + technical parameters
- **Energy tariffs** – peak, shoulder, off-peak, green power, feed-in for electricity, or specify
- **Financial** – commencement year, discount rate, analysis timeframe, learning rates for cost of key equipment, growth rate for energy prices, STC (number and value)

# Achieving ZNC status for Victorian houses

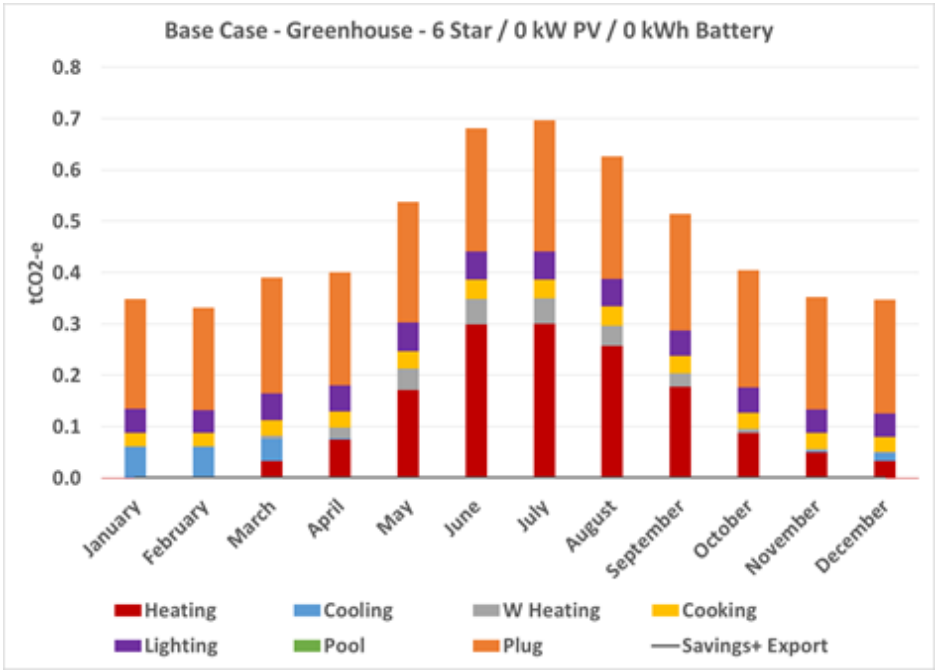
- Reference house modelled is a medium house located in Melbourne, 3 people with a “work day” occupancy profile
- Mixed gas and electric, with gas central heating and room air conditioner for cooling
- Improvements assumed to occur in 2017, with 40 year analysis period and 3% discount rate

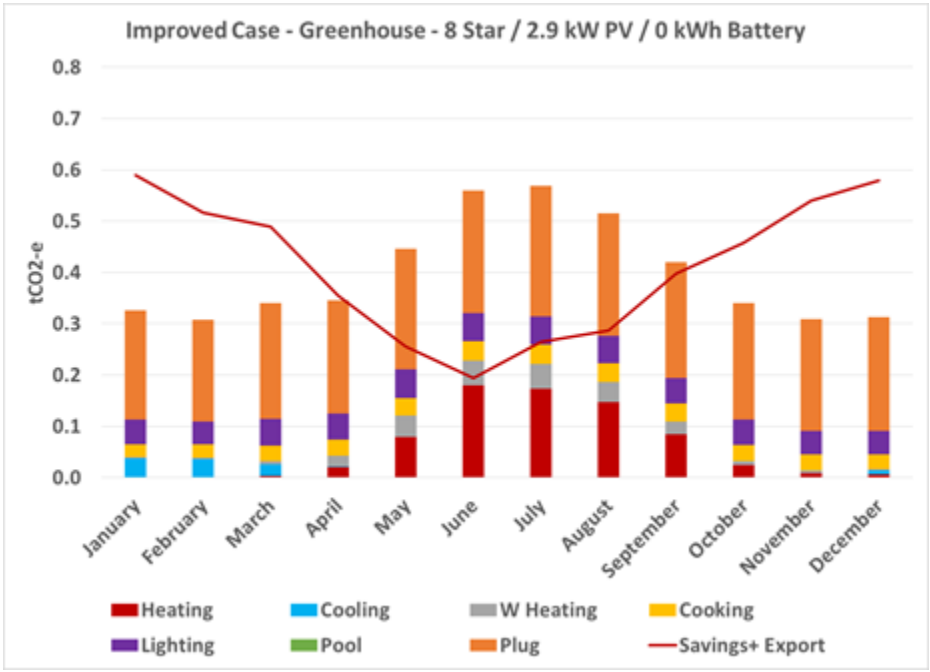
| House | Base reference house | Improved (ZNC) house |
|---|---|---|
| **New** | 6 Star HERS rating<br>Gas boosted solar water heater<br>Market average appliances | 8 Star HERS rating<br>Gas boosted solar water heater<br>Market average appliances<br>2.9 kW PV. No battery. |
| **Existing** | 2 Star HERS rating<br>Gas storage water heater<br>Stock average appliances | 5 Star HERS rating<br>Gas instantaneous water heater<br>Market average appliances<br>3.9 kW PV. No battery. |

# Summary of modelling outputs for reference house

| Output parameter | New house | Existing house |
|---|---|---|
| **Annual results** | | |
| Annual energy cost saving ($/Yr) | $708 | $1,673 |
| Annual greenhouse gas saving (t $CO_{2\text{-}e}$/yr) | 5.76 | 11.20 |
| % ZNC status achieved | 102% | 100% |
| **Present value of lifetime costs (3% discount)** | $3,766 | $15,845 |
| Building shell improvements | - | $4,880 |
| Appliance upgrades | $9,096 | $11,204 |
| Rooftop PV | ***$12,862*** | ***$31,929*** |
| ***Total improvement cost*** | | |
| **Present value of lifetime savings (3% discount)** | $6,194 | $28,410 |
| Building shell improvements + appliances | $11,908 | $14,100 |
| Rooftop PV | ***$18,002*** | ***$42,510*** |
| ***Total savings from improvements*** | 1.40 | 1.33 |
| Benefit-cost ratio | | |

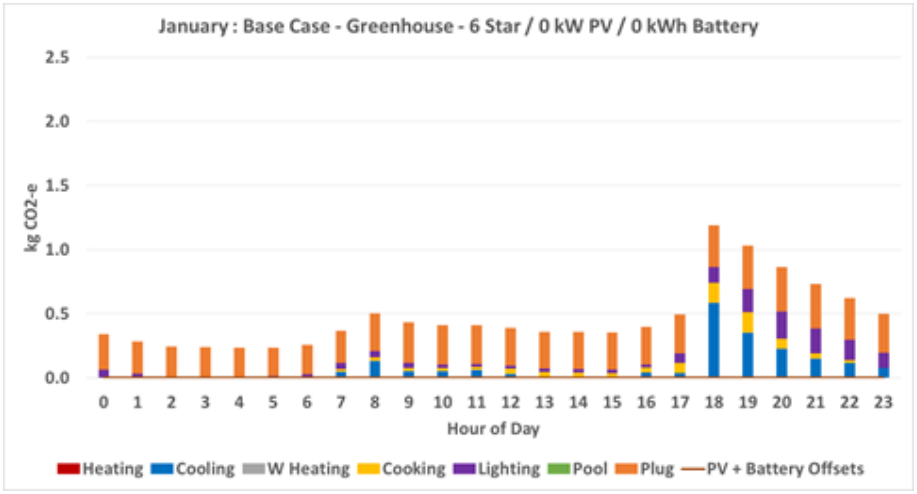
# New house – greenhouse gas emissions

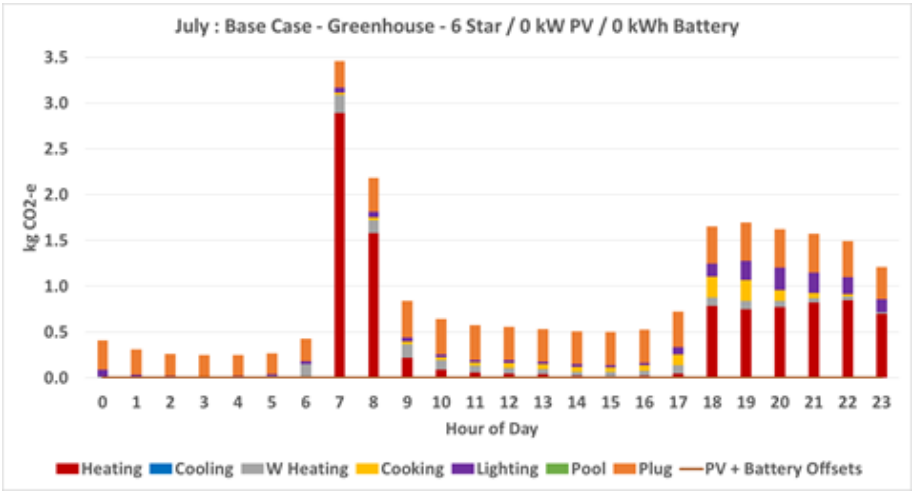


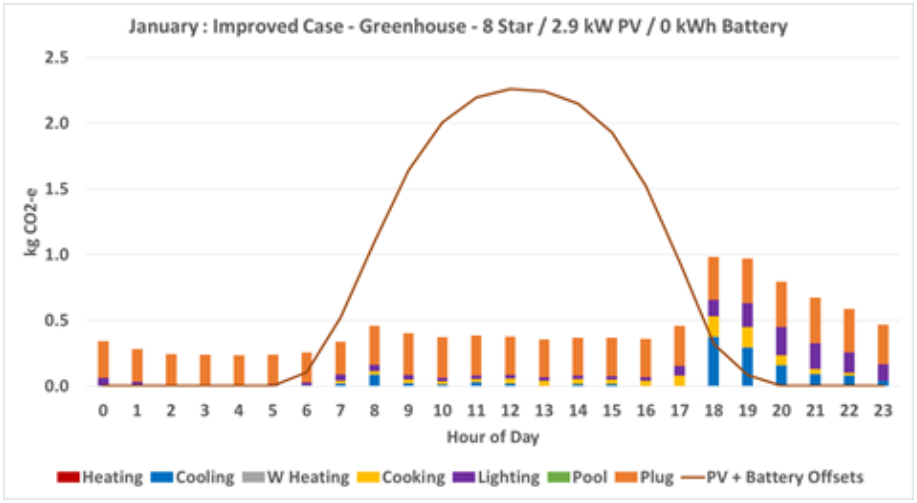



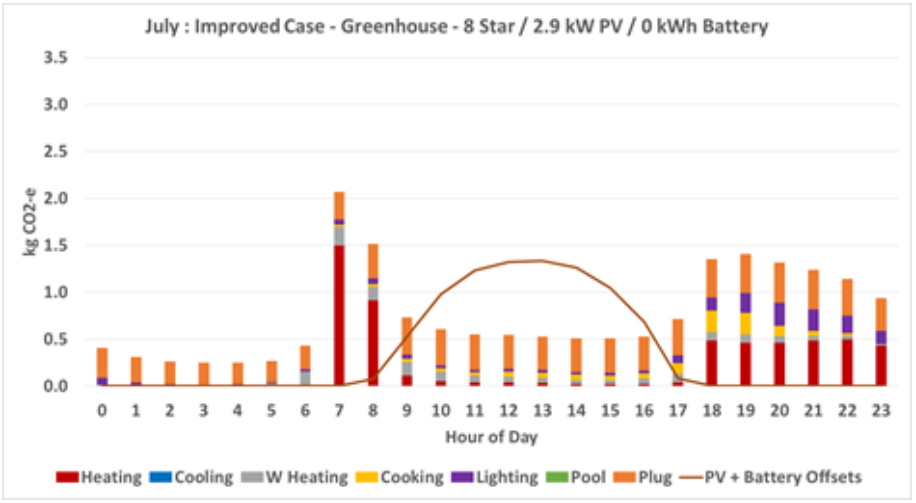

Similar graphs can be selected for energy, and energy cost.

# New house – daily greenhouse emissions profile




Graphs can be called up for any month of the year.

# Sensitivity modelling

> We have modelled a range of variations from the “reference house” for both the new and existing houses, including size, climate, number of occupants, occupancy profile, building shell and appliance efficiency, fuel choice and battery storage (see paper for results)

> Key learnings from the modelling are:

- While easier for new houses, attaining a ZNC status is practically achievable – for new house PV typically 2.5 to 4 kW and for existing house typically 3.5 to 6 kW
- The size of the PV system increased with: increases in house size and number of occupants; decreases in building shell and appliance efficiency; in colder climates; and if house was all electric or had a swimming pool
- In general the building shell and appliance upgrades were more cost effective than the PV (except ‘best in class’ appliances)
- PVs are most cost effective where the output profile of the PV system most closely matched the electricity consumption profile
- Presence of a battery slightly increases the size of the PV system, and (currently) significantly reduces the cost effectiveness of the upgrade

# Questions?

Ian McNicol & Robert Foster will be available to demonstrate the ZNC tool after the presentation