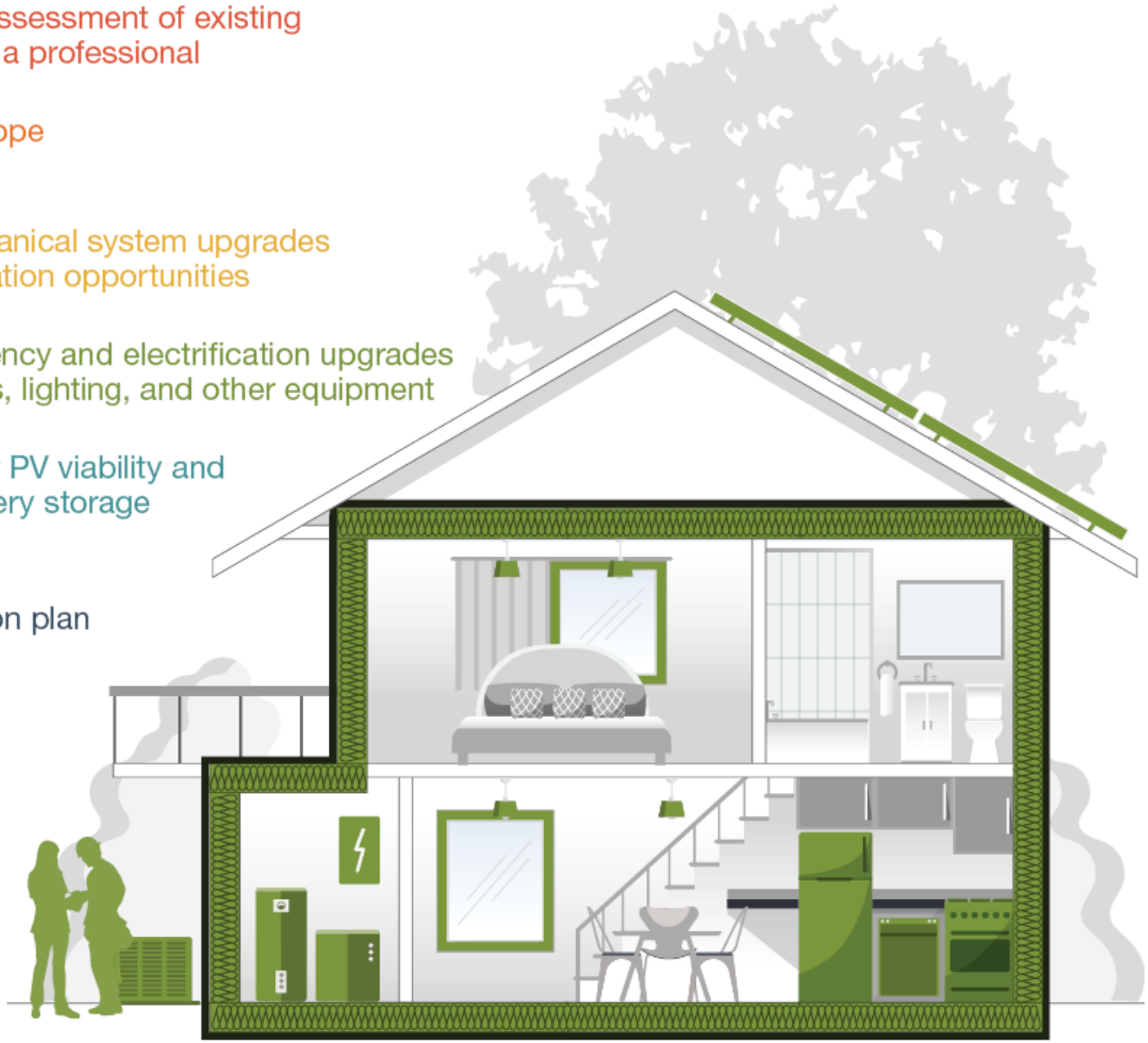
Cost Effective Steps to ZERO Energy Retrofits

1. Conduct an assessment of existing conditions by a professional
2. Identify envelope upgrades
3. Identify mechanical system upgrades and electrification opportunities
4. Identify efficiency and electrification upgrades for appliances, lighting, and other equipment
5. Evaluate solar PV viability and consider battery storage
6. Develop implementation plan
7. Commission and monitor



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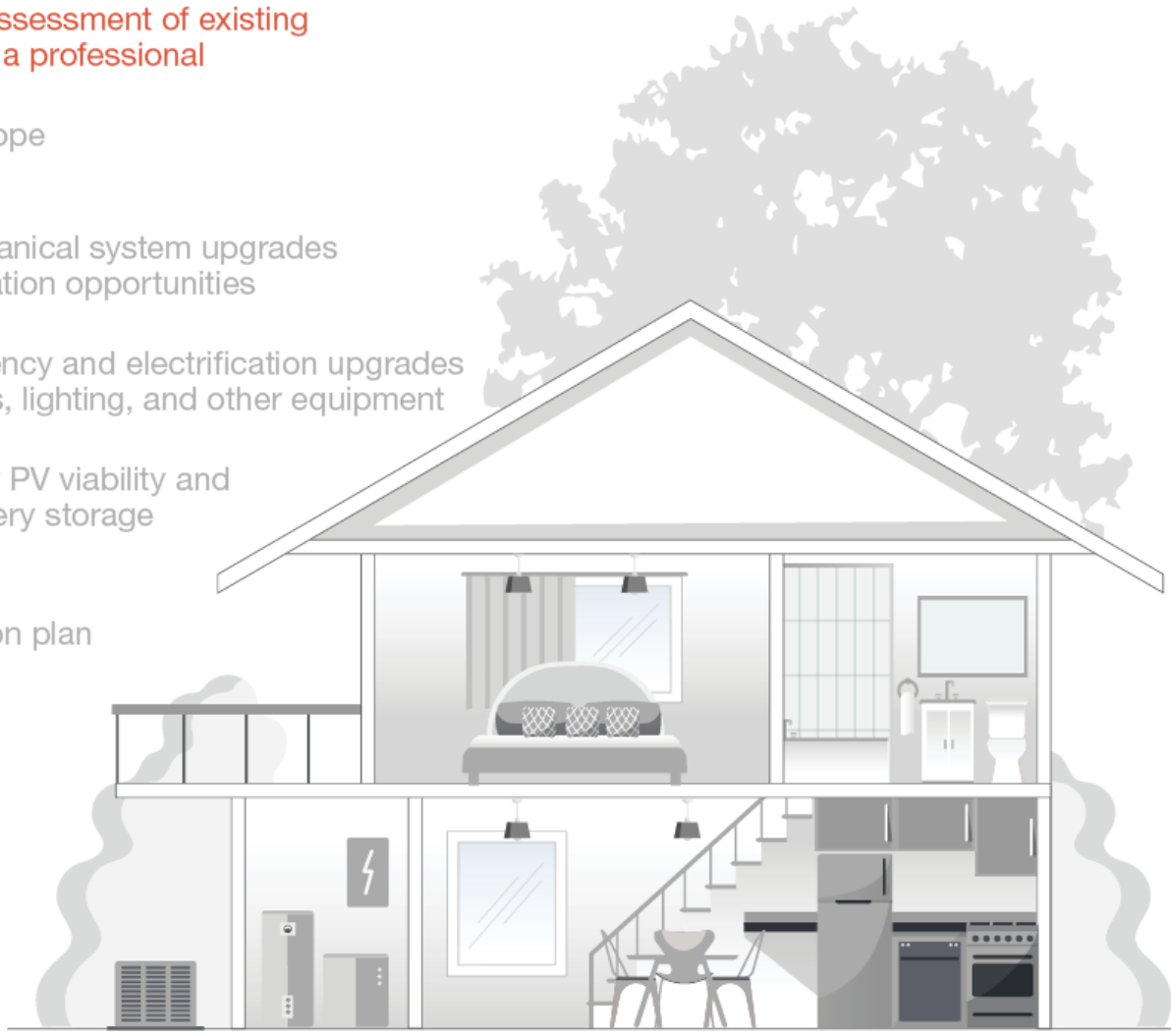

PURPOSE

Determine a baseline for existing building systems, assemblies, and solar potential of the roof and/or project site. Benefits of improvements include: comfort, indoor air quality, durability, resiliency, health and safety, monthly utility savings, and increased market value.

STRATEGIES

- Schedule an appointment with a qualified professional energy consultant that uses diagnostic tools. Discuss project energy reduction upgrades against energy production possibilities.
- Consider electrification at every step of the way.
- Discuss options for a phased approach based on access to financial resources.

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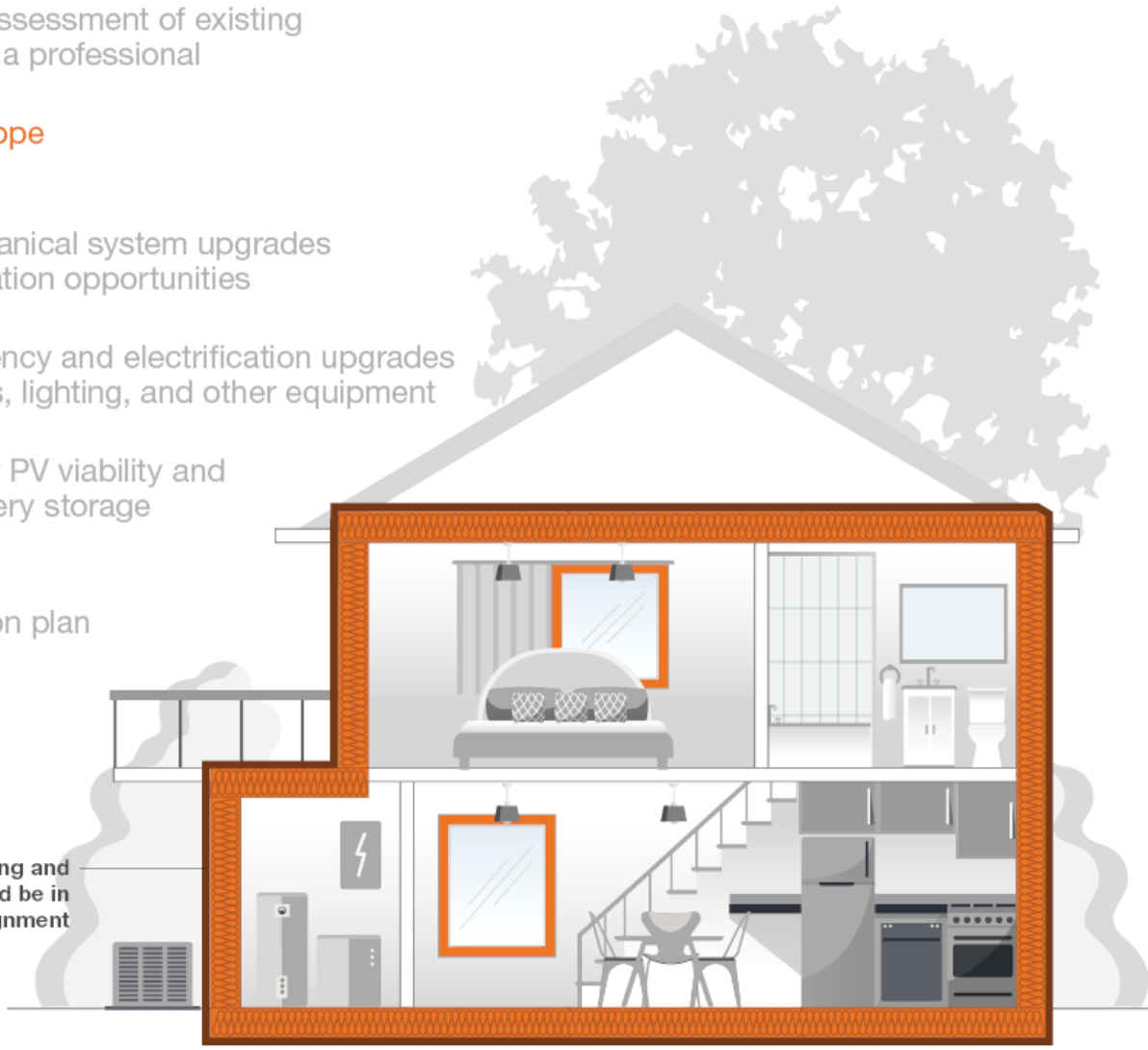

PURPOSE

Because heating and cooling represents the largest energy load in a typical building focusing on passive strategies to reduce heat transfer through the building's envelope can offer significant energy savings. Existing buildings are often poorly insulated and drafty so envelope upgrades can offer additional benefits including comfort, durability, better indoor air quality, and noise reduction. Envelope upgrades can also help maintain safe indoor temperatures in an extended power outage so they offer additional resiliency. Envelope upgrades require significantly less maintenance and replacement costs in contrast to mechanical system or appliance upgrades.

STRATEGIES

- Prioritize air sealing with the use of a blower door test, clearly define/align thermal boundaries between inside and outside, maximize insulation levels, and consider adding exterior insulation when residing.
- Optimize window performance with storm windows or Indow windows for historic windows, consider triple pane windows when upgrading to new windows.

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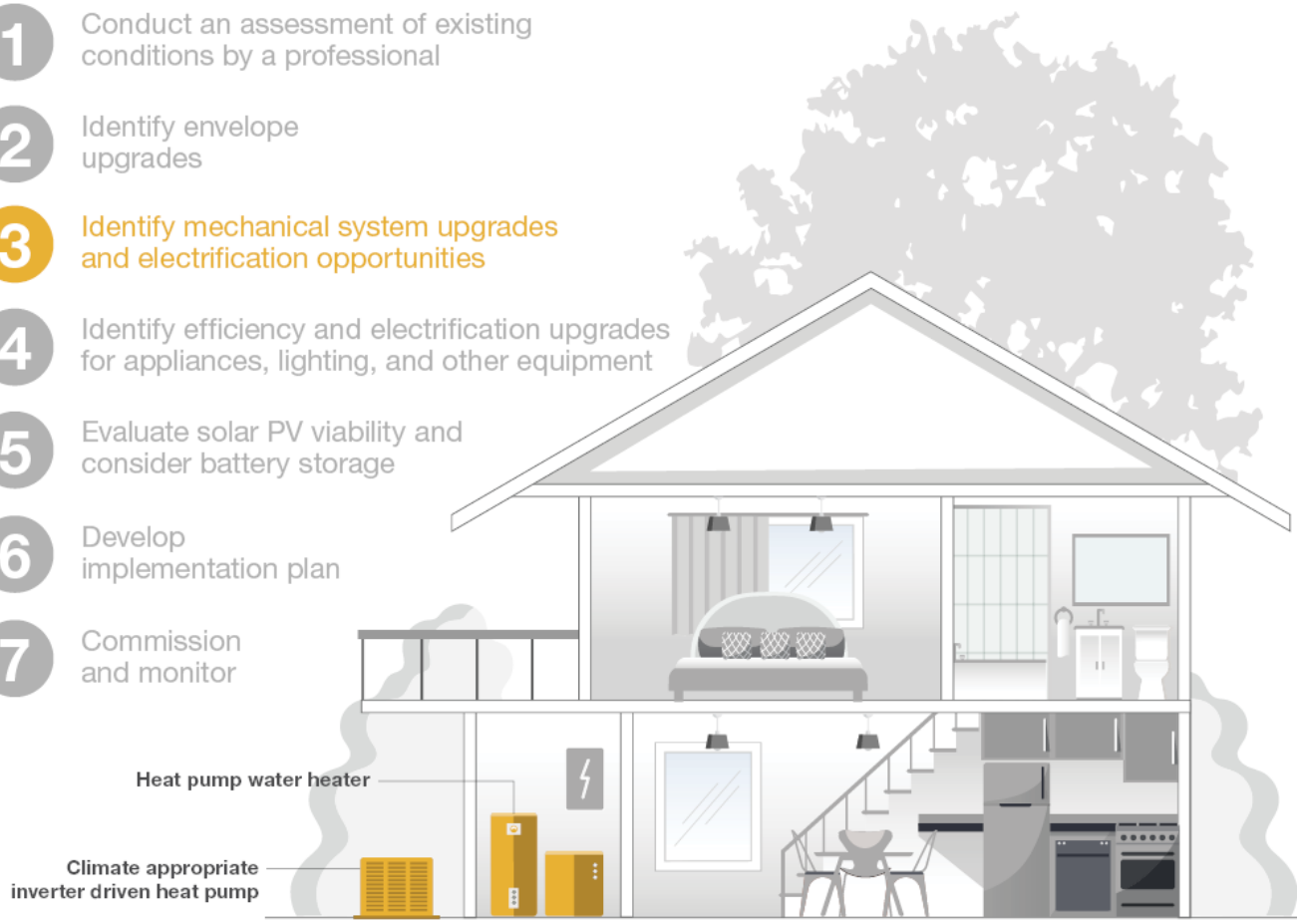

PURPOSE

Properly sized mechanical systems greatly effects efficiency, performance, comfort, system life, and could help save on installed and operational costs. Properly sizing mechanical systems requires detailed information determined by the results of step 2. Balanced whole building mechanical ventilation strategies often utilize the same ducting as the heating and cooling system so identifying opportunities for ventilation, filtration, and heat / energy recovery are prudent at this stage. Because water heating is often the 2nd largest energy use in buildings after space heating it's important to carve out a space in the electric panel for heat pump water heating at this stage. Consider low Global Warming Potential refrigerant heat pumps which can also play a role in the overall efficiency of the system.

STRATEGIES

- Prioritize heat pump technology for space heating and water heating. Semiconditioned spaces like unfinished basements and attached garages are ideal locations for heat pump water heaters.
- Work with an HVAC professional experienced in high performance buildings to properly size and design the space heating system using software tools.
- Ductwork is ideally located inside conditioned space or ductless mechanical equipment is utilized. Ductwork that cannot located inside should be air sealed and insulated.
- Consider smart thermostats that suggest and learn efficient behavior.
- Whole building, balanced mechanical ventilation with heat recovery provides comfort in addition to energy efficiency.
- Design for the highest level of filtration practical.
- The highest levels of filtration can negatively effect airflows in HVAC systems and should be always be accounted for in system design with an HVAC professional.
- Consider replacing exhaust fans with high efficiency DC brushless fans.

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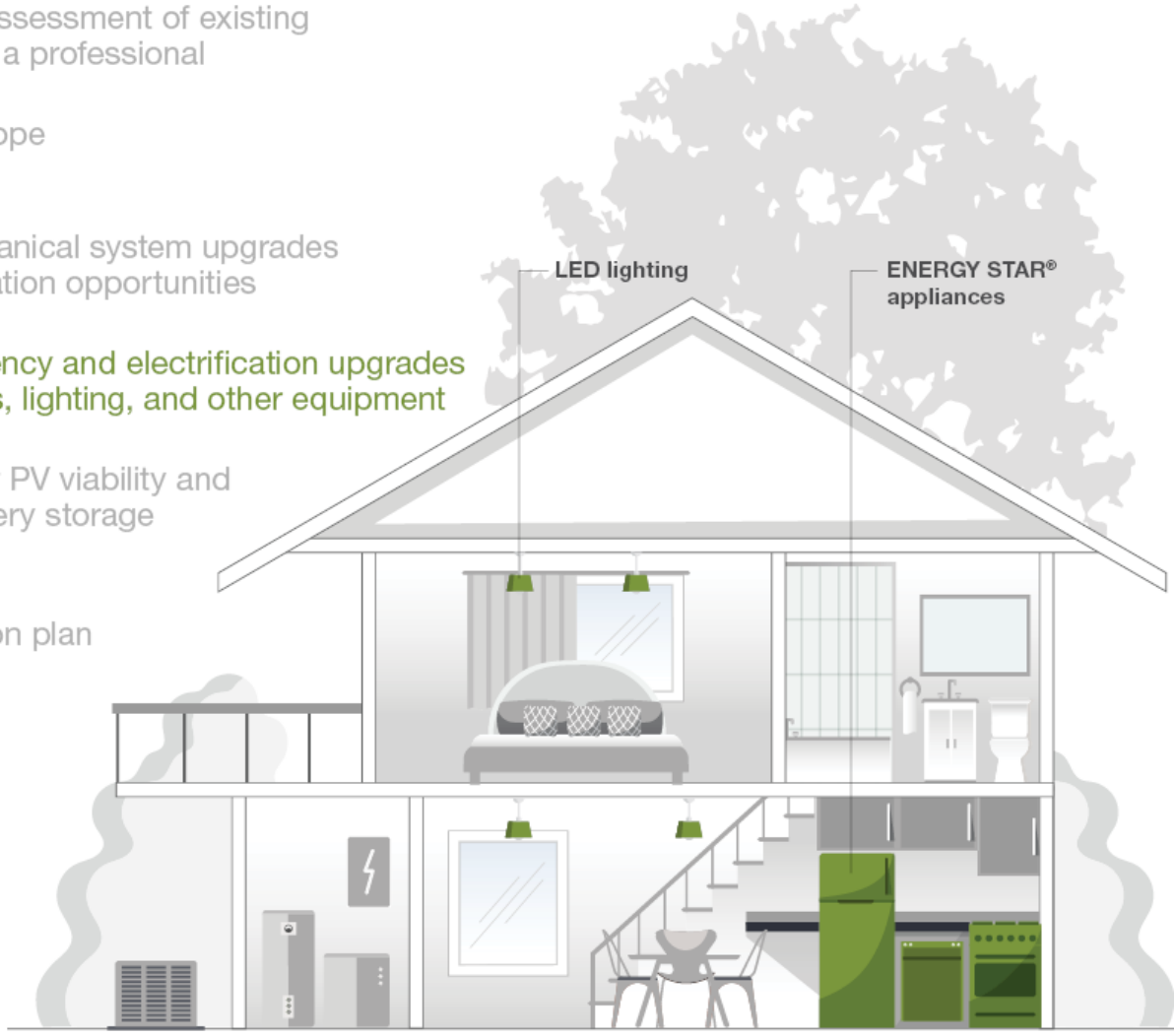

PURPOSE

Space heating and water heating energy consumption decrease with efficiency upgrades to the home's envelope and mechanical systems. Now the appliances, plug loads, and lighting represent a much larger percentage of overall energy consumption.

STRATEGIES

- Specify ENERGY STAR® rated appliances at minimum.
- ENERGY STAR® "Most Efficient Products" recommended.
- 100% LED Lighting.
- Smart controls.
- Specify WaterSense® rated plumbing fixtures.
- Reduce plug loads with smart technology and consider electrification opportunities for aging gas equipment.

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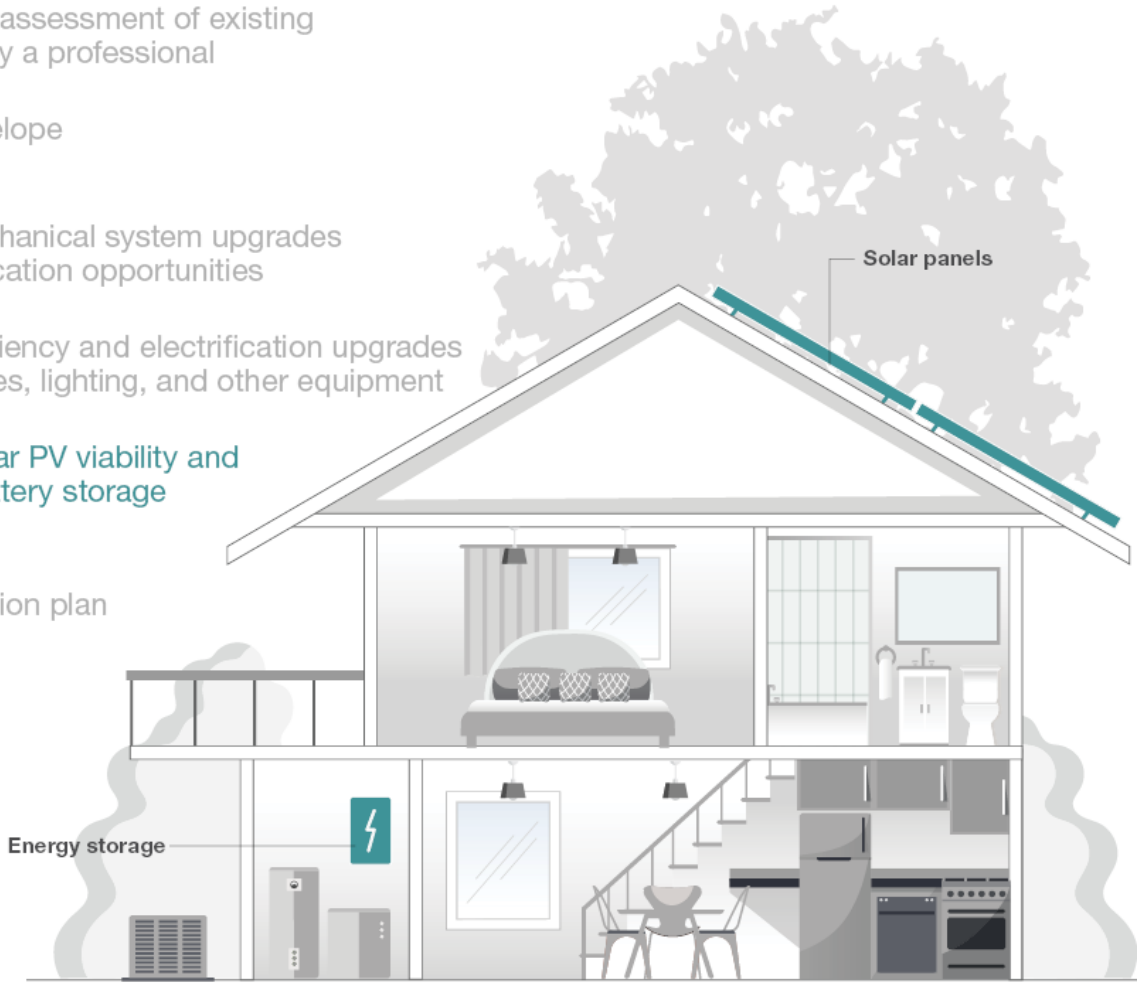

PURPOSE

Solar PV is the most accessible, practical, carbon-free strategy to offset remaining energy consumption to reach net zero energy. In addition, battery storage is recommended to be evaluated at this stage by the same contractor for resiliency purposes and energy cost savings in places where time of use utility rates apply.

STRATEGIES

- Engage solar PV consultant.
- Prioritize on-site solar or consider solar ready.
- If the above is not an option then consider community solar or purchase certified renewable energy credits.
- Battery storage enables the capability of using the solar PV system during a power outage as well using renewable energy at night time.
- Another option for battery storage would be a transfer switch that allows for bidirectional charging for future Vehicle to Grid capabilities.
- Battery storage also helps utilities manage peak loads with renewable energy and can help negate the need for fossil fuel consumption.
- A critical loads sub panels and smart electrical panels are also effective resiliency strategies for buildings that can't install enough battery storage to back up all energy loads.

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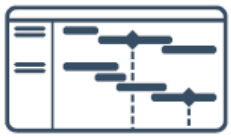

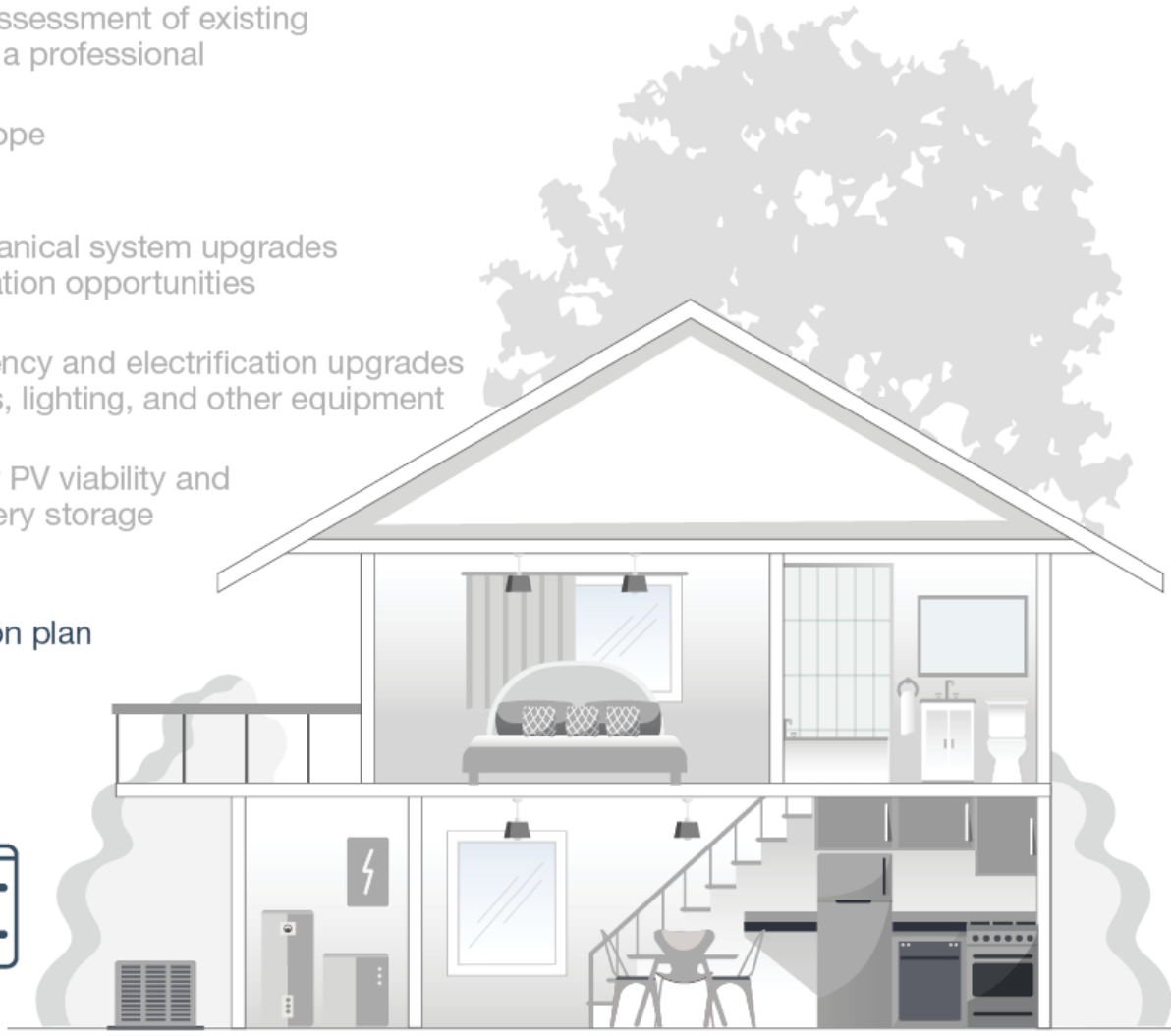

PURPOSE

Every existing building is different, so it is essential first to develop an implementation plan that acknowledges the current state of the building. Ideally, upgrades should follow the sequence above which emphasizes energy conservation through passive strategies like envelope upgrades before mechanical upgrades and onsite energy production. All upgrades interact with each other and sequencing and phasing requires careful consideration. Electrification offers energy savings, comfort, cleaner indoor air quality, smart controls, energy independence, resilience, and future-proofing the electric grid to be cleaner and healthier down the line. Existing buildings are our largest building stock and contain large amounts of embodied carbon. The value of preservation and smart updating grows when embodied carbon is considered. If cost barriers are present, a slower, phased approach to retrofitting is recommended.

STRATEGIES

- Work with a professional / consultant to analyze upgrades defined above for synergy, feasibility, and sequencing.
- Run proposed scenarios through energy modeling to evaluate costs vs benefit. A phased approach over time might be the best approach for buildings with limited budgets.
- Smart planning can allow for future proofing and longterm success.
- Prioritize opportunities for electrification.
- Changes to the exterior envelope can play large role in the safety of combustion appliances, the need for mechanical ventilation, and condensation risks therefore working with a professional consultant on upgrade strategies is extremely important.

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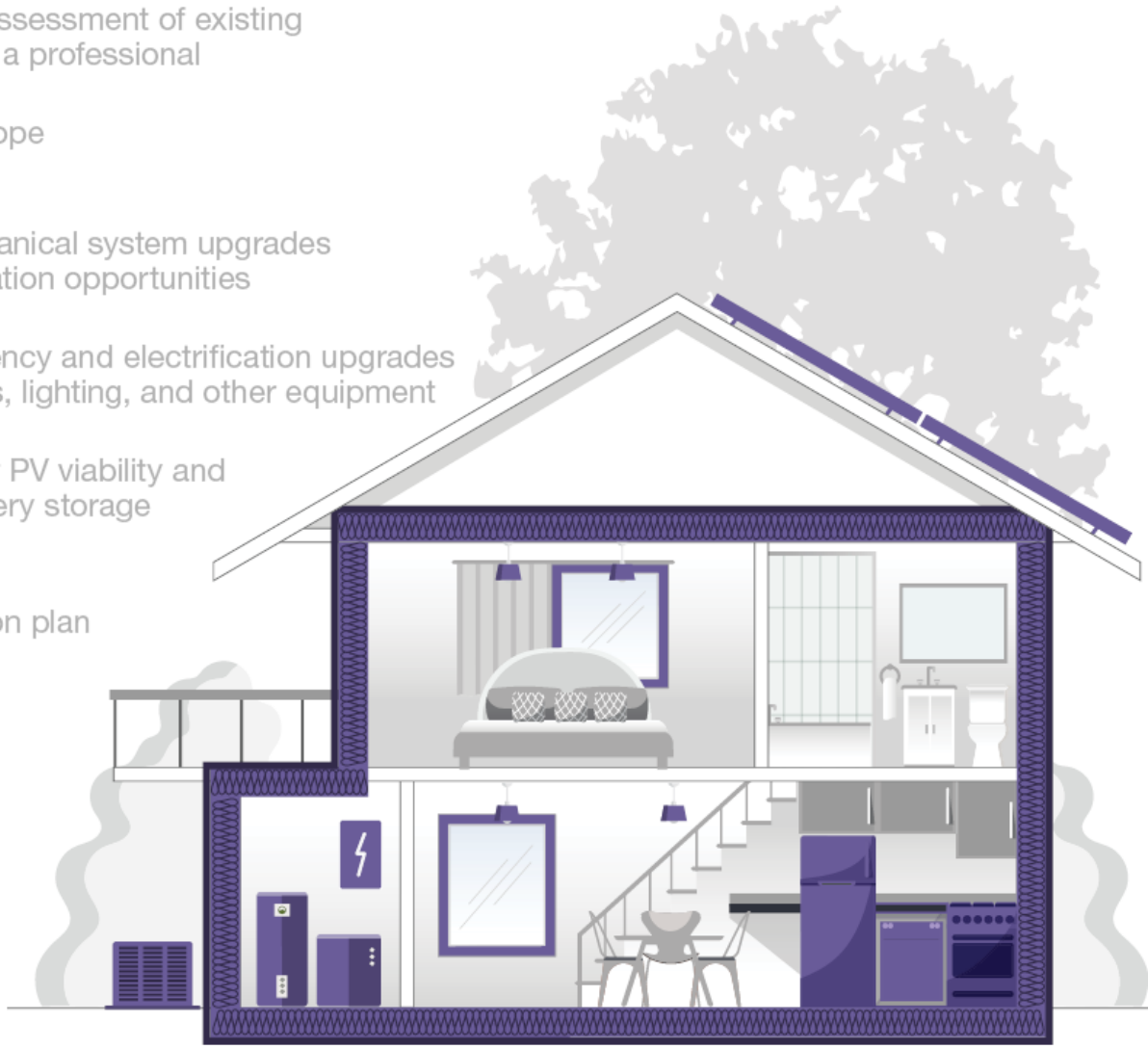

PURPOSE

Proper testing and adjusting is necessary to confirm systems were installed and operating as intended. Energy monitoring can help educate occupants how their choices impact performance. Systems monitoring can also provide notifications of system failures and can help optimize energy usage with respect to time of use or demand response utility programs. Documenting energy performance can also help with establishing financial value.

STRATEGIES

- When viable third-party building certifications are recommended.
- Energy monitoring, dashboards, and smart controls are encouraged.
- For buildings that haven't reached zero energy return to step 6.