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Leeds

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GMI Energy

Energy for Business

The future is battery powered

Who are GMI Energy

GMI Energy are the specialist energy arm of GMI Construction Group

We have a unique skill set and service offering; this includes almost 30 years of experience in construction, knowledge and integration of wider energy technologies

NEC ENERGY SOLUTIONS

TESLA ENERGY

ABB

LG Chem

SAMSUNG SDI

Schneider Electric

Kokam Great Power for Everyone

SUNGROW

EVBOX

Energy is changing

Q4 2015. Coal generation 25% - Renewables 25%

Q4 2016. Coal generation 7 % - Renewables 28%

- Coal is dead, gas exposure increasing now 44% of generation stack giving rise to increasing gas price volatility exposure in commodity price
- Government legislation is now in place to accelerate the transition to low carbon with green taxes and levies set to rise dramatically

A moment from history

Sometimes changes happen quickly!

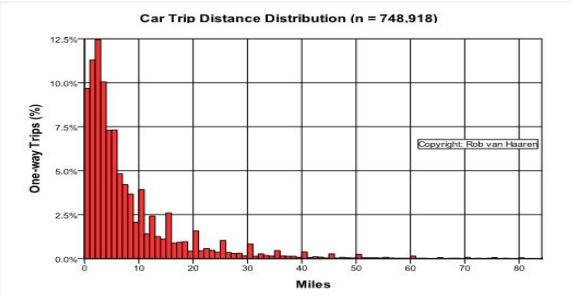
To understand the market you need to understand the drivers

[Article - Wall Street Journal - Why electric cars will be here sooner than you think!]

An Electric Revolution!

- We are about to experience one of the largest changes to transport in the last 100 years.
- The shift from fossil fuel powered cars to electric will be one of the defining changes of our times.
- Why has it not happened yet?
  - **Range anxiety** battery size issue
  - **Purchase is expensive** for long range large batteries
  - **Financial advantage not understood**
  - **Who has one** people don't know someone else with one
  - **Electric vehicle performance** – Milkfloat association
- The current real world situation
  - **Battery cost currently limits range**, battery size and thus range are increasing proportional with falling battery cost
  - **Battery cost is 50% of vehicle cost**
  - **Battery vehicles are substantially cheaper to run already** 1000 miles, battery = £39 electric, fossil fuel = £123 petrol
  - **Tesla model 3 game changer** expected 50kWh battery, 200 mile range (Typical petrol 42mpg ave on 55 litre tank gives 512 mile range) gives 3hr driving range most journeys are below 40 mile (see graph)

Model S P100D 2.5sec 0-60mph
381-mile (NEDC) range



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An Electric Revolution!

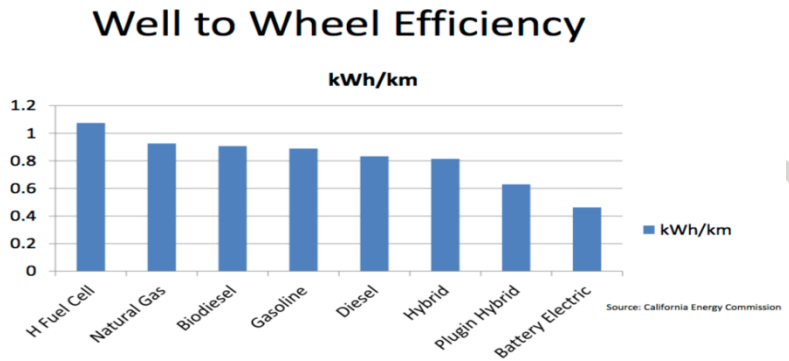
There's not quite enough financial advantage this year but next year there will be! The launch in 2017 of Tesla model 3, GM Bolt and Nissan Leaf 50kW model will start the mainstream market. They will have a shorter range but much cheaper operating costs, particularly for company car drivers

Model	Passat BiTdi R (240PS) '17	Tesla Model S (75kWh) '17	Tesla Model 3 (50kWh) '18
	2017 Diesel model (EU6)	2017 Electric model	2018 Electric model
On the road cost	£36,240	£57,835	£35,500 est
Range / MPG/mi-kW	640mi / 44mpg	230mi / 3.8mi-kWh	200mi / 4mi-kWh est
Fuel cost (20k/yr)	£2,273/yr (£1.10/litre)	£685 (13p/kWh)	£650 (13p/kWh)
Servicing (20k/yr)	£375	£800	£480 est
Vehicle Excise duty	£145	£0	£0 est
BIK (Tax-tax rate)	30% (£2,123/20% £4,245/40%)	9% (£1040/20% £2,080/40%)	9% (£640/20% £1,280/40%)
Tax liability 3 yrs	£7,087 20% - £14,174 40%	£4,391 20% - £8,783 40%	£2,703 20% - £5,333 40%
3 yr running cost	£50,988	£57,833	**£38,890**

Manufacturers are making the switch

- All major manufacturers have announced multiple models
  - Daimler have announced 9 models to be available from 2019 onwards, they are also building a new €500m battery factory (Accumotive) on top of previous €200m investment to produce both static and vehicle batteries
  - Volkswagen after recent problems over diesel emissions have announced 30 electric models by 2025 to help rebuild the company image
  - Nissan are developing the Leaf on year by year basis, originally a 22kW ('11) unit the 2016 version is 40kW with a 50kW version coming in 2017 this will give near 200 mile range
  - **Samsung** (who supply a number of partners including BMW) have announced an **upgrade** to their battery chemistry rolling out in **2021** with expected almost doubling of density within the current pack size and giving a potential **80% charge in 20 minutes**. Potentially giving 500km refuel in 20 min.

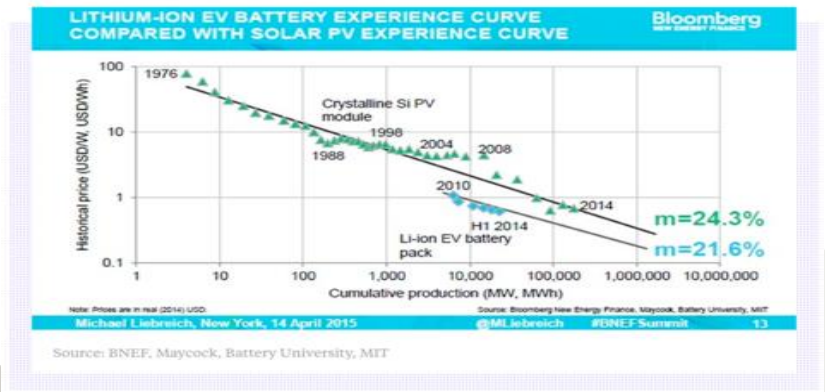
- Why Battery vehicles though?
- As the chart shows they are more efficient
- Less energy is expended from source to use
- Efficiency always wins!

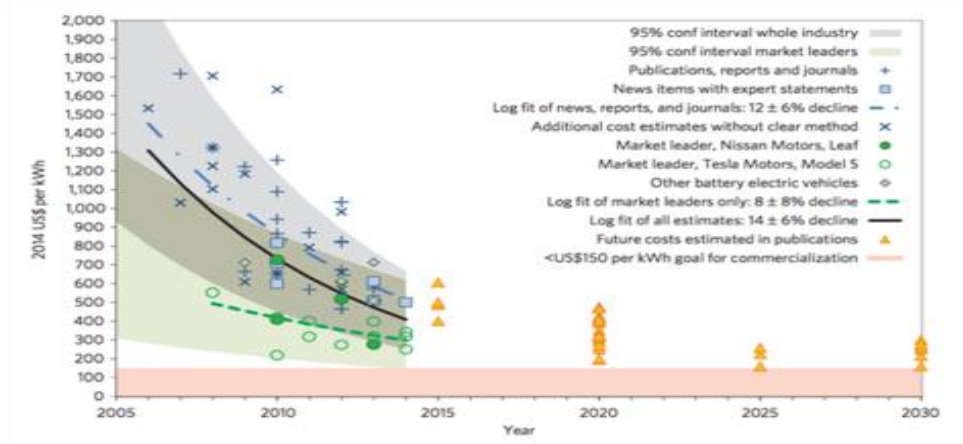


Why do electric cars cost so much and whats driving the cost?

- Upto 60% of an electric car cost is battery, it's the biggest price influence on a vehicle
- Tesla forecast 25% battery cost reduction over 2016 by the end of 2017 alone
- Stationary batteries and electric vehicles will expand the current battery market at a 20-30% compound rate for at least the next 5 years
- This will drive further cost reduction much the same as has happened in solar over the last 5 years
- Cost reduction will drive further uptake of stationary storage and EV's driving a virtuous circle of expansion
- Oil wont be able to compete as its almost sold at its cost of recovery at the moment

Electric Car Battery Costs Are Falling as Fast as Solar Panel Costs





How will this effect storage?
Whats the current market?

What is the market - Why Batteries?

Battery systems offer an attractive simple solution to **provide a revenue stream**, **manage a sites power demand**, **cut pass-through costs** as well as offering vital **backup power** protecting against grid failure.

What can a battery do?

- They can **time shift renewable power**,
  - moving power from when its generated to when its needed – overnight cheap power to daytime, moving solar power from daytime into the evening
- They can provide **services to the National Grid** providing power to
  - balance supply and demand, provide emergency extra generation, absorb excess power, provide power to meet peak demands
- They can provide **services to the Local Grid** providing power to
  - Lowering peak loads on a connection or through a transformer, deferring investment on the grid to address grid issues, providing emergency generation to to stabilise grid issues
- They can provide **services to your site** providing power to
  - Backup power for grid outages, Manage pass through charges lowering peak use charges, lower TRIAD costs, improve the cost of purchasing power by flattening load demand, lowering peak use thus enabling max demands of a site to be met where grid cannot supply enough power

Business Case – In front of meter

- **Time shifting and arbitrage**

- Power stored at night is used in the morning when cost is higher - **arbitrage**
- Daytime generation of solar or wind is stored and used in the evening when cost is higher
- As the unit is a generator it qualifies under the **Capacity Market** for a 15 yr RPI linked contract to provide generation
- Battery can enable an aggregator to **trade power** for you to increase its value by trading power back out onto the spot market when its most expensive providing additional revenue
- By discharging the battery during **TRIAD** periods you will qualify for TRIAD generation or if on your site TRIAD charge reduction

- By using a mixture of the above services a battery can generate an income of between **£100k - £150k per 1MW** of battery installed giving a simple payback of **5 to 8 years**

- **This provides an attractive payback but Higher returns are possible!**

Business Case – In front of meter

- **Frequency Response (Dynamic)**

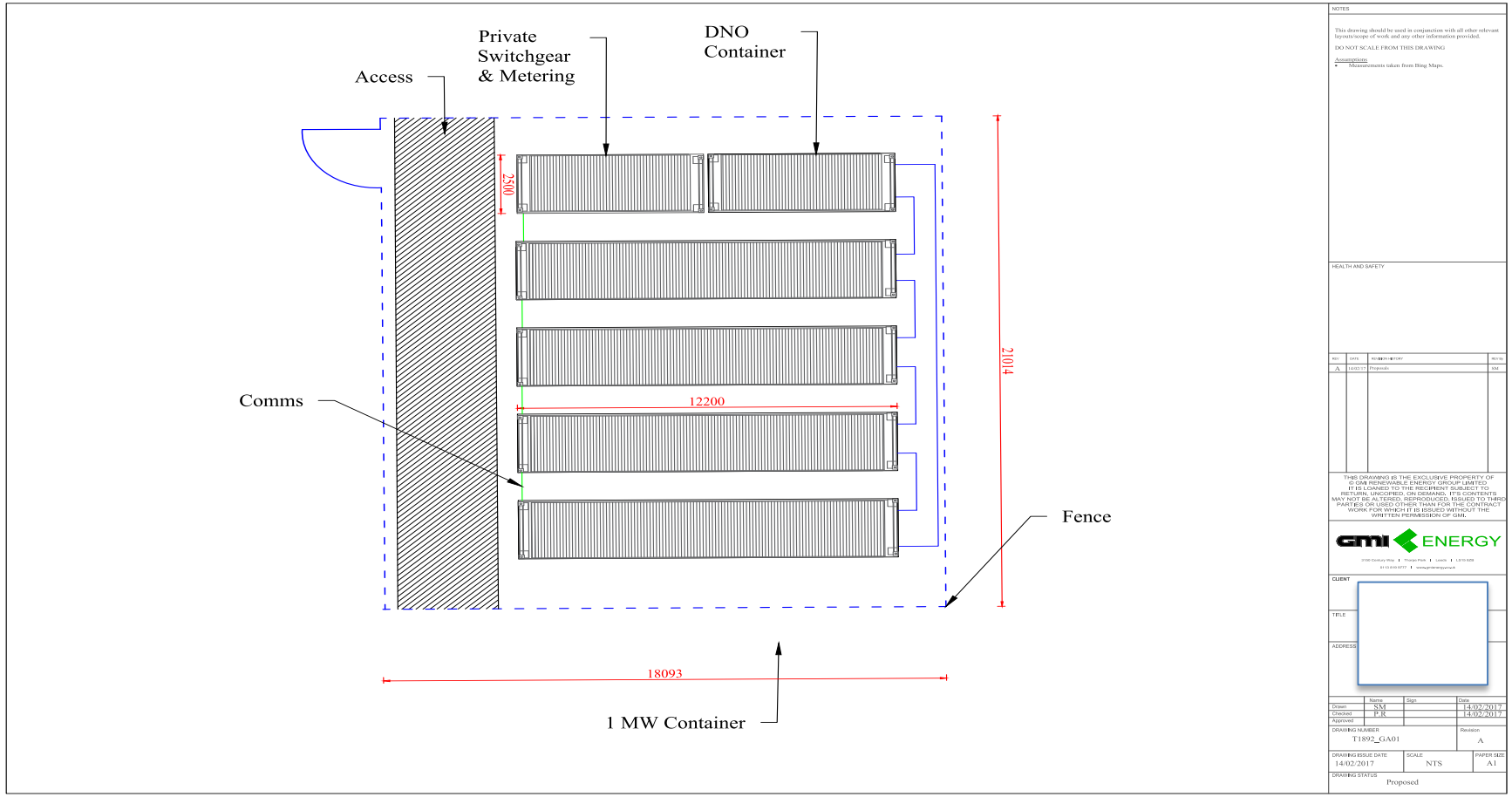
- The battery is used by an aggregator to provide services to National Grid for stabilising grid frequency
- The unit constantly charges or discharges to provide balancing services to the grid as load changes on the grid and thus recieves an availability payment for its use
- As the unit is a generator it qualifies under the Capacity Market for a 15 yr RPI linked contract to provide generation
- By discharging the battery during TRIAD periods you will qualify for TRIAD generation or if on your site TRIAD charge reduction

- By providing these services a battery can generate an income of around **£200k per 1MW** of battery installed giving a simple payback of **3.5 to 5 years**

- Frequency response is a 2 year rolling contract, only if you are not happy with the latest month bid value do you see out your current contract length at that point you are free to move to another service model

Whats a typical site

Typically located near load centres and local primary distribution network



Business Case – Behind the meter

- **What does the income stream look like for a behind the meter project?**

- Projects are often dependent on the site demand profile, a sites kWh costs are not equal through day or year
- Income is from a mixture of :-
- **Grid services -** Demand side reduction – Frequency Response
- **Time shifting of generation** to match use profiles
- Time shifting of demand to **lower peak rate use** charges
- If on pass through procurement contracts -
- **Capacity Market charge mitigation**, lower use within periods where charges for CM eminate
- **TRIAD Reduction** - National Grid has already forecast the next 5 years of charges for TRIAD these costs are increasing rapidly, lower use in these periods
- **Mitigation of use in charge periods,** for DUoS, TNUoS charges and losses charges, RO, FIT and other charges.
- **Location and cost structure make the returns unique to the project potential 5-7 yr payback but location sensitive**

Energy cost make up to 2020 provides not just increased cost but opportunity

Average Costs of electrical power forecast - p/kWh						
	2015	2016	2017	2018	2019	2020
Commodity	4.2	4.2	4.5	4.4	4.3	4.4
BSUoS	0.207	0.210	0.23	0.236	0.243	0.250
TNUoS	0.0003	0.0003	0.0004	0.0004	0.0004	0.0005
DUoS	0.0800	0.0848	0.0899	0.0953	0.1010	0.1071
Dist Losses	0.0025	0.0028	0.003	0.003	0.003	0.003
Settlement	0.00010	0.00011	0.00011	0.00012	0.00013	0.00013
BSC Charge	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060
CCL	0.541	0.559	0.568	0.583	0.847	0.872
CfD	0	0.06	0.29	0.57	0.84	0.9
FiT	0.445	0.507	0.558	0.573	0.589	0.606
RO	1.286	1.558	1.9	1.9	2	2.1
CM	0.191	0.445	0.46	0.47	0.49	0.5
Sum price p/kWh	6.95	7.63	8.60	8.83	9.41	9.74
% Increase	100	9.7	23.7	27.0	35.4	40.1
Pass Through	39.6	44.9	47.7	50.2	54.3	54.8
Pass Through	2.75	3.43	4.10	4.43	5.11	5.34
Commodity	60.4	55.1	52.3	49.8	45.7	45.2
Assumed RPI increase of 2.8%						
Estimate based on Smartest Energy legislation analysis						
Assumption based on gas forward market liquidity						

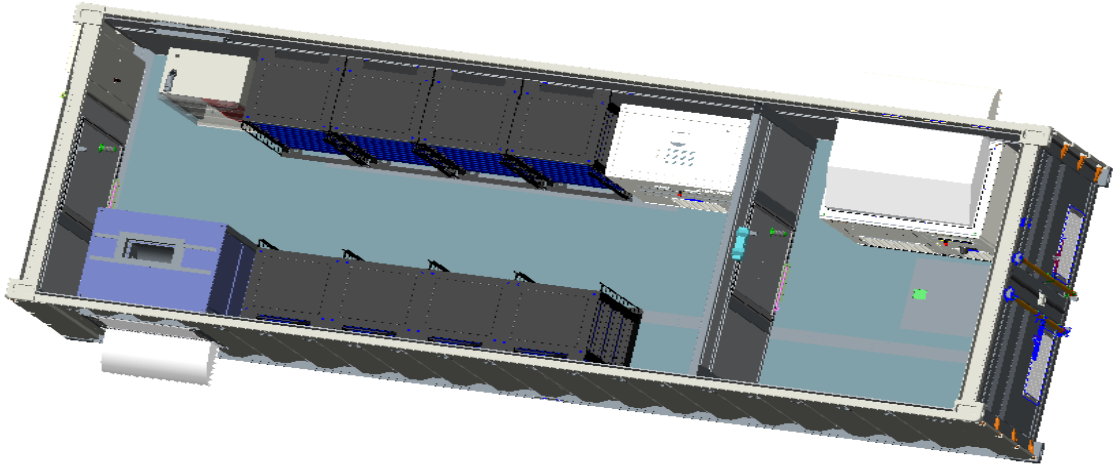
- Chart shows costs over next 4 years and the likely implications of tax legislation, these rates are taken from government legislation (white), Smartest Energy / Inenco (amber) legislation analysis and assumptions based on market analysis (green), cells in yellow assume RPI increase at 2.8%

Business Case – Backup Power

- **Backup power in the event of grid failure** can be one of the most valuable assets a business can have, however its also difficult to quantify. **We don't include this value in our appraisals but it can be one of the most valuable reasons for having a battery system**.
- The impacts can be many;
  - Business interruption – down time wages and running costs
  - Lost stock (loss of temperature control for product)
  - Time to restore processes – critical equipment
  - Lost productivity – loss of potential earnings
  - Prevent loss of information on sensitive equipment - IT and CADCAM machines
- Our systems are automated and switch from grid to backup in less than 20 milliseconds providing seamless cover to your site.
- **It's a generator that pays for itself, the revenue stream ensures that the unit is not just another dead cost asset**
- **You know it will work**, as the unit is always on and always being monitored you can count on it working instantaneously when needed.

Whats a typical site – behind the meter

- Samsung 0.5MW / 0.5MWh system
- System can run 0.5MW load for 1 hrs
- Self contained unit including HVAC and fire suppression



- Tesla 1MW / 2MWh system
- System can run 1MW load for 2 hrs
- Self contained units with inbuilt cooling

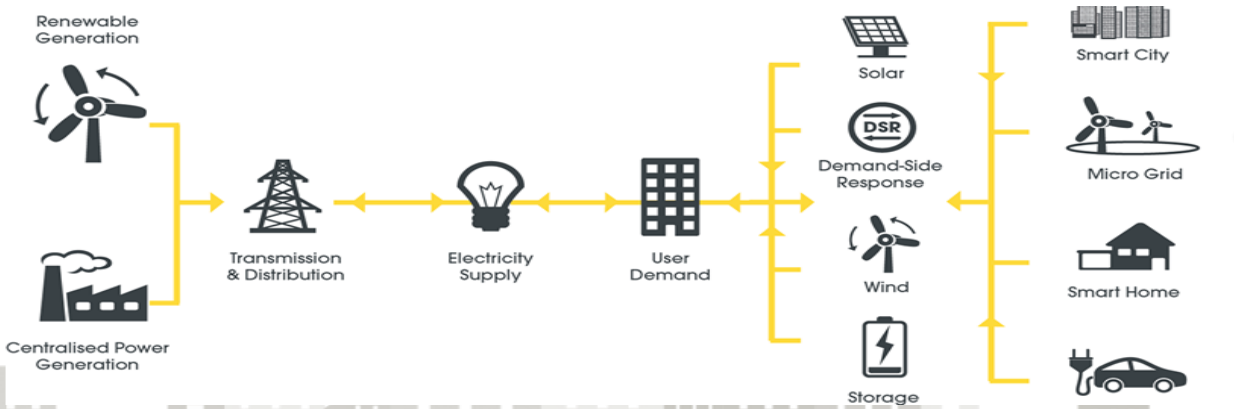
Important Considerations

- Important points to remember for battery projects
  - Battery chemistry – cycle life, generally the more cycles the more cost
  - Likely future cost of unit will be falling buy expensive now or cheap now and replace?
  - Service to be provided – cycles required per day
  - Whole life cost – purchase cost vs cycles
  - Depth of discharge and damage that may cause to the unit
  - Location of unit – temperature control, fire safety
  - Available load to charge
  - Grid connection – import / export size availability
  - Cost of charging – it wont all come from solar, may need charging in winter from grid
  - Throughput losses of the system – losses in DC to AC conversion
  - Energy required for temperature control
  - Who will be the aggregator
  - Retain as much flexibility to provide a different service than you planned for
  - Warranty
  - Warranty
  - Warranty… and who is behind that warranty!

A microgrid future?

- We think that the future for the distributed grid could well be what was initially designed as a solution for remote locations and small island grids – the microgrid
- Combining Solar, Batteries and Gas CHP in a robust fundable solution
- GMI can provide all these services in house and scalable upto 20MW
- Provides increased **cost certainty**, by linking to gas pricing and solar
- This allows integration into a **Demand Side Reduction** (DSR) strategy helping to control the demand on your site not exceed capacities and earn valuable income
- Can integrate with **car charging** to enable additional load on restricted connections
- Can automatically unload chargers to **avoid overcapacity** on your connection
- Can be **integrated with batteries** to control max demand and further facilitate **DSR** and **Grid services** on sites even with limited import / export connections

The new energy economy - Macro



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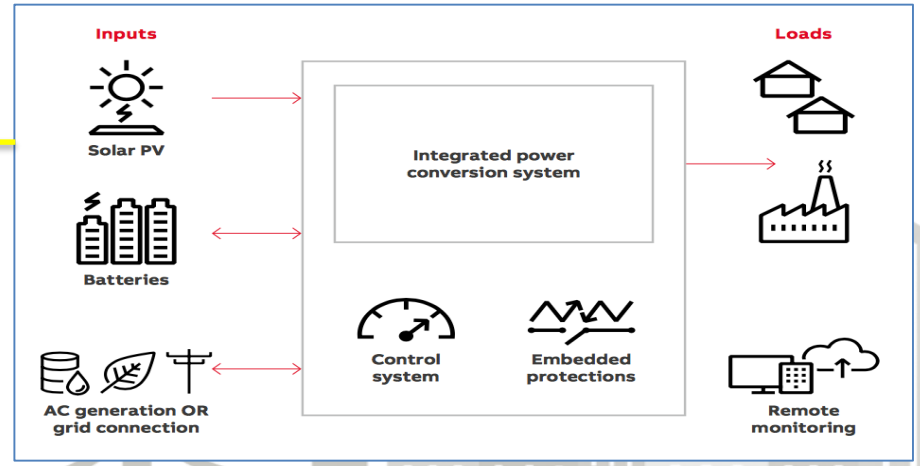
The new energy economy - Micro



5. The process

- **GMI offer a full turnkey service:**
  - Installation of suitable metering and monitoring (crucial for scheduling)
  - Application to Local Grid to connect the unit
  - Application to National Grid / Aggregator to undertake in services
  - Optimum sizing of unit to grid operators offer / available income streams
  - Design and specification of renewable generation, energy storage system and switchgear / system controls
  - Installation and commissioning of the system and associated switchgear
  - Ongoing management and scheduling of battery system
  - Performance reporting of the system
  - Operation and Maintenance of components and software
  - Installation is generally non invasive and minimal operational disturbance

GMI design and implement multi MW Solar, CHP, M&E, Metering and other generation technologies, these all form part of a complete energy system.
We develop, turnkey construct and fund systems

Who do we work for, what do they say?

"GMI epitomises going above and beyond for the customer. They installed a 144kWp solar array on time despite the original, client-selected supplier going into administration during the store build"

Ed Pitt Ford, Tesco Store Environmental Project Manager

"GMI Energy's award winning project fitting solar panels to the Morrison's Distribution Centre in Bridgwater is a terrific example of how solar PV can be successfully deployed on large scale commercial rooftops. I am keen to see more developments like this in the future."

Greg Barker, Minister for Energy and Climate Change

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