

# Energy Storage and Virtual Grid Services based on Demand Side Management

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19th April 2018

## **Abstract**

We offer new combination of technologies and business model for provision of multiple energy services based on smart Demand Side Management. By timing activity of customer appliances (currently water heaters) with help of statistical learning and prediction, we aim to create a portfolio of value added services which improve energy infrastructure utilization, solve problem of renewables integration, increase grid reliability and reduce emissions.

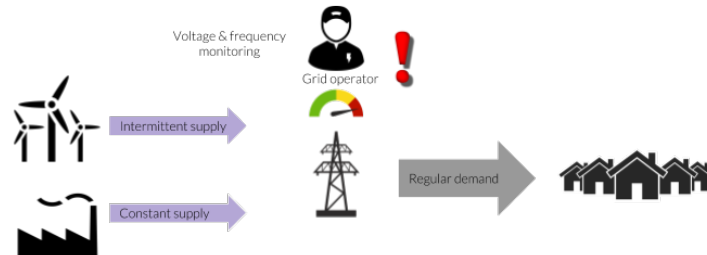
Technologically, our business case is highly scalable, fast responding thermal energy storage based on residential storage-type water heaters, without compromising end-user convenience and carrying extra benefits to all involved parties: grid operators, distributors, residents, and larger society. Since water is used as thermal storage, the solution has lowest possible cost and applicable worldwide.

In total, 100M residential water heaters in the US have energy capacity of up to 1 TeraWatt-hour, which we can utilize at a cost of \$20/kWh (less than 10% of other technologies' costs). We are targeting its use for electricity grid services such as consumption shift, as well as regulation, consumed and compensated by grid operators. Similarly, we can offer several demand side services in the gas distribution sector.

By offering benefits to both users and utilities, it has a potential to become an ultimate win-win "virtual utility" solution to utilize the cheapest possible form of energy storage, while solving the problems associated with adoption of clean renewable energy and other common problems in energy sector.

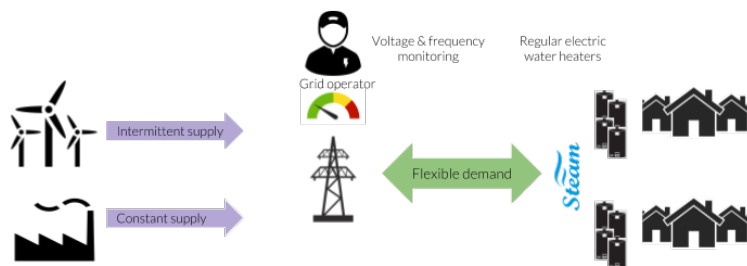
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**Context:** Increased penetration of renewable energy currently represents increasing challenge for electricity grids due to weather dependent generation variations. It can be mitigated by introducing *demand flexibility*, or by storing energy. Many other (ancillary) services can and are being provided by storage as well. Residential water heaters can store energy and reduce demand during low production times and absorb excess during overproduction, serving as a grid scale battery.



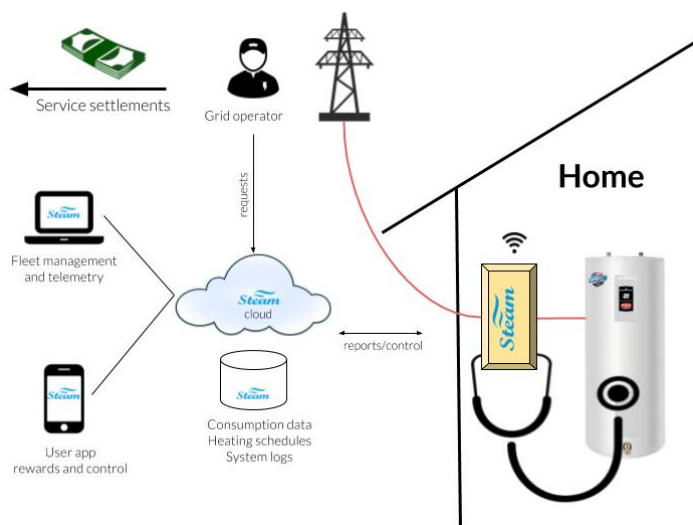
**Figure 1:** Problem: Intermittent energy from renewable sources causes grid volatility.

**Our system** is based on cloud controlled learning thermostat for residential electric resistance water heaters, fitting electric type water heaters and some gas ones. We aggregate large amounts of such tanks collectively as a Distributed Energy Resource (DER) and provide ancillary services to grid operators. Benefits to other parties: for the end user/tank owner, it is reduced heating bills, improved safety, and convenience. For the landlords, benefits include: maintenance/service alerts and data, as well as potential revenue sharing. For tank lessors or manufacturers we can provide service data and potential costs sharing.



**Figure 2:** Solution: Retrofitting some hot water tanks existing in the distribution area with our device. The installation takes minutes, and the device can function both with and without user intervention. It is convenient to be installed in multi-tenant buildings, but any kind of building is suitable. The device does not void tank warranty and in general has no impact on the household.

**Technology and IP:** We have developed multiple methods (patents) and combination of technologies allowing us to make the thermostat external without need for plumbing or any complex installation process, as well as making the functionality transparent to and yet controllable by the end user. The technology advantages (electric only): (1) About 10x cheaper than the specialized DLC tanks, and about 50x cheaper than batteries (in \$/kWh); (2) Low friction/low cost retrofit solution; (3) Uses existing equipment already in homes, instead of deploying specialized tanks or battery solutions; (4) Incentives for installation by end users: consumption data, control capabilities, monetary savings and/or ancillary service revenue sharing.



**Figure 3:** Steam components. Grid operator sends signals to Steam cloud via connectivity API, which in turn controls multiple tanks to match the request. User has still reporting and control app to override some conditions and optionally receive rewards for using his tank. The hot water availability is not affected. Steam has connection to tank via proprietary set of non-intrusive sensors learning of use schedule and state. (Picture is only schematic)

**Services** We envision provisioning multiple services associated with energy storage, such as demand response, frequency regulation, voltage support and others. Main customers in North America are grid operators (ISOs/RTOs in most areas). "Storage-as-a-Wire" / "Non-Wire Alternative" services, allowing delay or complete avoidance of transmission infrastructure upgrades, are beneficial to power distributing utilities. The main advantage is that our system is low cost and has very fast response times (within single seconds), allowing to participate in services on any time scale.

**Distribution** of the devices: We are establishing short- and long-term partnerships with organizations with either residential property access e.g. property management companies, social housing administrations; as well as utilities, smarthome integrators, home security companies, who all can see a value in co-marketing and distributing our product.

**Team:**

- **Elad Wallach:** Cofounder; MBA, B.Sc. Electrical eng., 15+ years in consumer products engineering;
- **Vitaly Rubinovich:** Cofounder; MBA, M.Sc. Computer Science, B.Sc. Physics, 20+ years in multidisciplinary software engineering, distributed algorithms.
- MaRS Venture Services (Toronto): David Bowden - Senior Advisor, Cleantech group. The company is part of MaRS incubator.
- Prolex electronics: Contract manufacturing, design support and QA.

In addition, we consult and remain in contact with several people in the industry. We presented our solution and remain in contact with innovative organizations like RMI - Rocky Mountain Institute (Colorado), CSIRO - Commonwealth Scientific Industrial Research Organization (Australia), Rensselaer Institute Center for Future Energy Systems, as well as several grid operators.