ENERGY UNLOCKED

THE EMERGING BUSINESSES
TRANSFORMING ENERGY SYSTEMS

EPIC100

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REPORT

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INTRODUCING EPIC

At the end of 2015, at COP21 in Paris, hundreds of countries agreed to an under '2 degree' global-warming goal, paving the way for an energy transition to meet a resilient and low-carbon future. However, national decarbonisation roadmaps point to an innovation gap[1]. We need exponential growth in solutions to meet exponential growth in emissions, which will only happen if low carbon businesses are outcompeting fossil fuels. The market challenge ahead is to create the right strategies and incentives for a new energy paradigm to meet climate goals.

Doubling energy productivity to 2.6% will contribute to energy-efficient, low-carbon transition ($2.8 trillion cheaper than a high-cost transition in 2030)[2], while also taking into account the need for economic growth in the coming decades. Doubling energy productivity is not an insignificant task for a firm, community or national government – hundreds of small actions might be needed.

The Energy Productivity Innovation Challenge (EPIC), an initiative supported by ClimateWorks Foundation, sought 100 exemplary companies that are supporting this goal by tackling inefficiencies in energy systems. The aim was to understand the business models already gaining traction in specific markets, the conditions under which they succeed – specifically in China, India, Europe, Australia, the USA and Brazil – and how to accelerate their impact. 80 of these companies were part of the EPIC competition. 21 finalists and five winners across five categories – homes, buildings, mobility, systems and finance – were selected as the most promising to drive new energy savings, revenues and behaviours that contribute to doubling of energy productivity. The international jury of 15 experts – including representatives from Rocky Mountain Institute, World Green Building Council, Bloomberg New Energy Finance and GreenBiz – spanned the energy, climate, finance and related industry sectors.

30

EPIC COMPANIES HAVE ATTRACTED AT LEAST

$370 MILLION

EQUITY INVESTMENT WITH HUNDREDS OF MILLIONS MORE IN PROJECT FINANCE COMMITTED[7]

MEETING EXPONENTIAL PROBLEMS WITH EXPONENTIAL SOLUTIONS

The promise of new, entrepreneurial solutions increasing momentum for a global transormation in energy productivity is already a reality at a small scale – the technologies, capabilities and business models are available and evolving quickly. We found that solutions spanned the existing value chains of energy, helping customers to reduce costs, enabling new behaviours or leapfrogging existing infrastructure. 10 business model types were identified: Energy as a Service (EaaS), Energy Management as a Service (eMaaS), Infomediary, Mobility as a Service (MaaS), P2P Energy, Infrastructure as a Service (IaaS), New demand-side infrastructure providers, and finally, Flexibility Services and associated hardware or software enablers including electricity storage, demand response and aggregators. Taken together, these solutions benefit society by making the energy system less wasteful and more productive per unit of energy consumed.

Today's energy systems lose at least

60%

of the primary energy inputs by the time factories, vehicles or homes make use of it in daily activities. While some of this cannot be avoided, there are huge opportunities for optimisation. By 2020, companies acting to double energy productivity would contribute to reducing the global fossil fuel bill by more than €2 trillion, creating more than 6 million jobs globally, according to Ecofys[3]. Some EPIC 100 companies are part of the digitisation of industries with exponential growth opportunities. 'Industry 4.0' revenues are expected to approach $200 billion by 2022[4]. The Internet of Things (IoT) more broadly is expected to be valued at close to $500 billion in 2020[5]. As ETF Partners, a clean-tech investor, put it, "This is a once-in-a-generation opportunity to benefit from the metamorphosis of a trillion dollar industry."[6]

[1] "To have a realistic chance of meeting a 2°C global temperature rise limit therefore – and keeping the 1.5°C objective in the Paris Agreement realistically in play – a step-change in low-carbon transformation is required, and rapidly." http://www.pwc.co.uk/sustainability-climate-change/assets/innovation-for-the-earth.pdf
[2] http://www.climateworks.org/report/how-energy-efficiency-cuts-costs-for-a-2c-future/
[3] http://www.ecofys.com/files/files/the-2015-energy-productivity-and-economic-prosperity-index.pdf
[4] http://www.marketsandmarkets.com/PressReleases/industrial-internet-of-things.asp
[5] https://www.forbes.com/sites/louiscolumbus/2016/11/27/roundup-of-internet-of-things-forecasts-and-market-estimates-2016/
[6] ETF White paper, 17 March 2017
[7] See methodology at http://www.energyunlocked.org/epic

HOW DO WE ACHIEVE THIS PROMISE?

So, what stands in the way? A common assumption from established energy stakeholders, including regulators, is that 'essential' energy services are threatened by innovation. EPIC companies contend instead that innovation is the only way to improve essential services that are overdue for a rethink. Although not every consumer or industrial customer will want to take advantage of 'niche' energy services, as such services are adopted, the mainstream choices will become cheaper and provide system benefits for everyone, after the early adopters have paved the way.

But more needs to happen to ensure that innovation can flourish given the urgent challenge of climate change. Companies entering energy markets today look at the on-the-ground conditions – infrastructure, markets, regulation – with fresh eyes. The barriers from where they sit vary depending on their sector or country, but what they all share is the desire to compete with what they see as the mainstream, but less optimised, ways of achieving our energy needs. However, interactions between technology innovation, regulation and policy at best make it easy to delay decisions to adopt new policies and solutions, or at worst are exploited by powerful interests that are happy to protect their existing assets even at the expense of better outcomes. New market entrants are at a natural disadvantage. "Regulation always favours the incumbents," reminds Benjamin Wainstain at Demeter Partners.[8]

To strengthen innovation ecosystems for energy transitions requires many actions not all of which can be covered here. We introduce a 'racetrack' of actions to support innovation toward energy transitions and productivity, and four principles to guide policy makers and corporate leaders in the coming age of real time, on-demand energy. Governments and corporates are already engaged in some of the racetrack actions, such as setting standards or targets for energy use in buildings or industry and developing the skills and partnerships needed to meet them. Our recommendations focus on emerging businesses' contribution to energy transition. New governance strategies and independent oversight is required if governments expect entrepreneurial competition to be allowed to drive the "digital, democratised, decentralised, decarbonised" energy system transition for greatest societal and environmental impact.

RECOMMENDATIONS

1. Data for innovation
2. Demand-side investment shift
3. *Market* (not tech) demonstrations
4. Create demand for innovation
5. New governance strategies
6. Digital energy services oversight

$2+ trillion savings and 6 million jobs by 2020

10 business model types

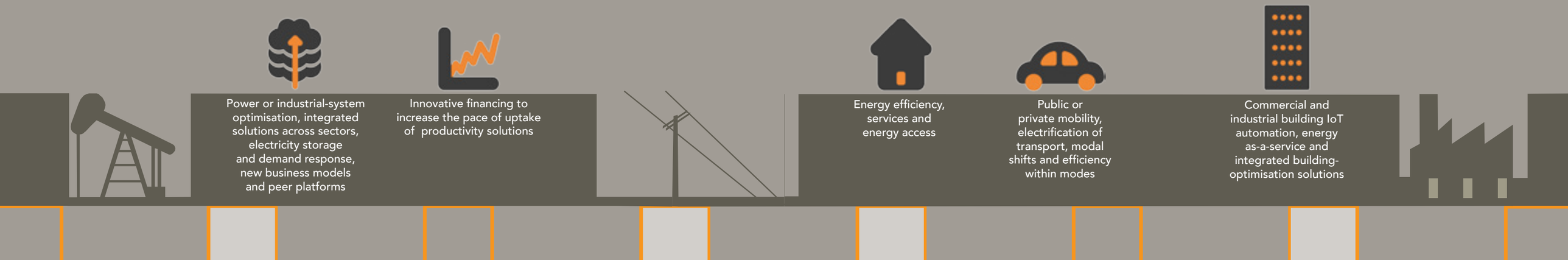
100 companies are just the beginning

3 years to peak emissions

[8] Hello Tomorrow Conference panel, 13 October, 2016

ENERGY PRODUCTIVITY IMPACT

We asked the EPIC 100 companies about their impact on energy productivity. Here is a selection of what they achieve for their customers and broader energy systems.



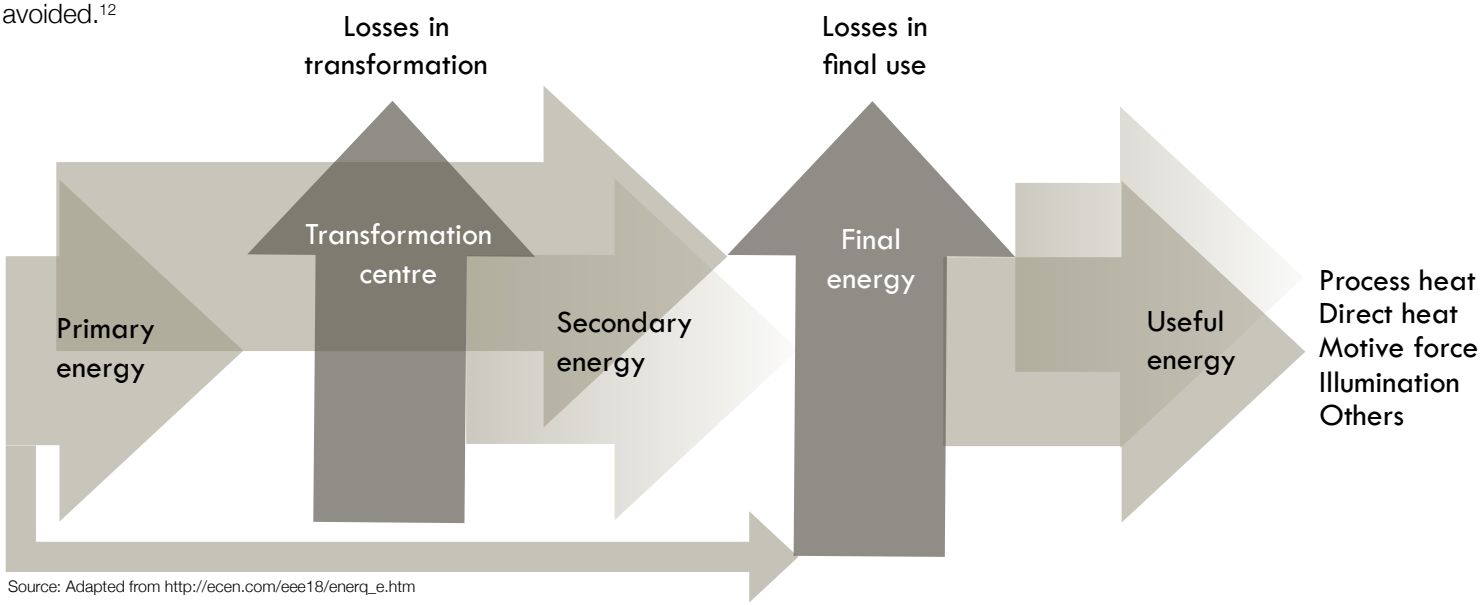
PRODUCTIVITY ACROSS ENERGY SYSTEMS

$$\text{Energy productivity} = \frac{\text{economic benefits}}{\text{energy inputs}}$$

Efficiency is led today by state-of-the-art appliances, LED lighting, more efficient heating, and technology shifts to combined heat and power or heat pumps, efficient air conditioning and insulation. The EPIC 100 business models tackle other inefficiencies across the value chain of energy and electricity, providing visibility on the energy demand-side solutions, starting with efficiency in final energy consumption, value-chain productivity, entirely new systems that are more productive value chains (such as microgrids) and energy storage or demand-side response for shifting the times at which energy is consumed. Although the mainstream efficiency technologies of today are crucial, the EPIC 100 allow us to peer ahead at what might be coming in future and at which business models could drive today's innovations to scale. Energy productivity is measured in a number of ways. The use of primary energy captures the system-wide efficiencies that come from reducing total final consumption (efficiency) but also the losses in conversion, export, import or transmission of energy. Using primary energy for policy provides an economy-wide metric that allows comparison of efficiency with other measures along the value chain of reducing energy waste on a like-for-like basis. Globally, as much as 60% of energy is wasted from extraction through to use, and this proportion can be even higher in some economies.[9] The use of 'final energy' consumption at the firm level identifies waste that can be avoided in production or operations. The Climate Group's EP100 campaign allows companies that commit to doubling their energy productivity to select from a basket of metrics related to a firm's profits or a product's value in relation to the energy consumed to produce it. In 2014, the Green Grid data centre task force issued a data centre energy-productivity metric, which defined energy productivity as useful work per energy unit consumed.[10]

ENERGY SYSTEM LOSSES

From the time when coal, oil and gas are extracted to when they are combusted or transported for use in cars, buses, homes, buildings and industry, more than half the original energy inputs have been lost.[11] Many of these losses could be avoided if we started to think about system optimisation. If demand for transport were reduced, then refinement and transport of oil could be avoided. If renewable generation was sited closer to demand, losses in transmission and distribution (8% globally) could be avoided.[12]



Source: Adapted from http://ecen.com/eee18/enerq_e.htm

[9] https://www.iea.org/sankey
[10] https://www.thegreengrid.org/
[11] Australia's losses are roughly 80% because of the long distances energy must travel. The UK is roughly 55%, Germany
[12] http://data.worldbank.org/indicator/EG.ELC.LOSS.ZS

BEYOND ENERGY PRODUCTIVITY

Reduction of the energy consumed per unit of useful work is cost effective, but the metric does not explicitly include carbon emissions. From a climate-change perspective, waste in the system is less of a concern if supply of energy is entirely renewable. Some analyses of energy productivity have highlighted the need to include not only economic benefits but also a broader definition of the value derived from that unit of energy consumed.[13]

As our EPIC companies demonstrate, the potential to shift demand, through use of electricity storage or smart control systems, to a low-carbon period creates real price incentives to utilise intermittent renewables when they are lowest cost, which results in a lower-carbon – and more productive – system. To track this shift, it would be necessary to add carbon intensity of supply to the energy-productivity metric.

Over 60% of the EPIC 100 companies are already generating revenues at various stages of growth. Some, such as Tech Mahindra, a systems integrator, have hundreds of thousands of employees, and are developing new innovations for spin-out. Others, such as Blue Pillar, Enlighted or Ecolibrium, focus all of their business on managing hundreds of megawatts of final energy savings on behalf of customers across diverse sectors or countries. Many companies with industrial and commercial customers also tackle direct energy use, such as diesel or coal, and not just electricity. More than 20 companies are delivering services on the demand side of electricity, which increase the ability to shift the time of energy consumption and will be discussed in more extensive detail later in the report.

THE EXPONENTIAL EPIC 100

New materials, storage, sensors and other advances in capabilities such as artificial intelligence are converging. The digital trends that underpin the business-model transition in many industries, such as music or car sharing, are beginning to be felt more significantly in energy. Technology is good for energy productivity, which increased at an average of 1.3% per year worldwide between 2001 and 2011.[14] In electronics, energy consumption halves every time processing power is doubled, which is known as 'Koomey's Law'.

Now is the time when the promise of hundreds of small actions adding up to a significant force for change could be realised. Energy services provided to markets full of niche customers was an unexpected scenario a few years ago, but an inevitable progression from the EPIC 100.

Epic Finalists: Bright Energy, the new Swedish electricity supplier, provides hourly EV charging services to anyone in Sweden, Transloc offers on-demand public transit services in over 150 public transit authorities in the USA, ON5 has retrofitted thousands of homes in France through an online customer experience that is 'democratising' energy retrofit, and OhmConnect are 'gamifying' demand response in California, with customers reacting 50% of the time, much more than current predictions for demand response.

A study by the International Transport Forum (part of the OECD) shows that fully switching to shared transit in a city such as Lisbon uses just 3% of the vehicles for the same mobility outcomes, with greatly increased access, 30% congestion reduction, and 40% carbon savings, with today's technologies. Nine out of ten cars are removed if we shift to autonomous vehicles.[15]

[13] https://climatepolicyinitiative.org/publication/the-productivity-of-international-financial-institutions-energy-interventions/
[14] The 2015 Energy Productivity and Economic Prosperity Index, http://www.ecofys.com/files/files/the-2015-energy-productivity-and-economic-prosperity-index.pdf
[15] http://www.itf-oecd.org/shared-mobility-innovation-liveable-cities

BUSINESS MODELS

EXPONENTIAL SHIFT

EPIC 100 companies together constitute a movement pointing to a new energy system.[16] We categorised the EPIC company routes to value for customers in four main ways (some business-model types combine all):
(1) Energy savings: unlock new sources of efficiency and productivity to save costs and energy
(2) New revenues: unlock new sources of revenue from demand shifting
(3) New behaviours: unlock new customer behaviour to drive scale of solutions, such as home retrofitting
(4) Leapfrog: create new energy value chains and systems that leapfrog existing best practices

As new energy services emerge, a set of new businesses are creating new value chains, which either provide the new service directly to customers or enable provision of the service through new technology, hardware, software or infrastructure. It is important to note that many companies cross between business-model types, to access revenues and overcome barriers to market, but for simplicity we have placed them in the below categories.[17] We note the countries where commercial scale or proof of concepts in each type are underway, along with the enabling conditions for these to exist, and their potential impact.

EPIC WINNERS

The EPIC jury selected five exemplars – one in each category, at all different stages of growth – as the most innovative and high-impact companies to watch. These companies are already managing and controlling energy demand to create a more flexible global energy system.

LO3 ENERGY

LO3 Energy's TransActive Grid, the first blockchain solution for energy, enables the formation of community microgrids. The first demonstration project in the USA, the Brooklyn Microgrid, enables participants to build, buy and sell local and hyperlocal community-generated energy.

ECOLIBRIUM

An energy analytics solutions provider for commercial and industrial consumers and utilities based out of India, Ecolibrium provides sector-specific analytics, helping more than 500 large consumers to optimise energy costs, and perform predictive maintenance for higher efficiency.

AUTOGRID

The AutoGrid Flex suite of energy internet applications empowers utilities and energy service providers to deliver cheap, clean and reliable energy by managing a network of distributed-energy resources in real time and at scale.

ELECTRASEED

A consortium of SolarCoin, ElectriCChain, Freeelio, Smappee and Solcrypto, ElectraSeed is an integration project to deliver modular microgrids, each serving up to 100 people, to bring energy to12 million people.

EMOTORWERKS

eMotorWerks has developed a novel approach to address tens of billions of dollars of inefficiencies in grids. The JuiceNet Energy Services Platform aims to control 2 gigawatts of Virtual Power Plant capacity in 2020 – built from aggregated charging load of more than 250,000 electric vehicles.

*EPIC finalists

[16] 80 companies were part of the initial competition in 2016, more companies have joined EPIC since (but were too late to be eligible to 'win')
[17] See how we categorised business models in our methodology http://www.energyunlocked.org/epic

Energy as a service

Description

Enables a range of energy services through, for instance, microgrids, decentralised renewables, energy management in buildings or lighting as a service.

Enabling conditions

Access to infrastructure that is either owned or operated by the provider

Regions

USA, Europe, Australia, India, China, Brazil

Impact

Enables varying levels of efficiency or productivity but benefits consumers who do not have to own the infrastructure to provide energy themselves, often leading to more efficient utilisation of the energy-consuming infrastructure

EPIC 100 companies

8m:nutes, Alphabet Energy, Alpheon Energy, E24, hEnergy Alternatives, PassivSystems, SparkFund, *Tech Mahindra

Energy management as a service

Description

Enables intelligent energy use – for instance, companies that are providing robust sensing, connectivity, analytics and control over energy-consuming systems (IoT)

Enabling conditions

Access to data on consumption of buildings or assets, or access to sensors, management systems or other infrastructure on customer premises to automate acquisition of data

Regions

USA, Europe, Australia, India, China, Brazil

Impact

Provides value by reducing the energy inputs to a process. Often, there are additional values (sometimes not quantifiable) associated with the change, such as employee retention or lower staff costs

EPIC 100 companies

*Blue Pillar, BuildingIQ, *Correlate, DEXMA, E-Cube Energy, *Ecolibrium, Ecorithm, EnergyDeck, EnergyElephant, Enfragy Solutions India, *Enlighted, *EQuota Energy, Green Running, / ndustrial.io, Newatt, Optishower, Smappee, Smart Joules, United Building & Energy Services, Wapo.io, Wattwatchers, Watty, WegoWise

Infomediary

Description

Brokers of data between buyers and customers that assist in better understanding a market and increasingly utilise big data or artificial intelligence

Enabling conditions

Access to internet or mobile for consumers, and access to data

Regions

USA, Europe, Australia, India, China, Brazil

Impact

Provide value by increasing the pace at which matchmaking occurs – outcomes are therefore achieved faster

EPIC 100 companies

Enerkeep, *ON5, Science for Society Techno Services, SmartEcoCity (SEC), *The Curve

EPIC Finlists: Equota, Blue Pillar and Enlighted bring together big data, energy analytics and services. Correlate and The Curve help building owners invest in strategic efficiency projects. Power Drive Efficiency imagines a world where every motor system has a power save mode. Geli streamlines developing, financing and monitoring electricity storage projects to drive scale.

*EPIC finalists

Mobility as a service

Description

Provides the capability for on-demand mobility for customers

Enabling conditions

Connectivity (for data exchange between users and transit assets), mobile phone access for customers

Regions

USA, Europe, Australia, India, China, Brazil

Impact

Provides value by increasing the utilisation of existing assets, avoids the need for buying new assets, guides infrastructure development to match demand, and increases predictive capability of transit patterns while providing shorter times waiting in traffic or riding public transit for consumers. Reduces associated pollution from movement of vehicles and congestion.

EPIC 100 companies

Blue Inductive, ConnectMyEV, Furrer+Frey, *TransLoc, XL Hybrids

*EPIC finalists

P2P Energy

Description

A form of energy service that allows any (peer) producer of energy to sell energy to others (peers) who need it, enabling local energy

Enabling conditions

Communities with access to their own energy generation assets, access to connectivity-enabled devices on customer premises, connectivity

Regions

USA, Europe, Australia, limited evidence in India, China, Brazil

Impact

Supports the better utilisation of renewables closer to their generation, reducing losses in transmission and increasing local revenue from electricity

EPIC 100 companies

Energo Labs, Etherisc, *LO3 Energy, Lumenaza, SolarChange, Green Running

Infrastructure as a service

Description

Provides access to infrastructure to optimise renewable inputs or efficient utilisation of infrastructure

Enabling conditions

Access to up-front finance for distributed infrastructure

Regions

USA, Europe, Australia, India, China, Brazil

Impact

Provides value by reducing the energy inputs to a process. Often, additional values (sometimes not quantifiable) are associated with the change, such as employee retention or lower staff costs

EPIC 100 companies

Cloud&Heat Technologies

EPIC Finalists: Faraday Grid hardware makes 2-way grids possible. GRIPS provides pay-per-use off grid utility scale power. Mobile4Energy makes prepay energy easy.

Pay-as-you-go financing

Description

Allows customers to pay for what they need, sometimes without the need for bank accounts

Enabling conditions

Access to connectivity

Regions

Mainly found where rapid acceleration of off-grid solutions are required

Impact

Pay-as-you-go financing overcomes up front costs for energy for customers, and accelerates build of distributed energy infrastructure

EPIC 100 companies

*ElectraSeed, *Global Renewable Independent Power Supplier (GRIPS), M-PAYG, *Mobile4Energy Enteprises, I-ON Communications, Green Running

Demand-side/new systems infrastructure

Description

These businesses are all creators and distributors of physical assets

Enabling conditions

Access to up-front finance for manufacturing

Regions

USA, Europe, Australia, India, China, Brazil

Impact

The impact on energy productivity will varies but all will deliver efficiency in creation and ongoing use of new infrastructure

EPIC 100 companies

aktivhaus, American Boronite Corporation, Amici Enterprises, Avant Garde Innovations, Caventou, Clean Energy Redesign, Cortus Energy, Dearman Engine Company, e.Ray Europa, Electrochaea, Epishine, Heng Hiap Industries, Independent Energy, Lucid Energy, Modvion, Nuru Energy, *Power Drive Efficiency, ReMaterials, SAHT Energy, Sustainer Homes, ZaaK Technologies

*EPIC finalists

Flexibility services

Description

These companies provide access to, aggregate or manage energy demand and distributed-energy resources such as micro generation, heating, cooling and storage

Enabling conditions

Access to wholesale or balancing markets and 'smart-enabled' infrastructure on customer premises, connectivity

Regions

USA, Europe, Australia

Impact

Provides greater utilisation of network assets, capacity adequacy, reductions in dirty 'peaking' power plants, increased market 'pull' for renewables.

EPIC 100 companies

Advanced Microgrid Solutions, Aquion Energy, *AutoGrid, Become Energy, *Bright Energy, Corardor, Electric Pocket, *eMotorWerks, GreenSync, *OhmConnect, Open Energi, sonnen, *Stem, Sunverge, Sympower, Tempus Energy, Virtual Power Solutions

Flexibility enablers

Description

Providers of hardware or software to make flexibility services possible

Enabling conditions

Access to data for business case development

Regions

USA, Europe, Australia, India, China, Brazil

Impact

Provides key components of the value chain to increase uptake of services

EPIC 100 companies

Electron, *Faraday Grid, freeel.io, *Geli, Grid Singularity, GridDuck, I-ON Communications, Nextenergylabs, SMAP Energy, Smartwatt, SolarCoin

BLOCKCHAIN AND ON-DEMAND ENERGY: HYPE OR REALITY?

Blockchain is a new capability migrating from finance, where it is famous for underpinning the cryptocurrency Bitcoin. The EPIC companies using blockchain include Electron, Energo Labs, Etherisc, LO3 Energy, M-PAYG, SolarChange, SolarCoin and Grid Singularity, ranging from currency to platforms to insurance and peer-to-peer energy solutions. Hundreds of companies claim they are working on utilising the basic functionality of mutual-distributed ledgers for energy transactions – for instance to make settlement or switching electricity suppliers more efficient. Some new services also make it possible to realise the potential of the 'prosumer' in places as diverse as Dar es Salaam or Brooklyn – where local production can be consumed or stored locally, increasing the value that stays in the community. A smart energy report for Cornwall in the UK found that £1 in every £8 of household expenditure was going out of communities as energy costs.[18]

*EPIC finalists

[18] Cornwall Smart Energy report

PATHWAYS TO SCALE

How easily will solutions move to new markets? Although we can be optimistic when we see rapid global growth curves for solar or wind technologies,[19] the reality for demand-side companies that are actively seeking market share is that today's commercial but small-scale activities need to have scalable routes to market, faster. Many companies are 'born global', which means that they are looking early for international market opportunities that may be more favourable than their home country, particularly the companies engaging in storage, distributed-energy resources and flexibility services.

EPIC companies were identified and encouraged to join the platform because their solutions could potentially transfer or scale to new markets. It is very difficult to assess whether a company's specific business model will transfer, but within the business-model types previously described, we researched six regions or countries based on whether the enabling conditions for each business model were in place or likely to continue. Our assessments were based on several indicators for ease of access for new companies to enter new markets, electricity and broader market conditions, physical conditions such as infrastructure and connectivity, and policy such as efficiency standards or incentives, and provide high-level insight into key growth opportunities.

CHINA

China will grow its energy systems to meet demand, and is poised to both transfer and develop its own standards, products and services. Electricity access is nearly universal, and market reform is underway. However, overall the Chinese market is complex to enter, and suits well-proven commercial technologies that can scale rapidly.

USA

The USA is overall an attractive market for energy business, but big differences will be apparent at state level. Flexibility services will be shaped by Independent System Operators or specific state utilities commissions. Energy productivity and efficiency was a priority under the previous federal government, along with innovation support to align energy with industrial strategy.

AUSTRALIA

Australia's 'energy-only' electricity markets are the best opportunity for flexibility-services providers. Innovation is rapidly being driven by the spiky energy prices resulting from high penetration of distributed renewables. Although national discourse may not always align, the market need and infrastructure access will ensure that companies see Australia as an attractive new market.

INDIA

India has the biggest challenge with energy access of all countries in this report, with electricity not meeting demand. Non-technical losses are high. India is not considered an easy market to enter, but huge opportunities exist for both efficiency and new models of energy access. Voluntary energy-efficiency schemes are taking hold, but are not mandated.

EUROPE

The ease of doing business, the frameworks for aligning energy and industrial goals, and the good infrastructure make Europe a favourable market for new energy services. However, opportunities vary across the specific regulatory and energy conditions in each country. Germany's rapid renewables transition provides good entry for storage and flexibility. By contrast, the UK is removing incentives for flexibility.

BRAZIL

Brazil faces high energy prices, which should drive energy efficiency, but the market is difficult to enter and ranks near India in ease of doing business. Mobile connectivity is also lower than Europe or the USA, but hydro power – natural storage – is plentiful. Some corporates have direct access to wholesale energy markets. Energy efficiency in logistics or electricity would require short return on investment to flourish, but the need for efficiency during extreme weather events, such as droughts, cannot be ignored.

[19] Carbon Tracker applies up to date cost solar PV and EV cost projections, they show oil and coal demand peaking in 2020, and gas demand curtailed, in contrast to Shell scenarios which show this in 2040. http://www.carbontracker.org/report/expect-the-unexpected-disruptive-power-low-carbon-technology-solar-electric-vehicles-grantham-imperial/

MARKETS THAT ENABLE FLEXIBILITY SERVICES: THE REAL-TIME VIEW

One reason why flexibility services are exciting is that they can help to scale the distributed infrastructure needed for energy efficiency with new potential revenues. Flexibility and energy efficiency are complementary in today's markets for providing 'capacity adequacy' or 'dispatchable, temporary load reduction' in system peak hours.[20] But flexibility has further potential to support electricity-system balancing (some ancillary services) and to provide a new route to market for lower marginal cost renewables. In other words, these services can replace the need for overbuilding energy supply (such as coal power plants or backup diesel generation) by getting customers to 'turn down' demand at peak times or 'turn up' and store cheap, renewable power for later use. The shift to demand-side revenue opportunities, if adopted, could outpace uptake of energy efficiency alone. This revenue opportunity comes from optimisation of the electricity grid or other existing infrastructure.

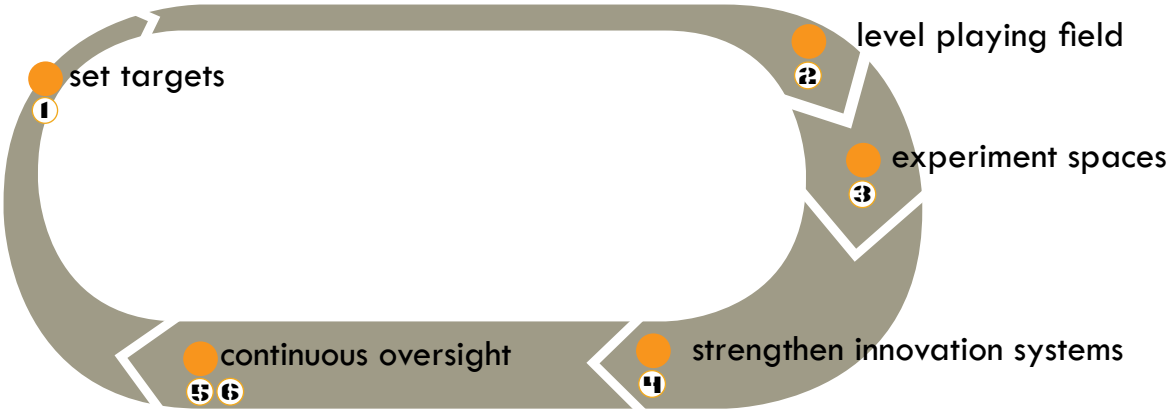
However, the stability of revenues to drive scale remains a challenge. Some of the experiments in auctions for capacity show the day-to-day reality can be counterproductive to low-carbon goals. UK capacity markets over the past three years have allocated $4 billion to existing gas, coal and nuclear generation rather than incentivising new investments in distributed demand-side infrastructure (including storage), which will be required to keep decarbonisation on track. Europe-wide, capacity markets are under investigation to ensure that they support the energy transition. The California mechanism to bring in third-party innovators to provide demand-side grid assets – the Demand Response Auction Mechanism – has faced criticism because, in 2016, utilities did not at first purchase the minimum services required, and provision of data to third parties was too slow. The Reserve Capacity Mechanism in Western Australia, under reform, has been criticised for passing on hundreds of millions in costs to customers for unnecessary excess capacity. The rest of Australia does not have separate auction mechanisms for capacity or balancing, which makes it attractive, but cost-reflective pricing is not applied uniformly across all states, and the more familiar issues arise around lack of standards for installing storage, and high integration and transaction costs.

ACTIONS TO SUPPORT PATHWAYS FOR ON-DEMAND REAL-TIME ENERGY TRANSITION

If we expect emerging businesses to contribute to a productive energy transition, actions by governments, the finance sector, organisations and corporates can support an innovation approach that sits alongside environmental policy, such as limits on polluting fuels, and climate policy, such as national climate-change legislation. As new solutions converge for a transition to on-demand, real-time energy management and associated outcomes, a new set of principles for an innovation approach to energy-productivity governance is needed. Our recommendations specifically highlight gaps that need to be addressed as governments and the private sector take this innovation approach to supporting the energy transition.

[20] Liu, Yingqi: Demand response and energy efficiency in the capacity resource procurement: Case studies of forward capacity markets in ISO New England, PJM and Great Britain. Energy Policy | Vol 100, pp 271–282, (January 2017)

THE INNOVATION RACETRACK



PRINCIPLES

Industrial and energy policy alignment: new value chains emerging require us to look beyond traditional energy policy

Focus on outcomes: rather than supporting individual technologies, set performance outcomes to aspire to

Citizen-consumer led: starting with citizens, systems are aligned towards innovative integration

Timing is everything: start with early interventions, supported by strategic ongoing evaluation and improvement

RECOMMENDATIONS

1. Align data collection with target setting to better prioritise innovation activities
2. Create conditions for investment in demand-side infrastructure
3. Enable experimentation in market arrangements, not only in technology
4. Build 'pre-procurement' capacity for government and corporate demand for innovation
5. Develop governance strategies for competition law to support energy transitions
6. Providing independent oversight of utilities' digital services to ensure performance

SET TARGETS

Targets at government or organisational level need to be technology agnostic. For instance, the USA, by starting with a national target for doubling energy productivity by 2030, allows like-for-like comparison between interventions across the value chain of energy, which can be delivered through research and deployment, increasingly efficient fuel, and building standards (until the recent administration), which in turn can inform further policy. For early adopter corporates or new businesses with a core focus on disruptive or radical innovation, setting innovation targets for goals such as doubling energy productivity[21] or aligning their business within 1.5 degree warming[22] will be the first step in identifying how they can revolutionise their own operations and their business offers.

1 More should be done to ensure that the data collected at local level is aligned with the tracking of outcomes at the national and international level, and that in turn it informs innovation – both new inventions and the deployment and scaling of existing solutions, particularly as new value chains emerge that integrate existing sectors and disciplines.[23]

[21] http://www.theclimategroup.org/project/ep100, http://www.globalproductivity.org
[22] sciencebasedtargets.org
[23] The most detailed data available in the US from Other Lab https://blog.adafruit.com/2016/08/10/this-very-very-detailed-chart-shows-how-all-the-energy-in-the-u-s-is-used/

LEVEL THE PLAYING FIELD

It isn't unusual to hear companies saying 'we just want a level playing field'. This sentiment reflects the complexity of policies that have been designed with one specific outcome in mind – such as subsidising nuclear or solar power – resulting in a market failure to deliver sustainable low-carbon transition at low cost to the customer. The 'levelling' therefore requires a strategy that aligns industrial and energy policy, addressing infrastructure investments through to daily market operations.

(2) The main shift required is to redirect supply-side energy investments towards the infrastructure and services required for energy efficiency and flexibility. In 2015, global supply-side energy investments were roughly five times higher than demand-side investments.[24] There are several ways to support this shift.

The most obvious way for government strategy to remove barriers to energy innovation is to remove subsidies for fossil fuels, where much needs to be done. Globally, the production associated with fossil fuels, which dwarfs renewables by four to one, continues to be subsidised, and that disincentives efficiency.[25] Many companies call for the removal of these and other barriers, and technology-agnostic government policy, but such changes are difficult to achieve in practice – particularly in heavily regulated energy markets.

New investments in infrastructure often benefit from agreed returns on investment, whether that is a new city bus or power plant, or distribution-network reinforcement. New deployments of services that do not benefit from these existing arrangements will be less likely to happen. Governments should require regulated entities to look at the value of interventions that reduce demand, or the distributed 'infrastructure' of optimisation solutions that integrate hardware and software. Although returns on these investments might not be guaranteed by government, they can result in lower costs to consumers. Transloc is able to provide transit authorities with savings of 20% simply by finding 'low-hanging fruit' of inefficiency in current transit allocation. Even more efficiency is possible when on-demand services are provided.

Although companies are offering business 'service' models to overcome the upfront costs of everything from building energy management and control systems to sensors to electricity storage, the cost for rolling out real-time energy efficiency and demand-side flexibility cannot be ignored, nor can the cost of integration with legacy infrastructure. In capacity market auctions, as we have seen previously, allowing demand-side resources to compete equally with supply-side investments will be critical during the energy transition. Otherwise there is a real risk that unstable funding on the demand side will hinder infrastructure development.

In heavily regulated energy industries, the shift to 'principles-based' regulation allows for competition to progress as long as certain outcomes are met. In the financial industry, for instance, the UK Financial Services Authority set out their objectives stating that "Principles-based regulation means, where possible, moving away from dictating through detailed, prescriptive rules and supervisory actions how firms should operate their business."[26]

SAFE SPACES FOR COMMERCIAL SCALE EXPERIMENTATION

There is a high level of political scrutiny on the essential services of energy that underpin basic access to food, water, shelter and comfort. This scrutiny can result in a situation whereby governments and incumbents see innovation as a threat to essential services. Intermittent renewables threaten the security of supply and to make 'the lights go out'.[27] Removing fuel subsidies increases the price of a loaf of bread. New market entrants see their role as taking these contradictions and risks, and turning them into opportunities. Sara Bell of Tempus Energy says: "Focusing on and exaggerating these risks results in high-cost energy systems and low innovation uptake when the real risk is increasingly less productive economies that fail to continue innovating."

Any new innovation will be risky until commercial arrangements are further established, and timing is everything for companies that need to prove they can earn revenues quickly. Early interventions with strategic, ongoing, operational, continuous improvement need to sit alongside business as usual if we expect emissions to peak by 2020.

(3) Countries, states, cities and communities need to increase their ability to test market arrangements – and not just new technologies – that incentivise new investments. Market demonstrations can be achieved in several ways.

[24] http://www.irena.org/DocumentDownloads/Publications/Perspectives_for_the_Energy_Transition_2017.pdf
[25] https://www.odi.org/publications/10058-empty-promises-g20-subsidies-oil-gas-and-coal-production
[26] http://www.fsa.gov.uk/pubs/other/principles.pdf
[27] https://www.theguardian.com/business/2015/nov/12/will-the-lights-go-out-in-the-uk-this-winterf

Governments can provide the space for commercial-scale 'experimentation' so that companies can test business processes and propositions with real customers. One example is the 1300 megawatt battery storage by 2020 mandate in California. "Almost any market would benefit from coming up the learning curve," says Ted Ko from Stem. "With a mandate, it forces everyone to go through the market motions of contracting" and learning early at the megawatt rather than gigawatt scale.

An interesting new pilot in the UK takes another approach. The regulator Ofgem's Innovation Link is providing "fast, frank feedback" for new market entrants on how their solution may or may not work in existing markets, and has recently launched a 'sandbox' to allow innovators to trial new business propositions. The benefit of the sandbox is that existing regulatory barriers are removed for the duration of the trial, which can be a challenge in the real world. These also allow optimal arrangements for flexibility markets to be tested, such as those proposed by the Universal Smart Energy Framework.[28]

City-scale demonstrations provide evidence for aligning industrial strategy and national energy-market design, and finance-sector recommendations for how distributed-energy infrastructure financing can best be scaled.

STRENGTHEN INNOVATION SYSTEMS

Innovators cannot work alone. They are building new value chains, new practices and new processes, from payment and transaction platforms to hardware and software solutions. As these new ecosystems develop, there is a role for both governments and corporates to support new niche innovation ecosystems by increasing their ability to absorb and scale innovation.

Government's role in leading industrial strategy as innovation funder is the most significant driver of innovation historically.[29] Funding can support not only sustained, basic R&D, such as the foundation of new paradigms like the internet and mobile telecommunications, but also integration, deployment and testing of new market arrangements. For instance, a new project announced by GreenSync to link existing customer's batteries and storage to a marketplace for 'peer' trading is partially funded by the Australian Renewable Energy Agency, creating impact by reducing the need for centralised supply of electricity.[30] Governments also can provide basic tracking and support to niches of interest, and, given the importance of the energy transition, could help to identify high-growth energy companies ('scale-ups') with global potential, track whether these companies are progressing year on year, locate barriers and advise on how to improve their track record.[31]

Societies also need to build capacity for increasing demand for new innovation. National governments are drivers of innovation in their own procurement at national or local levels. Cities are the sites of 75% of economic activity, and where the most infrastructure will be added in the coming decades. More than 90% of global urban growth is taking place in Africa, Asia and Latin America, where 70 million new residents are added to urban areas yearly.[32] As the cities tackle increasingly complex challenges, they are looking internationally and locally for energy solutions, and they require capacity to understand, evaluate and test new innovation, all of which take place before procurement can be a force for change. The benefits for early-adopter governments include access to low-cost solutions and provision of a welcoming environment for innovators to operate.

For governments in the fastest-growing countries where international donor governments or multilateral development banks have a presence, their role as conveners, funding bodies and sources of international best practices should be

[28] https://www.usef.energy/
[29] Mariana Mazzucato, The Entrepreneurial State, 2011
[30] Accessed Feburary 23, 2017 https://www.greensync.com.au/arena-green-sync-launch-dex-a-new-renewable-energy-digital-marketplace-that-will-transform-australias-energy-industry/
[31] (from Scale-ups report)
[32] https://unhabitat.org/un-habitat-global-activities-report-2013-our-presence-and-partnerships/

directed towards capacity building, and ensuring that markets are not 'replicated' from existing energy paradigms but instead support leapfrogging potential. In Dar es Salaam in Tanzania, M-PAYG offers a $5 per month flat fee for unlimited electricity from a 50w solar panel and is outcompeting grid connections that cost $300 or more just to install. The potential for faster energy access aligned with productivity in infrastructure development cannot be ignored.

For corporates, we recommend joining peer communities of practice that can support them in identifying new innovation to meet their business targets, building strong ecosystems around them. By recognising the increase in digital energy alongside infrastructure, they could also encourage more corporate–university retraining programmes. The potential benefits for early-adopter corporates are that they could stay competitive in their existing markets, identify new growth opportunities, attract talent, reduce waste and losses to save costs, and increase brand value.

CONTINUOUS OVERSIGHT

During a transition when 'stretch' targets must be met through innovation, new governance strategies at corporate, city or national level are necessary as new energy services integrate into legacy systems or leapfrog them. At organisational and operational levels, continuous energy management in today's global energy-system transition will drive productivity outcomes. An organisation's improvement can be measured by standards such as ISO 50001, and can be facilitated with solutions that EPIC companies provide for sensing, analytics, control, demand shifting and storage of energy. Financial and energy oversight should be aligned at firm level. Particularly where successful energy systems are heavily entrenched, to drive a flexible, low-carbon transition will require strong independent oversight focused on evolving the competitive conditions for new systems to arise. At first, independent organisations are best placed to deliver this, although regulators and governments may quickly legislate or regulate.

5 Regions need to develop governance strategies that faster align bottom-up innovation with high-level policy goals, and create capabilities for understanding and applying competition law to ensure that climate-change and energy goals are being met. These strategies would help independent organisations to proactively identify where new solutions are locked out, and act to increase competitiveness, which could include legal action or lobbying. "Balancing and ancillary services have become a breeding ground for covert indirect discrimination, as incumbents protect themselves," notes the European Climate Foundation's Sophie Yule-Bennett.

6 Data access from network operators or utility monopolies needs rigorous oversight. Discussions have reinforced the principle that citizens own their energy data, and standards like the US Green Button uphold this by providing a way for utilities to share electricity data with third parties if customers consent. But we need to go further, first by opening time- and location-dependent grid fees so that innovators can help customers avoid them. Second, access to customers' meter data should be secured from digital outages, argues Mission:data Coalition's Michael Murray. Regulated utilities prevent innovative companies from accessing such data easily, even when customers consent. Performance requirements for data exchange need to be enforced so that demand-side energy solutions can compete on a level playing field – particularly when data is needed to deliver 'negawatts' to power grids.

ENERGY TRANSITIONS

WHERE WE GO FROM HERE

The investment decisions that we make in the next three years will determine our climate for decades. A 66% chance of achieving under 2 degree warming requires unparalleled ramp-up of all low-carbon technologies in all countries[33] to peak emissions by 2020, with a 70% drop in emissions over today's levels by 2020.

100 companies are just the beginning. There are hundreds and thousands of innovators that increasingly are being supported in new energy-focused accelerators or by clean-tech investors. Early-stage companies benefit from the same types of government support available to all sectors, such as procurement policies that enable governments to invest in small businesses or private individuals to see tax benefits from early support for small- and medium-sized enterprises.

Beyond this, governments supporting efficiency or renewables standards and targets will increasingly need to look at the ecosystem in which this innovation can thrive, aligning industrial and innovation policy support that enables energy business practices, skills development and ease of financing to progress in tandem. Financing for supply-side energy infrastructure dwarfs energy efficiency, which can be redirected towards renewables and 'demand-side' energy opportunities.[34] Here the task is more comprehensive and challenging, and we will see a role for communities, city and state governments as well as national direction to encourage the kind of distributed, citizen-led energy systems that the EPIC 100 portend.

Large corporates are scaling engines, and those that recognise the need for energy transition to take place are increasingly looking both internally and externally for innovation as a way to remain competitive. They may create new corporate venturing arms or innovation units that source and partner to create new value for customers. Such behaviours are welcome, because innovative activity across sectors will be important for energy transitions, and the technology solutions available today will have more chance of adoption through new business models.

The energy transition today could benefit from advances in materials, biotech, nanotech, computing, power electronics, IoT, Blockchain and the business models that enable convergence in these trends towards a shift in how we produce and consume energy. New value chains and business models will be emerging that require attention at both strategic and operational levels to ensure that they are not locked out of providing viable, economic alternatives, today.

We will have key questions to address during the transition. How can technologies that enable democratisation of energy really live up to their promise in all countries and economies? How will decentralisation be facilitated in the context of very different legacy infrastructures? How do political leaders handle the risk from existing and ongoing investments of hundreds of billions in fossil fuels? Is energy and related usage data on transport or industry public or private, and how is it governed? As Daniel Hoornweg at the Ontario Institute of Technology notes, "when electricity was first developed at Niagara Falls by a private company, the province of Ontario reasoned it was too valuable to leave it to the private sector. We may now be at the same place 100 years later with energy and city data."[35]

Climate change is already felt today: increasing frequency of extreme weather events and shrinking access to water or arable land. On the other hand, we find evidence of the nascent components of a new energy system beyond the age of oil.

Both futures are coming to meet us.

[33] http://www.irena.org/DocumentDownloads/Publications/Perspectives_for_the_Energy_Transition_2017.pdf
[34] http://www.irena.org/DocumentDownloads/Publications/Perspectives_for_the_Energy_Transition_2017.pdf
[35] Interview

8m:nutes [More power to you] . Advanced Microgrid Solutions [Tomorrow's energy grid] . aktivhaus [The house with the power to change the world] . Alphabet Energy [We make waste heat valuable] . Alpheon Energy [Smart energy investment] . American Boronite Corporation [Extraordinary materials for a demanding world] . Amici Enterprises [Cool, clean, conditioned power] . Aquion Energy [Energy storage, clean and simple] . AutoGrid [Enabling a smarter energy internet] . Avant Garde Innovations [Empowering the unpowered] . Become Energy [Make positive energy simple] . Blue Inductive [Efficient wireless power] . Blue Pillar [Connecting the energy things that power our world] . Bright Energy [We make the energy demand more responsive to supply] . BuildingIQ Maximum Efficiency [Maximum savings. Maximum comfort] . Caventou [Independent renewable power sources] . Clean Energy Redesign [Concentrated resilient solar energy] . Cloud&Heat Technologies [The future of IT] . ConnectMyEV [A leading company in autonomous charging] . Corardor [Platforms that redefine the Australian electricity market] . Correlate [Your virtual energy team] . Cortus Energy [WoodRoll – taking bioenergy forward!] . Dearman Engine Company [Delivering clean & cold power] . DEXMA [Verified savings worldwide] . E-Cube Energy [Data to insights. Insights to action] . e.Ray Europa [We build sustainable rivers] . E24 [Bridging the energy gap] . Ecolibrium Energy [Creating a world where every watt counts] . Ecorithm [True Analytics™] . ElectraSeed [multi-GW microgrid project] . Electric Pocket [Making young people better at managing energy] . Electrochaea [Power-to-gas process utility-scale energy storage] . Electron [Blockchain solutions for the energy sector] . eMotorWerks [Smart-grid EV charging] . Energo Labs [Blockchain-enabled cleantech & energy efficiency] . EnergyDeck [We help run buildings better] . EnergyElephant [Make better energy decisions] . Enerkeep [Your online solar adviser] . Enfragy Solutions India [Enter the world of butterfly kiss solutions] . Enlighted [Beyond smart buildings. Brilliant buildings] . Epishine [Affordable solar energy anywhere] . EQuota Energy [Business intelligence for energy optimisation] . Etherisc [Decentralised insurance applications] . Faraday Grid [Emergent energy network] . freeel.io [Experience your energy freely] . Furrer+Frey [Opbrid charging stations] . Geli [A platform for the rapid deployment of networked energy storage] . Global Renewable Independent Power Supplier (GRIPS) [Competitive energy beyond the grid] . Green Running [Energy monitoring: at home. At work. On the grid] . GreenSync [We are reshaping the grid] . Grid Singularity [Energy + Blockchain] . GridDuck [Hardware + cloud solution for demand response] . GSy [Empowering the individual] . hEnergy Alternatives [Improving lives by energising communities] . Heng Hiap Industries [Making plastics smarter] . I-ON Communications [Demand response, SmartGrid, SaaS, energy efficiency] . Independent Energy [A new disruptive green-energy technology] . LO3 Energy [We build tools for the energy-sharing economy] . Lucid Energy [Energy harvesting from water utilities] . Lumenaza [The software for the energy transition] . M-PAYG [Financing bottom-of-the-pyramid customers] . Mobile4Energy [Securing value from real-time energy data] . Modvion [The IKEA of windpower] . /ndustrial.io [The next industrial revolution] . Newatt [Energy under control] . Nextenergylabs [Energy storage, battery, clean energy, unlimited energy] . Nuru Energy [Energy to empower] . OhmConnect [Save energy. Get paid.] . ON5 [Energy efficiency for all] . Open Energi [Making our energy smarter] . Optishower [Water, energy, smart city, gamification, optimisation, track, monitor] . PassivSystems [Create sustainable value] . Power Drive Efficiency [Saving energy without slowing down] . ReMaterials [High-quality roofing for the developing world] . SAHT Energy [Unlock the power of canals] . Science for Society Techno Services [Food for Everyone] . SMAP Energy [Creating value from energy-consumption data] . Smappee [Smart appliance for energy efficiency] . Smart Joules [Pay-as-you-save energy using cutting-edge building energy optimisation systems] . SmartEcoCity (SEC) [Smarter, greener, together!] . Smartwatt Energy Services [Solutions for energy systems] . SolarCoin [Like airmiles for solar energy generators] . SolarChange [Blockchain technology for renewable energy revolution] . sonnen [Energy is yours] . SparkFund [Invest in efficiency] . Stem [Energy + insight when it matters most] . Sunverge [Energy moving energy forward] . Sustainer Homes [Sustainable living made easy] . Sympower [Smarter energy for a low-carbon future] . Tech Mahindra Americas [Connected world, connected solutions] . Tempus Energy [It's about time] . The Curve [The TripAdvisor for energy management] . TransLoc [On-demand public transit] . United Building & Energy Services [Changing the future of energy with proprietary technology] . Virtual Power Solutions [Because saving energy is all about doing more with less] . Wapo.io [Smart talk for buildings] . Wattwatchers [Digital energy] . Watty Watty [Gives you control of your energy consumption] . WegoWise [Benchmark your energy and water usage] . XL Hybrids [The leader in connected fleet electrification] . ZaaK Technologies [Build the future on smart sand] .

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