CROWD POWER

A Renaissance Energy Initiative

HOW CROWD POWER WORKS

AVOIDING PEAK DEMAND-DRIVEN INFRASTRUCTURE INVESTMENT

OCTOBER 2012

Crowd Power is a distributed solution for offsetting the infrastructure requirements in responding to the growth in peak demand. It is specifically designed to remove the socially uneconomic investment in infrastructure that is utilised for only hours a year.

The transmission infrastructure is a complex network of thousands of transformers and millions of kilometres of cable. Every time the peak demand rises in a street, the numerous components of the part of the network linking the consumption to the generation eventually need upgrading. Collectively, the growth stresses the capacity of generation and due to the extreme prices electricity can reach in the wholesale market results in the justification and development of 'peaker' generation capacity.

The result in the National Electricity Market is that $6.41 is committed per watt of extra peak capacity. That is, every typical split-system air-conditioner is justifying over $10,000 in infrastructure. Clearly this is a broken system. There is no one solution, but part of the suite of addressing this socially regressive challenge is Crowd Power.

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How Crowd Power Works

Introduction

There are fewer more active debates than that attributable to the electricity price. The price of electricity has risen dramatically and sufficiently to shift the materiality of its cost for households and businesses.

The drivers for the increase are many and not equal between parts of Australia. Part the unravelling of regulatory manipulation that suppressed cost pressures in the market, part the linking of the domestic non-oil energy sector with international markets, part the timing of obsolescence of the large expansions in capacity and reach of the grid that occurred in the late 1970s/early 1980s, part the structural shift away from coal for base load power, and part the increasing standards for the quality of supply.

The part missing from this list is the most important. It is the most important as unlike those listed, it keeps happening — all those listed above are more or less once-off events[1]. The most important factor driving price increases is the requirement to build the distribution and generation infrastructure to meet the capacity of peak demand.

Peak demand is growing considerably faster than population, while aggregate demand has in recent years actually fallen. This changes the underlying economics for the amortisation of the infrastructure into the supply price. The peak demand capacity of the 1970s is less than the lowest level of demand today. The expectation that, at some stage, base demand would grow to exceed the peak demand of today, simplifies the justification of implementing capacity that in the short term will only be utilised a tiny fraction of the year. The picture is far less clear today. It is probable that despite the forecast population growth for Australia over the coming 25 years, the capacity of today's transmission infrastructure will only ever be utilised for peak demand.

The sensible efforts for a more resilient and sustainable energy supply are shifting this supply off base load and away from the grid. This path provides a future where the expectation for guaranteed supply drives a network and generation capacity to respond to the unlikely event of all distributed generation and utility scale renewables being offline just as peak load occurs. This population tracking or even beating peak load occurs while aggregate demand from the infrastructure will be considerably lower per head of population. In such a scenario, transmission would drive prices to a multiple of current levels in real terms.

These issues were evident several years ago and prompted our research and development. Crowd Power is the name of the solution built on our patent and related intellectual property to address the most important and ongoing driver for price increases. Our technology breaks this noted 'death spiral' for the base load supply system. Crowd Power provides security of supply at peak loads while improving utilisation of the base load supply system. A solution that releases the majority of the capital requirement in chasing the ever growing peak demand.

This paper provides a basic overview of how this is achieved, what the wider benefits to the stakeholders are and how this cheaper and more sustainable approach to energy security can be realised.

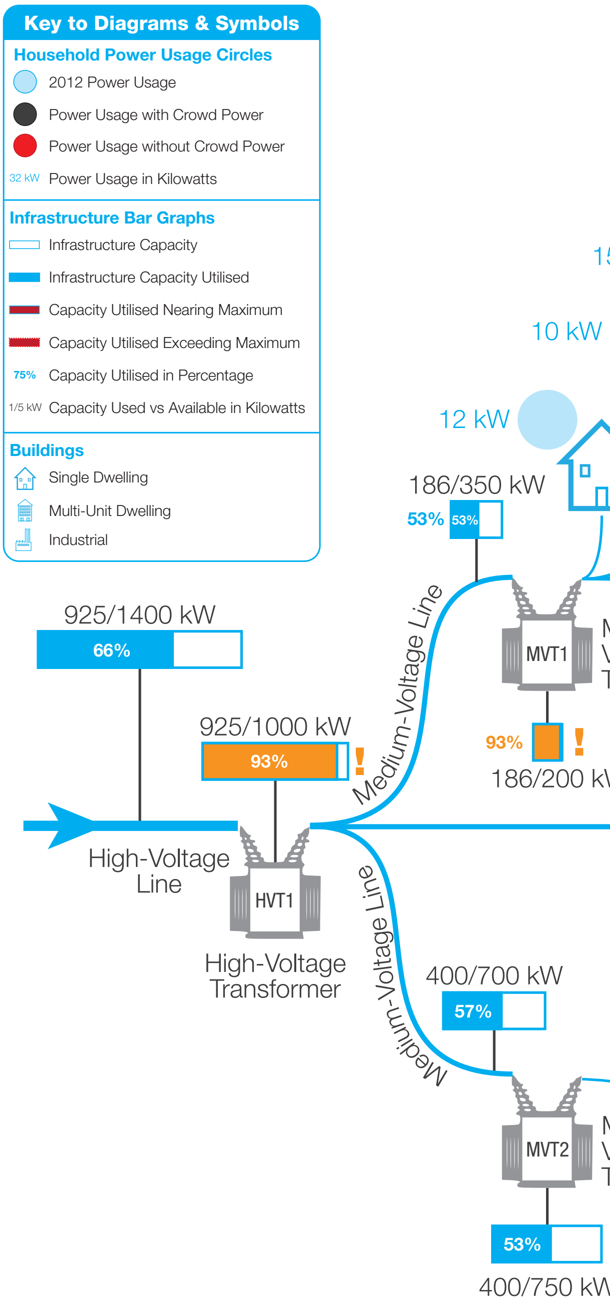
[1] A notable exception is the eventual secondary impact from the linking to international markets when the Australia dollar devalues to its long term sustainable level.

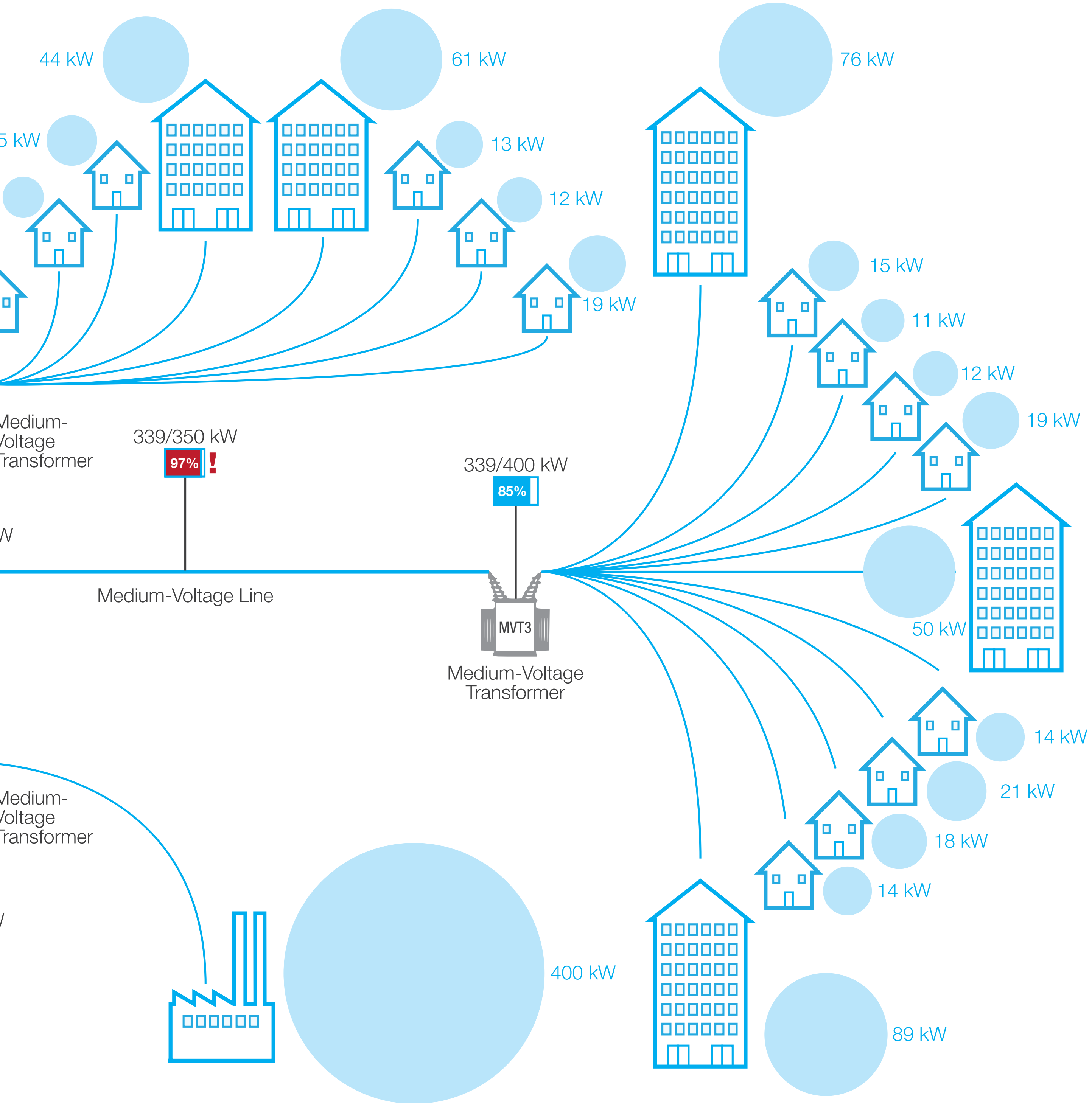
Current Situation

Electricity generation and consumption occurs at a location; until recently, the two locations were always different and, often, many kilometres apart. Connecting the two locations together is the transmission infrastructure, typically consisting of high-voltage, medium-voltage and low voltage cabling interlinked by transformers that step down the voltage and manage the frequency. As a whole, the infrastructure operates to distribute centralised generation with the dispersed urban area maintaining supply and quality of the electricity.

The network consists of thousands of elements each of which has capacity constraints and quality control requirements. These elements provide little or no feedback to a central control and represent potential points of failure in terms of capacity constraint in that each line, each transformer and each circuit breaker can only carry so much current. In this respect, while the network as a whole may not experience a peak demand, a part of the network may experience sufficient growth in peak demand to stress the capacity of that part of the network. That is, each part of the network has its own peak capacity and can require upgrading.

In order to explore how Crowd Power addresses growth in peak demand and compare it to the current practice, it is necessary to consider a hypothetical part of the network and the peak demand it experiences as it approaches capacity. The diagram provides a snapshot of a part of the network where a long-distance high-voltage line is providing a number of residential, commercial and industrial consumers with electricity. The diagram illustrates a possible peak use event where a series of the transmission assets are nearing their maximum capacity.



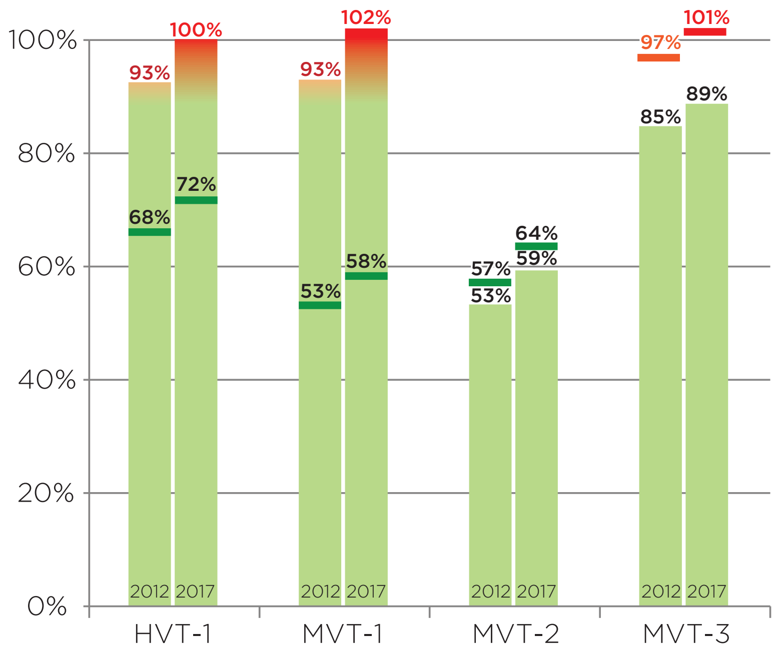


44 kW
61 kW
76 kW
5 kW
13 kW
12 kW
15 kW
19 kW
11 kW
12 kW
19 kW
Medium-
Voltage
Transformer
339/350 kW
97%
!
339/400 kW
85%
Medium-Voltage Line
MVT3
Medium-Voltage
Transformer
50 kW
14 kW
21 kW
18 kW
14 kW
Medium-
Voltage
Transformer
400 kW
89 kW

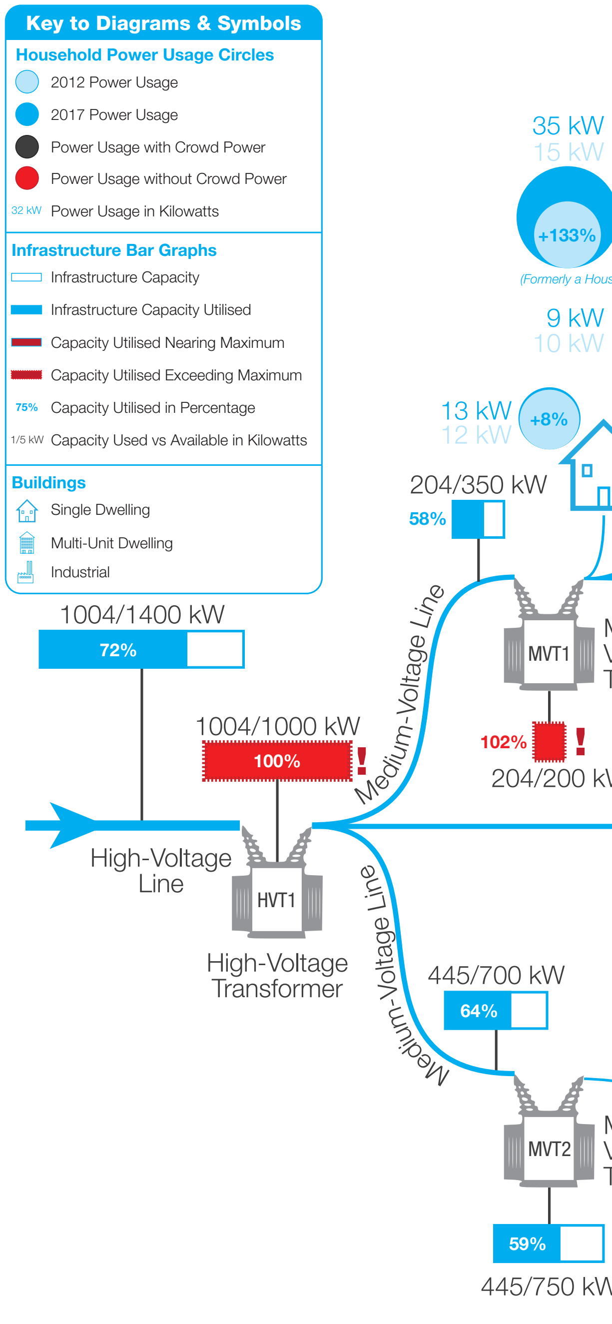
Five Years Later

The urban environment is not static. In this sample section of network, houses have been redeveloped into medum density townhouses or apartments and land has been sub-divided to add dwellings. Energy efficiency initiatives and distributed renewable generation have lowered consumption and peak use in some circumstances whilst additional pools, air conditioning and other quality-of-life consumption has added to aggregate and peak demands.

In the unlikely event that no upgraded capacity had been added to this local network, the new peak demand scenario would exceed the capacity of the transmission infrastructure. In the event that the medium-scale industrial consumer was on a demand management agreement, the peak load at the High-Voltage transformer could be managed to a safer level. However, this option is not available for the rest of the local network and supply would be disrupted.



Bars indicate the load of the transformers. Horizontal lines indicate the load of the lines providing the power to/from the transformers.



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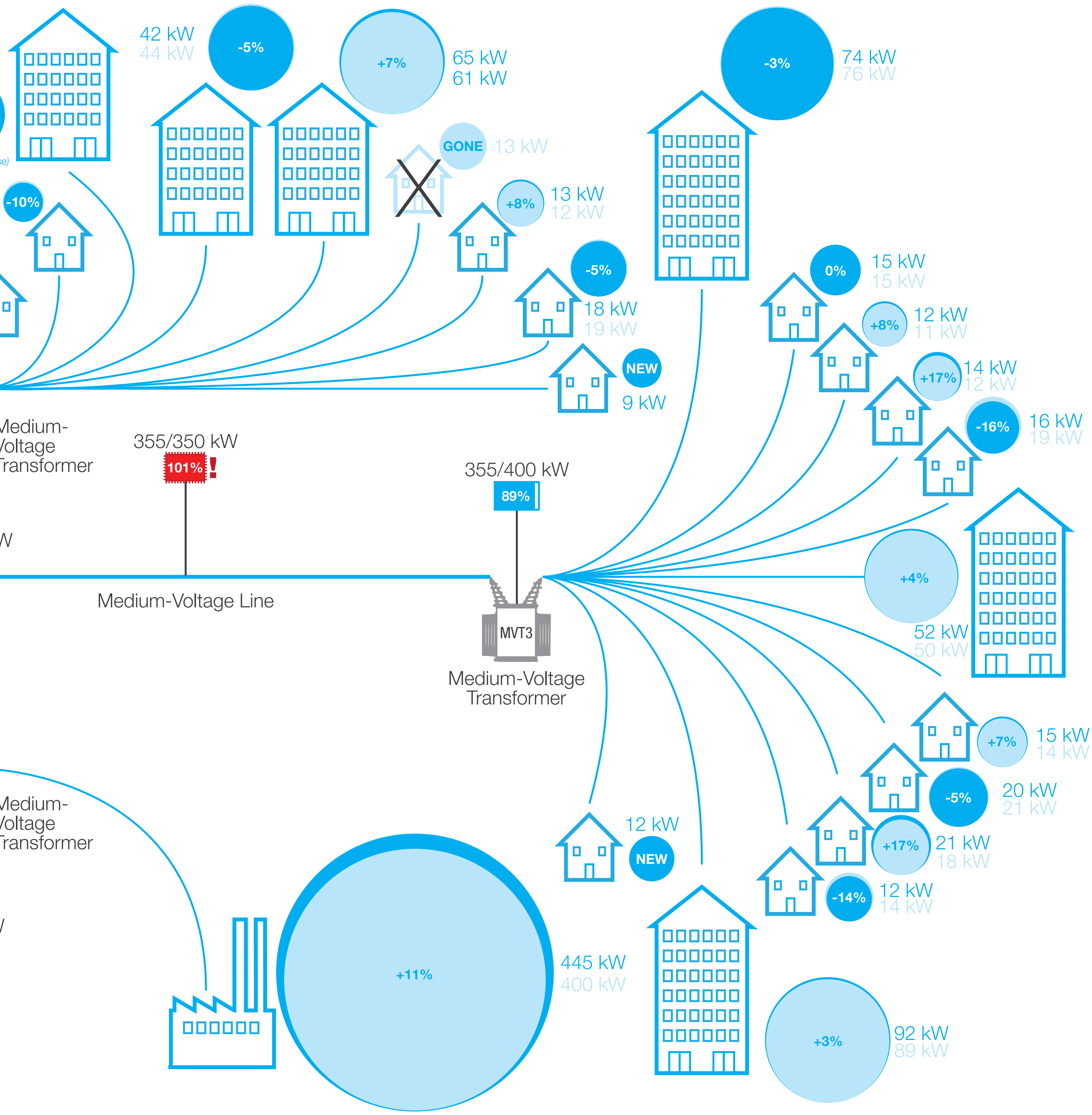


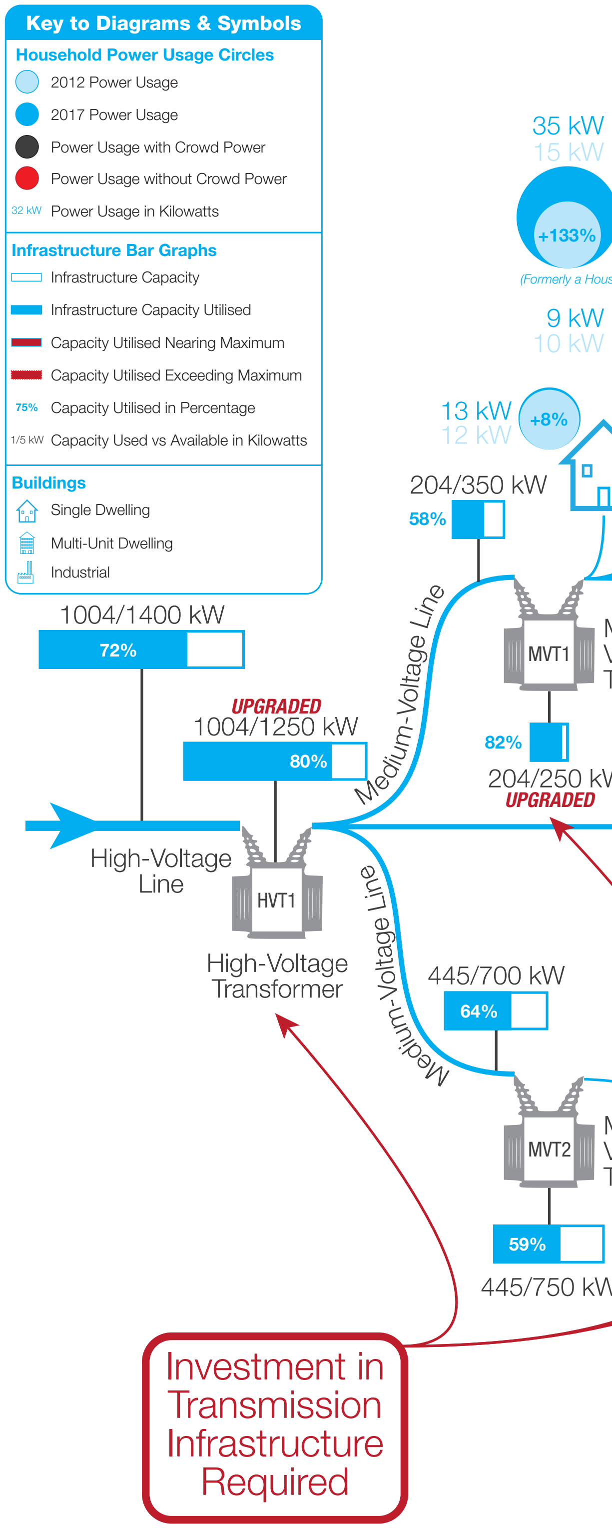
Traditional Approach

The past century has seen the relocation of 'dirty' generation away from the urban environment requiring progressive implementation of transmission capacity. Until the 1990s, base load and peak demand grew in a similar fashion. This provided a stable framework for the economic justification of infrastructure investment and the expectation that over time today's peak load would become tomorrow's base load. However, for the past decade, peak load has grown faster than base load and has most recently maintained its growth despite a decrease in aggregate demand. This trend has stressed, if not broken, the economic justification for investment in peak transmission infrastructure.

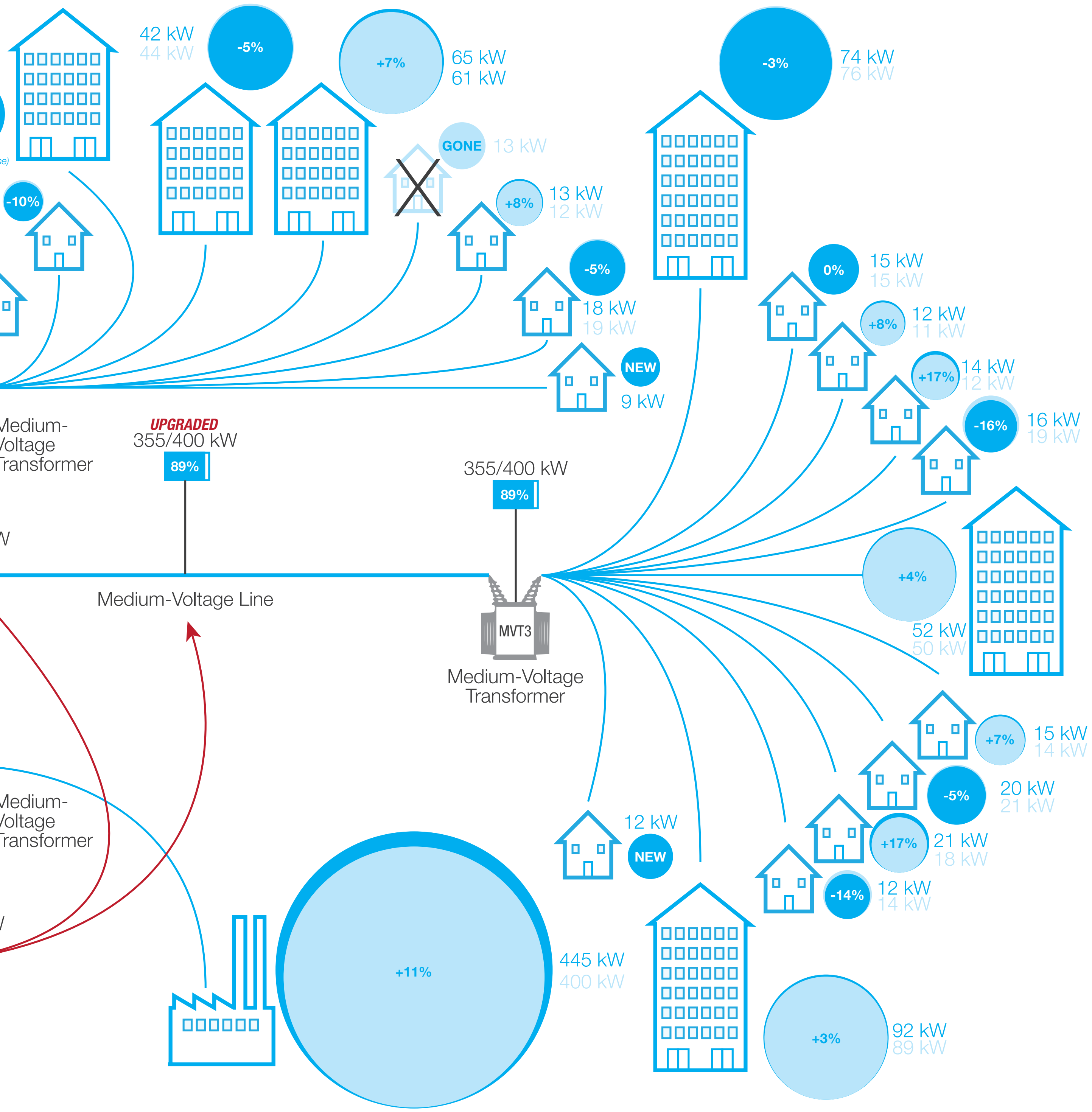
The diagram shows the same section of network with the same growth scenario, five years on. The traditional approach is to monitor and forecast the peak demand segment-by-segment and where quality of supply is potential threatened by capacity constraints, the associated assets are upgraded.

The demand across a segment of the network is subject to a complex series of changes resulting in the requirement to upgrade lines and transformers. In this case, the nominated 8.5% growth actually represents a reduced load per dwelling and per capita. Yet, assuming this was a typical marginal capacity increase across the National Electricity Market, in excess of $500,000 would have been invested over the five years to meet increased peak demands to less than fifty customers that are actually consuming less total energy over the year.

The arrival of market support for demand side participation (which is generally used only by industrial customers) will assist in containing overall growth, and in the scenario pictured here, possibly avoid the upgrade of the HVT1 transformer. However, without the assistance provided from smart meter and smart grid investment (requiring significant investment) it is unlikely that within the near-term a material impact would occur in the collective consumption pattern. It is precisely this demand side impact that Crowd Power aims to enable and foster.



Cost: $500,000



42 kW
44 kW
-5%
+7%
65 kW
61 kW
-3%
74 kW
76 kW
GONE
13 kW
-10%
+8%
13 kW
12 kW
-5%
18 kW
19 kW
0%
15 kW
15 kW
+8%
12 kW
11 kW
NEW
9 kW
+17%
14 kW
12 kW
-16%
16 kW
19 kW
Medium-
Voltage
Transformer
UPGRADED
355/400 kW
89%
355/400 kW
89%
+4%
52 kW
50 kW
Medium-Voltage Line
MVT3
Medium-Voltage
Transformer
+7%
15 kW
14 kW
-5%
20 kW
21 kW
Medium-
Voltage
Transformer
12 kW
NEW
+17%
21 kW
18 kW
-14%
12 kW
14 kW
+11%
445 kW
400 kW
+3%
92 kW
89 kW

Crowd Power Approach

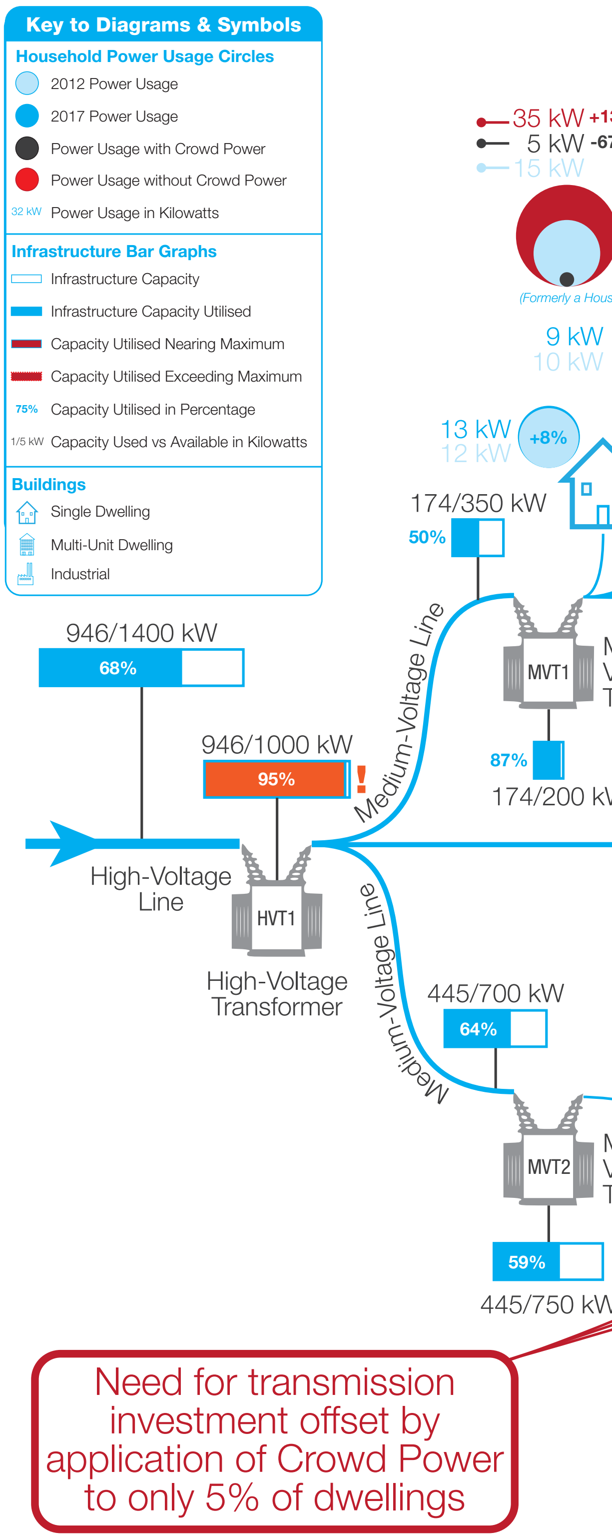
The distributed nature of the effect of peak demand presents considerable challenges to any attempt to constrain the investment in transmission infrastructure.

In contrast to the traditional approach, implementing Crowd Power at 3–5% of selected dwellings in the network contains or reverses peak demand growth. In managing a 'crowd' of distributed consumption-point generation and storage devices, our technology permits the grid to be sized below peak demand while maintaining supply and quality. In essence, the implementation of Crowd Power is allowing peak demand growth to continue without the expense of grid infrastructure investment.

In the illustrated network segment, 60 kW of Crowd Power capacity is implemented across three key buildings at a fraction of the cost of the traditional approach. In these sections of the network, peak demand as experienced on the transmission infrastructure has been reversed and decreased by 1%.

In this fashion, Crowd Power decouples the quality-of-life driven increases in peak consumption from the peak capacity of the generation and transmission infrastructure to respond to it. That is, our technology eliminates the social inequity from the poorest families subsidising the improved life-style of those more fortunate.

Implemented across the network, a deployment of Crowd Power to 3–5% of key dwellings offsets the need for any of the forecast 3+ GW transmission and generation capacity investment over the coming five years saving in excess of $5 billion - $5 billion that, all else equal, will be sourced from household budgets via higher than necessary electricity bills.



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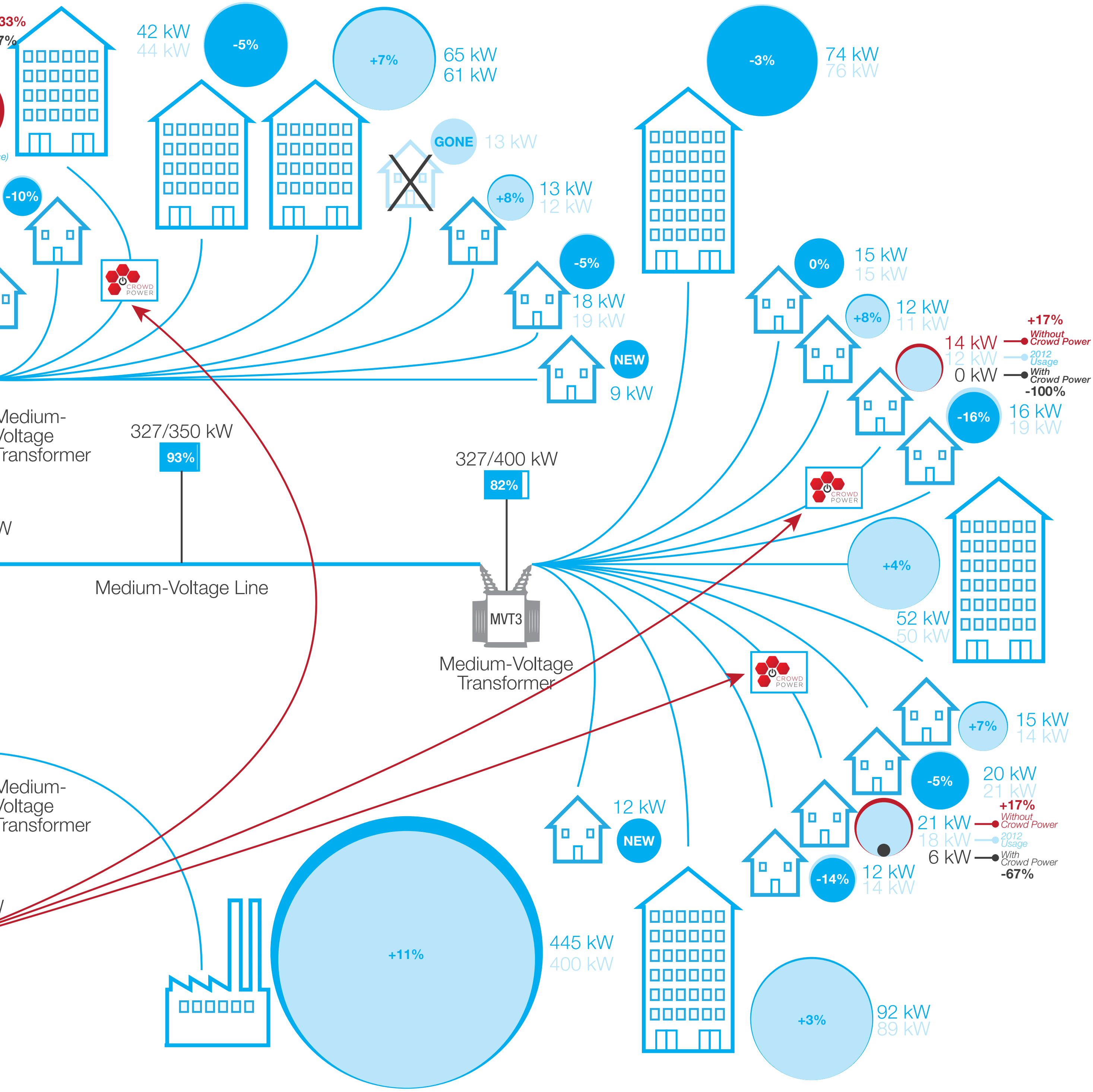


Benefits

The benefits of any technology are rarely limited to the purely commercial. A direct commercial benefit is required for the technology to reach its market, but energy sector technologies typically have social, in-direct commercial and environmental benefits. Crowd Power's main benefit is the offset of planned transmission and generation infrastructure to address peak load, a benefit in excess of $100,000 per 15KW unit. This value is created in operating in the appropriate mode for just the few hours in a year when peak load exceeds the existing grid capacity. Outside of these peak times, Crowd Power operates to add value to the rest of the participants in the market.

Electricity consumer benefits

For the retail consumer, the technology lowers the average cost per kwh of the electricity bought from the retailer — an arbitrage that allows a lower charge to the end-use consumer and funding for the service.

Crowd Power also allows renewable energy that is unused at the time of generation to offset peak priced retail electricity that would otherwise only receive a wholesale market relevant feed-in tariff. In most parts of Australia, this represents a doubling or more in the value consumers receive for their distributed renewable energy.

In this way, Crowd Power directly lowers the cost of the electricity consumed, potentially by as much as 25%.

Crowd Power can also be used as an information tool. The technology empowers consumers regarding their currently 'blind' choices being made regarding energy use. Newly informed, many Crowd Power customers will change poor habits and actively manage their consumption.

Electricity generation benefits

For the wholesale market, the use of storage re-distributes load to periods of lower demand removing volatility from the pricing and in turn, improving the market's capital management and transparency. In time, the virtual removal of the spot wholesale price exceeding the revenue recovered via the retail price, allows retailers to withdraw from their messy and inefficient participation as peak load generators. For the base load generators, the shifting of load improves their utilisation and shifts aggregate demand off 'peaker' generation, both of which improve the long term marginal revenue of their assets. All these outcomes provide the better performers with the capacity to leverage their efficiency into market share, sustainable commercial operation and lower pricing for the end-user.

Renewable generation benefits

The renewable sector receives a boost through the increased offset value and removal of limits for the energy generated in small-scale systems through implementation of distributed energy storage. At the utility scale, the removal of much of the volatility in the wholesale market, while lowering the aggregate cost of energy, increases the median price improving the marginal revenue for the sector.

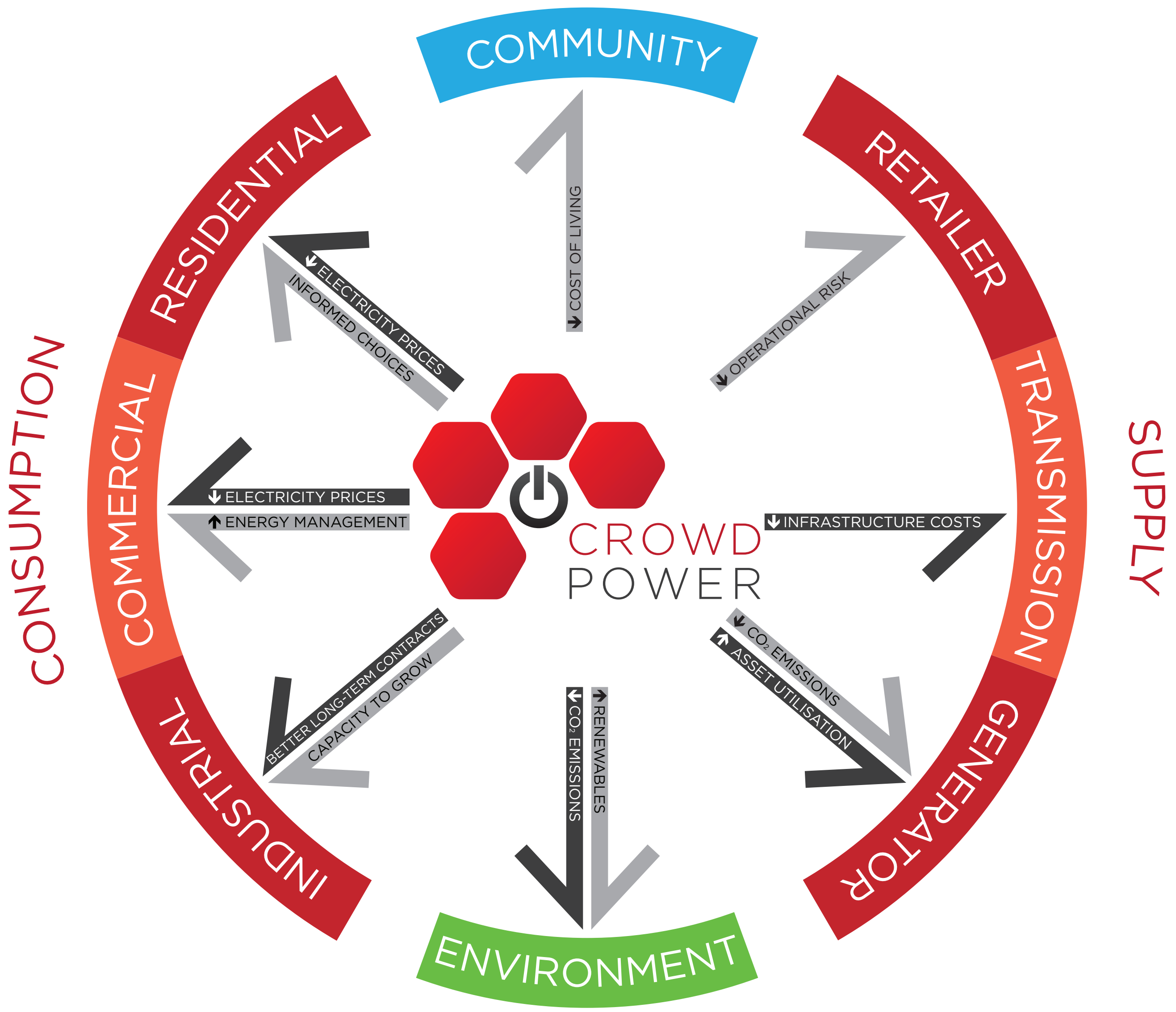
Use of waste heat and reducing emissions

When operating as a distributed generator, Crowd Power more than doubles the efficiency of recovering energy from fuel, by using heat currently wasted by the large central generation assets. Additionally, in using natural gas, carbon emissions per unit of electricity delivered are more than halved when compared to coal-fired generation.

In improving the utilisation and efficiency of base load generation, general pollution and carbon emissions are reduced.

A deployment seeking to offset the peak load investment in the National Electricity Market over the next five years could save in excess of 20 million tonnes of CO2 emissions, representing an annual reduction of 1% of our national greenhouse gas inventory.

Indirectly, the reduction for the capital intensity of energy supply, the assistance in addressing Australia's obligations regarding carbon emissions provides more efficient allocation of resources improving productivity and lowering pressures on the cost of living.



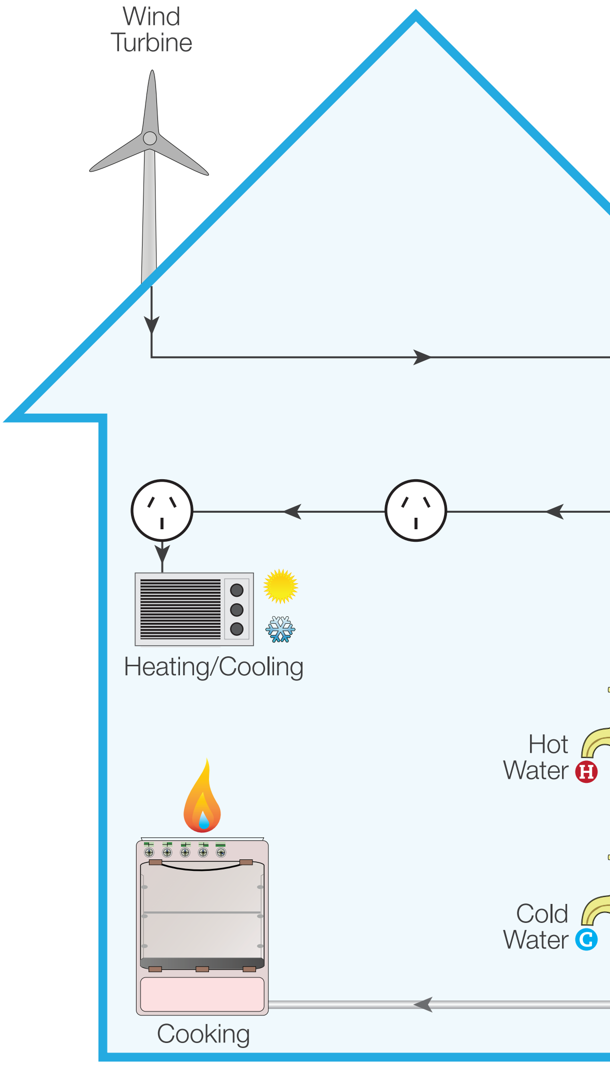
Enabling the Consumer

A key driver in the future of energy services is the empowerment of the consumer, whether this be residential, commercial or industrial. The significance of energy costs in industrial and to a lesser extent commercial operations has built an industry of consultants and solutions in energy efficiency and demand management. The issue of cost is no less relevant to residential consumers, yet as few of the traditional approaches scale down to the residential level, the majority of customers are without choice and blind to the effects of their energy consumption habits.

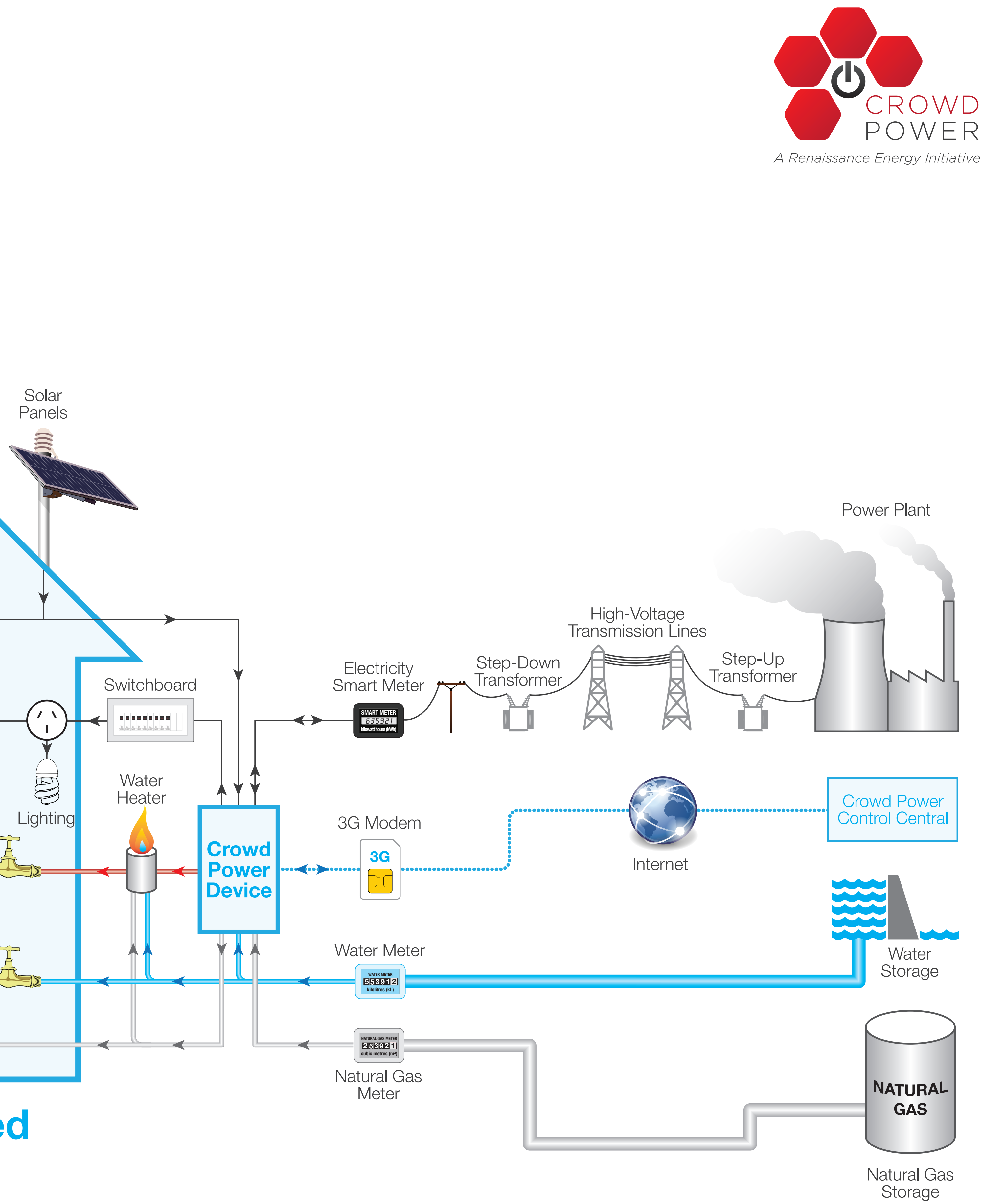
Crowd Power disconnects the consumer's dependency from when and how their energy is generated and delivered. Crowd Power empowers the consumer with information regarding their energy use providing guidance on how to lower their bill, which could for example be delivered via a smartphone interface.

Crowd Power provides the capacity for residential consumers to scale their own renewable energy systems to offset their consumption from the energy retailer at any time of the day — no longer is the capacity constrained by daytime use levels or justified by fickle feed-in tariffs. In using combined heat and power generation, and by optimising energy sources, Crowd Power makes fuel use more efficient and provides low cost heat energy. For the consumer, this enables energy supply as a service to match their lifestyle and where cost is paramount, support the capacity to manage their demand proactively and reactively.

In the same way that mobile phone service providers now provide real-time feedback that enables management of cost, so too will Crowd Power for energy.



Crowd Powere
Household


Solar Panels
Power Plant
High-Voltage Transmission Lines
Electricity Smart Meter
Step-Down Transformer
Step-Up Transformer
Switchboard
SMART METER
Water Heater
Lighting
Crowd Power Device
3G Modem
3G
Internet
Crowd Power Control Central
Water Meter
Water Storage
Natural Gas Meter
NATURAL GAS
Natural Gas Storage
ed

Our Patent

About Us

Renaissance Energy is the arm of the Tipping Point Group charged with commercialising energy sector research and intellectual property developed by The Tipping Point Institute or elsewhere across the group. Established in Sydney in 1994 and London in 1996, the organisation relocated its headquarters to Hong Kong in 2008, launching the Institute in Australia the same year.

Our focus is on enabling Liveable Cities. The Tipping Point Institute has been actively engaged in the energy and transport sectors in Australia providing advice to Government, undertaking research for advocacy groups, responding to requests for information and leading sustainable-focused commercial projects. Our team are regular speakers at events including the Australian Institute of Energy Conference, the urban transport conferences and various events on carbon pricing.

We have in the past been more generally and actively concerned with transport infrastructure, a sector which we see as considerably more challenged in making our cities resilient and liveable. Recent trends however, have encouraged us to expand our efforts in tackling the issues associated with investment in peak load transmission and generation infrastructure.

Crowd Power is the name for the technology that is the subject of our Australian Patent Application No. 2,012,903,420.

In 2008, our research into infrastructure optimisation included a review of the energy sector. The key finding from this review related to the divergent nature taken in addressing peak demand and the lack of capacity in the sector to follow the approaches utilised in transport and telecommunications. Subsequently, a proposal was provided to our research review committee to approve a programme of research into approaches for reducing the requirement for peak load infrastructure.

Commencing in late 2008, the research initially focused on energy storage methods, co-generation and improved efficiency in heating and cooling. The engagement with industry as part of this early research provided considerable insight into market barriers, promoting and/or distorting policy and the general lack of understanding in the market processes for electricity supply. The challenges proved too much for many, with a number of our early contacts no longer trading.

The advent of policy for the pricing of carbon provided yet another complexity and avenue for research seeking commercial mechanisms to support reduced peak load. The policy then progressively shifted with the mechanisms to address trade exposed carbon-intensive industry and the asset impairment charges for electricity generators revealing too minor a micro-economic impact to drive any re-active response. That is, the pricing of carbon was not going to cause a change in the actions of industry or elsewhere in respect of electricity consumption.

During 2010, the focus of the research shifted. It became apparent that even the most successful efficiency campaign coupled with demand management and a wide deployment of small-scale renewable energy generation would not offset most of the transmission infrastructure investment. Considering each approach in turn:

Energy efficiency

Achieves considerable reduction in overall demand but, to its detriment, can cause complacency regarding the absolute number of 'efficient' devices which together actually drive increased peak load.

Demand management

Achieves significant reduction in peak offset generation capacity requirement and a reduction in peak demand for the specific path of supply to the typically industrial locations where demand management is practically applied. However, this does not attend to demand on any other pathway between the generation assets and end-use consumption.

Distributed small-scale renewables

Most typically solar power, the energy generated has had a considerable impact on wholesale pricing during peak periods aligned with the event of generation, but the intermittent nature of the generation and the approach to feed-in spare generation for distribution doesn't offset the need for peak infrastructure, only its likelihood of use. Counter-intuitively, distributed generation can become a management problem for the grid and actually drive additional infrastructure investment

In telecommunications it's called the 'last mile' — the network reality that 80-90% of the infrastructure is in the last connection link. The ratio may be different in the distribution network of electricity, but the concept holds true. The peak load in your residential street requires its infrastructure to assure quality and supply. Demand management 10km away doesn't shift the need for the link from your street to the generator to deal with the air conditioning, second fridge and third flat-screen television.

This realisation provided the context for a core attribute of the technology, the management of the electricity occurs at the point of consumption from the grid. In providing a demand response mechanism for the consumption of electricity at its connection to the grid, the grid is released from the burden to manage the peak load while remaining justified economically to provide the majority of the power needs. The intervening two years developed the concept, commercial framework and culminated in the patent.

Proposed Next Steps

Crowd Power implemented today could justify a 10-15% drop in the regulated electricity prices and remove the need for much of the forecast growth in prices. This is possible as the industry would no longer require the funding in the coming years to expand capacity to respond to projected peak loads. Unfortunately, implementing today is not possible. Instead a series of steps need to be taken to progress the technology from its current stage of development to a solution that the regulators across Australia accept as an alternative to the traditional infrastructure investment approach.

it is proposed that the next step target acceptance by the regulators:

- acceptance that it is safe;
- acceptance that it represents at worst a zero-sum gain for the security of supply for the directly dependant households or businesses; and most importantly
- acceptance that in peak load, it alleviates the need for transmission and generation capacity to the extent that the peak load is addressed via the Crowd Power platform.

The solution is a paradigm shift in the nature of how energy supply is guaranteed. Gaining acceptance for the solution in achieving its true value will appropriately require significant due diligence.

A challenge to starting the process is the market failure due to the absence of a commercial incentive to reduce the infrastructure investment. It could be argued that the risk adverse nature of the stakeholders drives a disincentive or what is often labelled a perverse incentive. Today, this means the due diligence process can only be sponsored by government, led by the regulators and overseen by independent parties.

It is proposed that Government provide a grant and funding for the regulator and oversight to facilitate a technology capability and capacity proving effort. It is further proposed that this would proceed in a two phase approach, an initial proof of concept phase and a subsequent pilot phase.

Proof of Concept

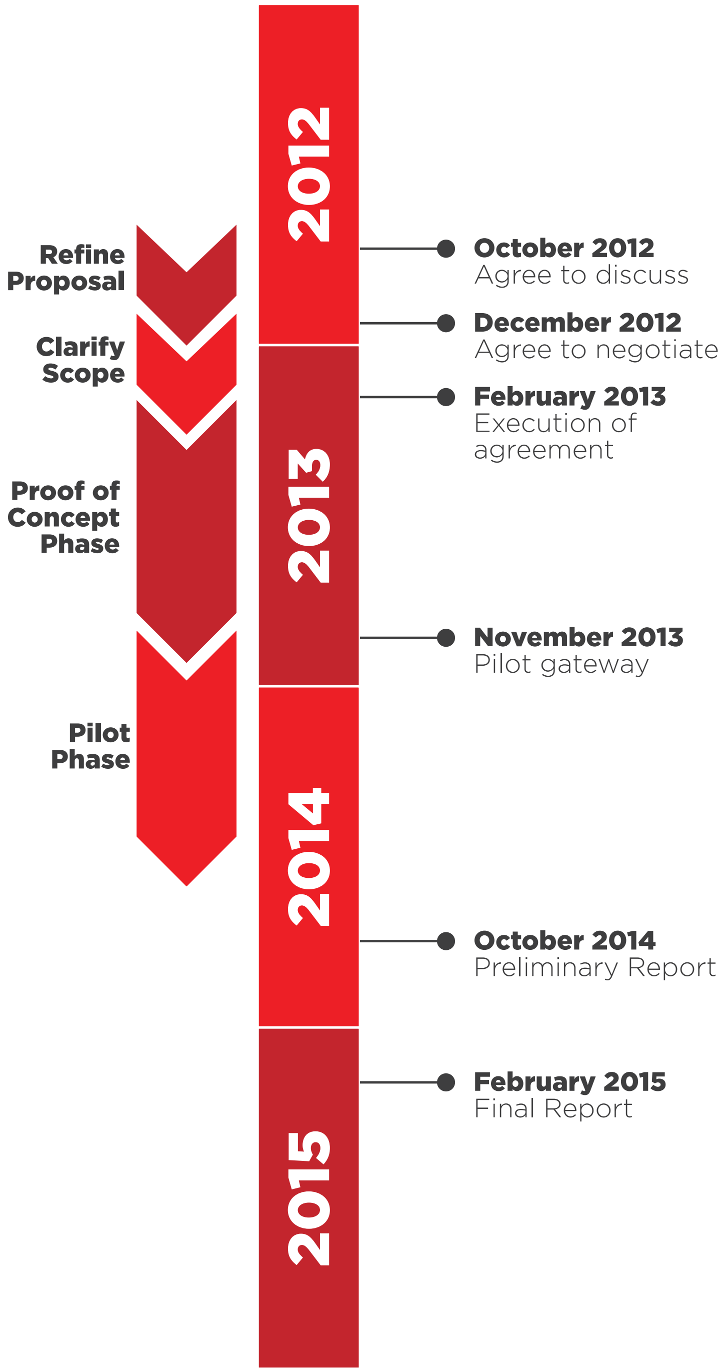
In general, the component technologies are proven and many trials currently proceed across the globe in their capacity to deliver benefits from their functionality. However, the integrated solution is not proven and the essential proof of the performance requirements to achieve the acceptance for offsetting grid and generation infrastructure for peak load are unknown and unproven.

The proof of concept phase undertakes bench testing of the technology, engages with the industry and regulatory stakeholders to develop the criteria for the performance of the technology to be accepted, and models the bench tested operation against the criteria.

Pilot Phase

The proof of concept phase will provide performance criteria that the technology needs to meet in order to be accepted as a solution to offset infrastructure investment. It will also provide a selection of configurations of the technology that modelling indicates meet and exceed the criteria. The pilot phase is a field test of the technology to verify the performance and modelling.

The pilot phase is also targeted to develop the deployment methodology that minimises the capital investment in the Crowd Power technology for a given peak load offset capacity. To achieve its goal, a series of pilot deployments will be planned, implemented and monitored in areas of differing land and socio-demographic profiles.



The process is intended to proceed in consultation with government and industry stakeholders to ensure the approach is evaluated for its impact on industry sustainability and capacity in adding value and conveying benefit beyond the electricity market.

A final report likely in early 2015 would provide guidence for policy development and outline the path, risks, benfits and costs for a broader implementation of the technology as a proven alternative to the 'gold plating' of the electricity tranmission network.

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