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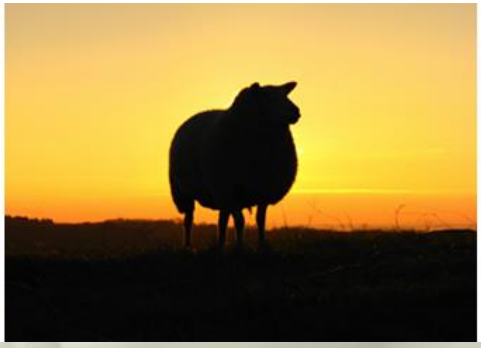

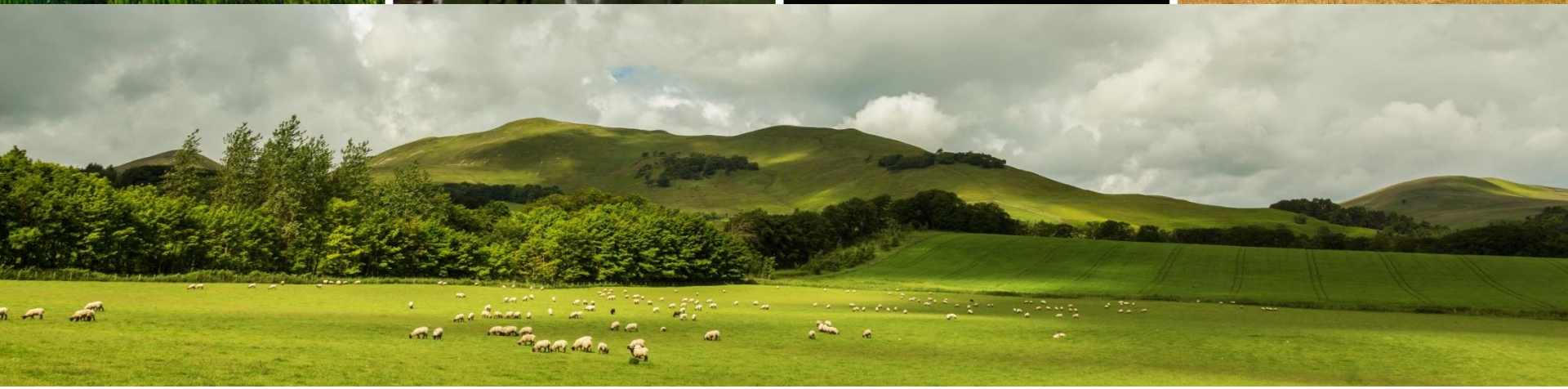

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Renewables & Energy Efficiency

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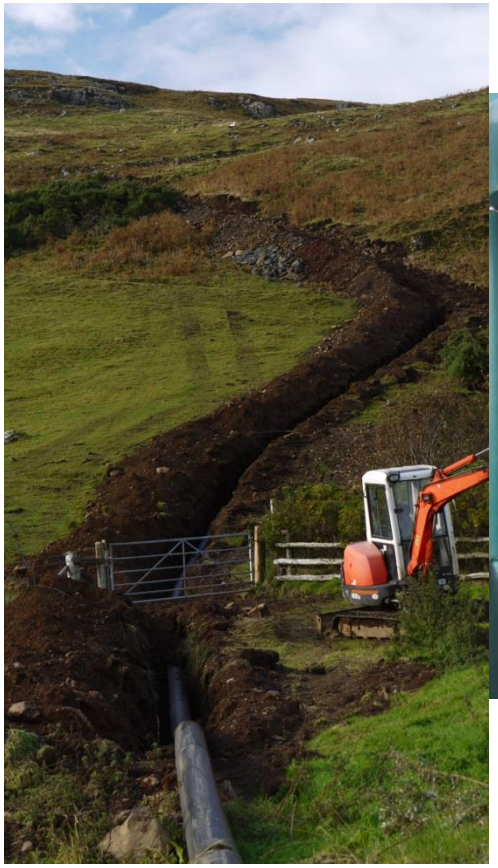

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COSTS/ASSETS

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Energy Costs

- Electricity
- Red Diesel
- White Diesel
- Petrol
- Kerosene
- Imbedded Energy
  - Fertiliser
  - Feed

Energy Assets

- Wind
- Water
- Crops
- Crop residues
- Slurry/FYM
- Land
- Underground

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Energy auditing

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1. Quantify existing energy usage
   - Keep records
   - Bills can be difficult to interpret and may be estimated
2. Identify usage with specific operations
   - Install additional meters on individual buildings/equipment
   - Record tractor and vehicle fuel usage against tasks

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Energy auditing

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3. Benchmark

- Relate energy usage to production or to stock numbers or hectares.
- Electricity consumption in dairying ranges from 200 to 400 kWh/cow/year
- Average fuel consumption for ploughing to 200mm is around 15 l/ha
- A typical farrowing house will use 8 kWh per pig produced, the most efficient installations use only 4kWh

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Energy auditing

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3. Identify potential savings

   - Upgrading of buildings
   - Modification/replacement of equipment
   - Alteration of management practices
   - Establish costs and payback periods for various options.
   - Implement zero and low cost options immediately.
   - Plan ahead for other viable options where investment of time and money are required.

4. Information compiled will inform decisions on investment in renewables

Farm scale renewables to date

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- Scotland's farmers have been at the vanguard of the country's move to de-carbonise the energy sector.
- Almost all on-shore technologies require at least some land for their deployment

- Diversification of businesses
- Additional income stream unrelated to crop and livestock prices
- Many challenges along the way
- Now an integral part of many farming businesses

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Renewables – the story so far

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- We have had a period of high incentive payments
  - Feasibility of schemes have been judged more on the amount of FITs, ROCs, RHI that they will generate
  - Less on the value of the energy they produce
  - Distortion in the market

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Renewables going forward

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- Incentive payments are now much lower and may drop to zero in the near to medium term
  - The value of the energy produced can be better appreciated and realised
  - Any increase in oil prices will improve viability of renewables
- Large scale renewables will have to compete with other large scale technologies
- Feasibility of small scale renewables will be judged on the amount of local demand they can supply

Maximise the value of energy produced

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50 kW PV example

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	FIT rates for Nov 2015 installation				Proposed FIT rates for Jan 2017 installation			
	25% on site usage		100% on site usage		25% on site usage		100% on site usage	
	£	% of total income	£	% of total income	£	% of total income	£	% of total income
Generation tariff	4802	65	4802	53	1474	36	1474	26
Export tariff	1546	21	0	0	1546	38	0	0
Electricity savings	1062	14	4250	47	1062	26	4250	74
Total annual income	7410	100	9052	100	4082	100	5724	100

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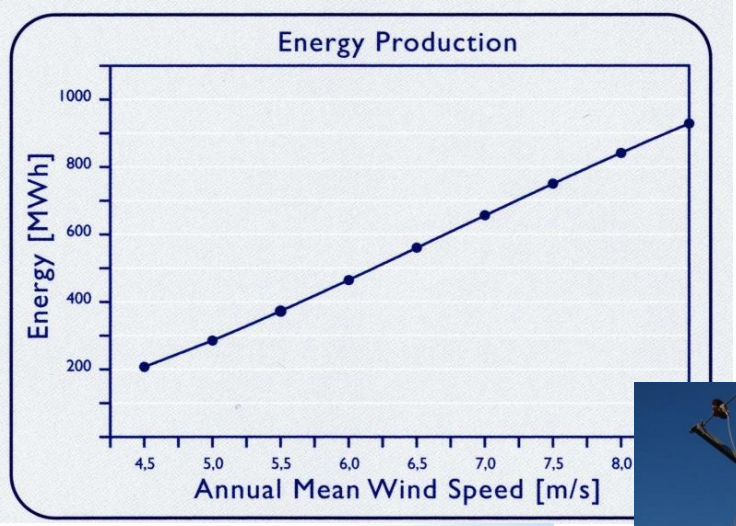
What projects can still be viable

- High yielding sites
  - Maximise return on capital investment
- Low cost
  - Simple installation
  - Low grid connection cost
- On- site usage
  - Offset cost of conventional energy



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Wind example

	50 kW wind turbine		
Average wind speed	5.5	7	8.5
Yield	120568	186238	237800
20% 0n site usage			
Generation tariff (£)	9959	15383	19642
Export tariff (£)	4440	6858	8757
Savings (£)	2411	3725	4756
Total annual benefit (£)	**16810**	**25966**	**33155**
100% 0n site usage			
Generation tariff (£)	9959	15383	19642
Export tariff (£)	0	0	0
Savings (£)	12057	18624	23780
Total annual benefit (£)	**22016**	**34007**	**43422**
Installed cost	**£180k to £300k**		
Jan 2017 tariff rates			

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Micro-hydro, Kames Fish Farm

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- High rainfall area = high yielding site
- Relatively low construction and connection cost
- Local demand from fish farm
- Low carbon footprint a marketing opportunity

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Anaerobic Digestion

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- Crop based feedstock can still provide reasonable return where;
  - Maximum benefit is obtained from electricity and heat or from grid injection
  - Installation and grid costs are relatively low
- However;
  - Use of crop likely to be limited for new installations from 2017 following proposals to change the RHI & FIT regulations
  - FIT Deployment caps greatly exceeded and projects queued for registration

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Biogas yields

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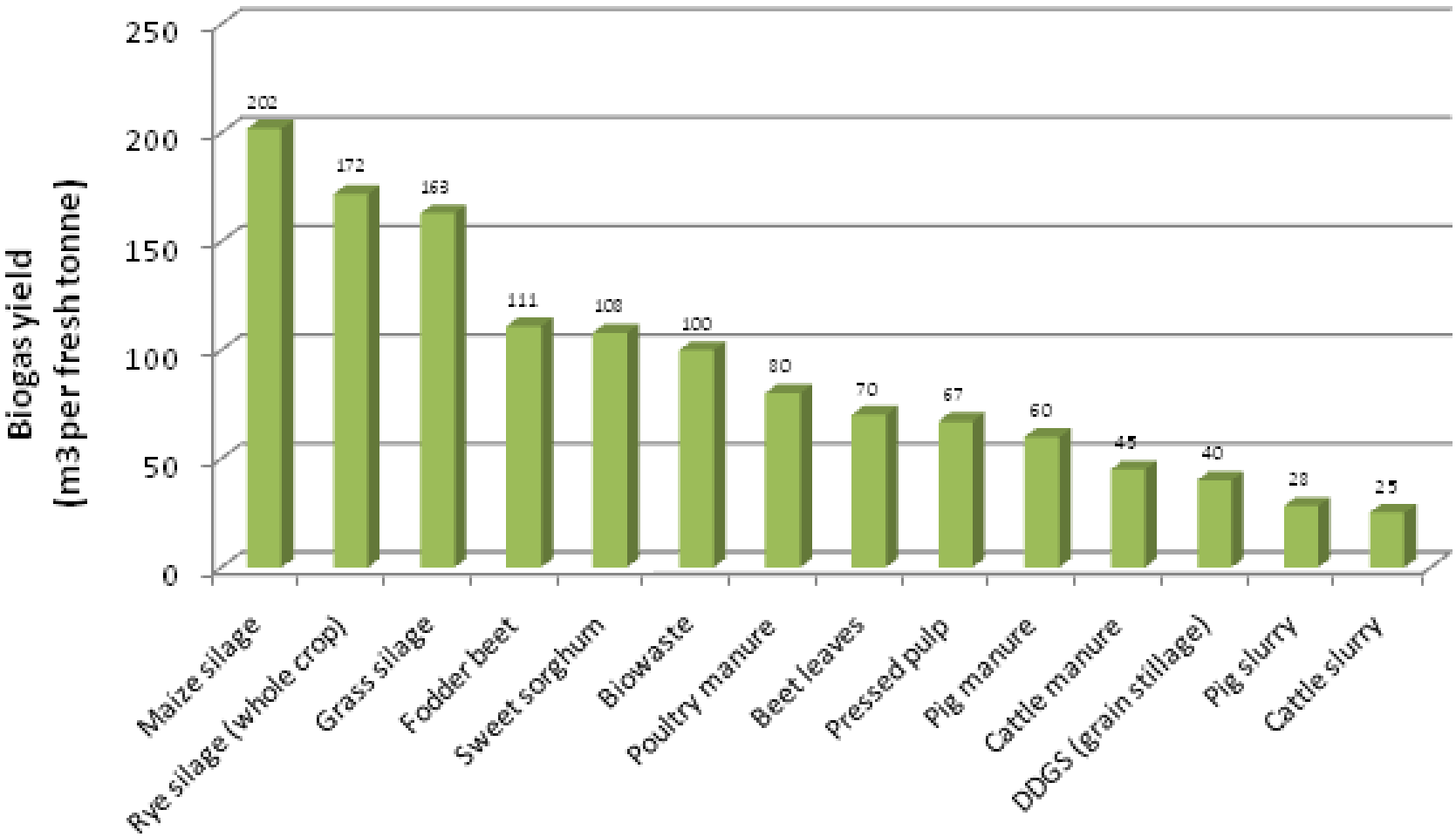

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Slurry/FYM only AD

- May become viable where;
  - Packaged plants become available at lower cost
  - Existing slurry storage can be used
  - Grid connection cost is minimal
  - Electricity is used to offset purchased power
  - Heat is used to offset purchased oil
  - Oil price goes back up
  - Enhanced incentives for this type of project?

Biomass

- Medium scale biomass heating installations are still a viable option but further RHI reductions likely.
- Efficient well designed systems critical.
- Changes proposed from next year will remove the tariff bands and introduce tiering for all scales of installation.

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Biomass CHP

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- Viable where there is an on-site demand for heat and power

- 1.8 ROC/MWh for electricity produced
  - Ending March 2017
  - No proposal to include Biomass CHP within the FIT
  - CfD likely to be dominated by wind

- RHI for heat used
  - Proposal to tier from next year

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Storage

- Storage technology expensive although costs are falling
- On-site storage of intermittent generation for export to grid via constrained connection.
  - Unlikely to add up due to increased costs and poorer efficiency than unconstrained site unless a premium can be obtained for time of supply.
- On-site storage of intermittent generation for on-site usage.
  - More likely to become viable as storage equipment price drops.

40 kWh Battery
When fully charged will supply:
10 kW for 4 hours or
5 kW for 8 hours

Storage with PV

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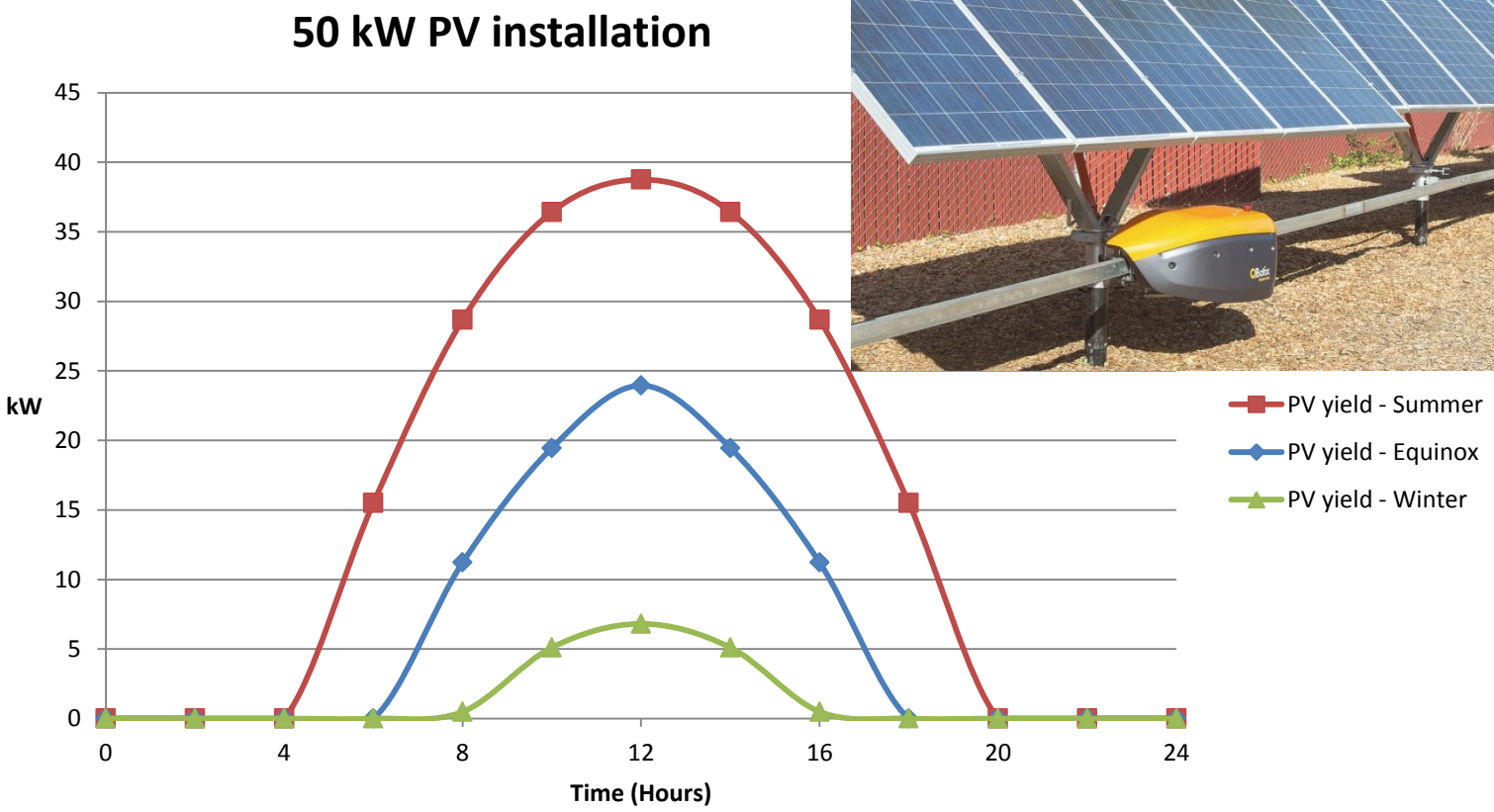

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Yield/demand profiles

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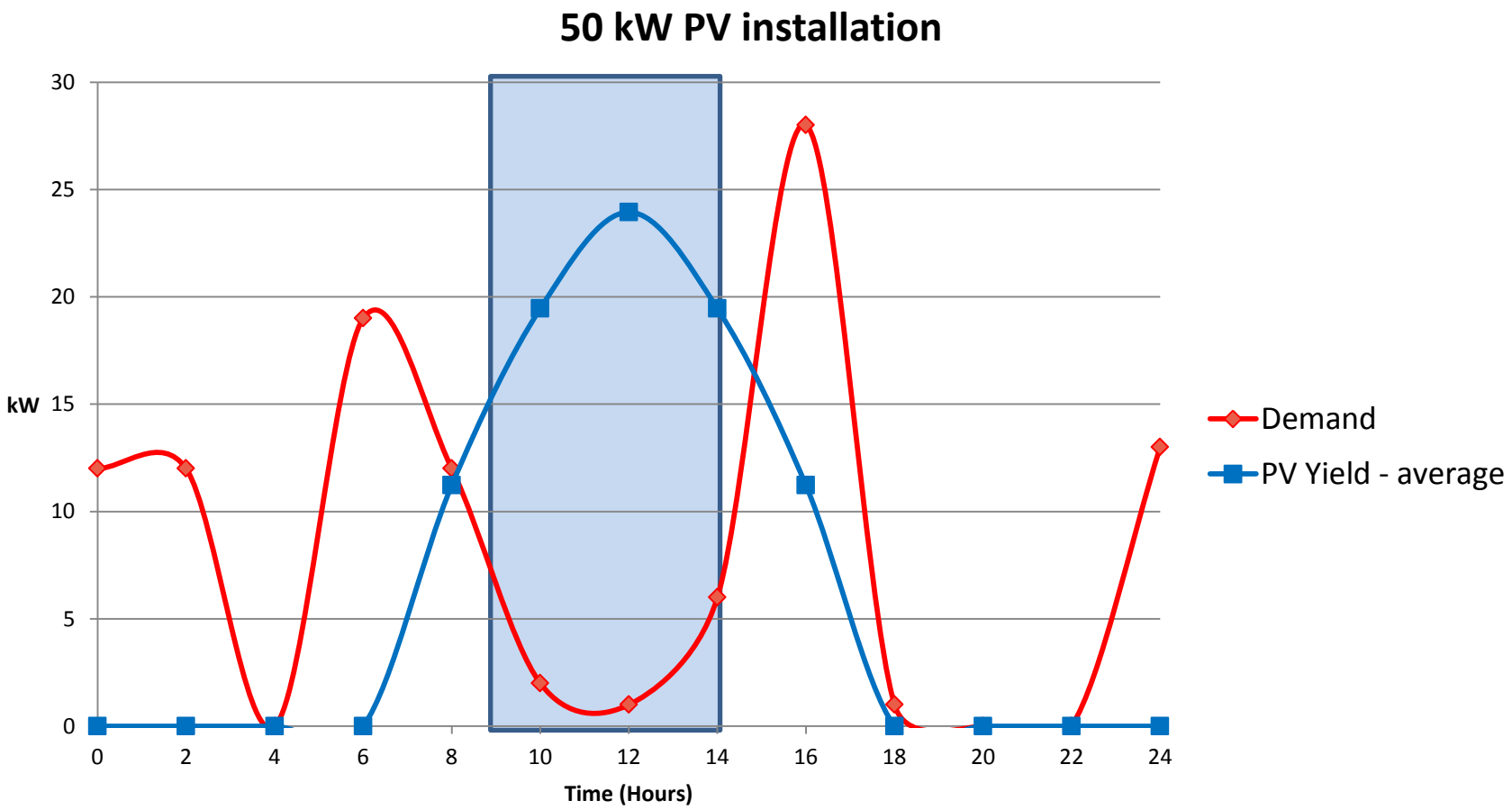

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Solar PV with storage

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Annual Average

• Average daily production from 50 kWp PV array	112 kWh
• Direct usage	37 kWh
• Export or available to store	75 kWh

May Average

• Average daily production from 50 kWp PV array	188 kWh
• Direct usage	25 kWh
• Export or available to store	163 kWh

• Current cost of storage for 100 kWh	£30,000
• Saving on an average day	£5.31
• Annual saving (needs to be confirmed with on site data)	£1940

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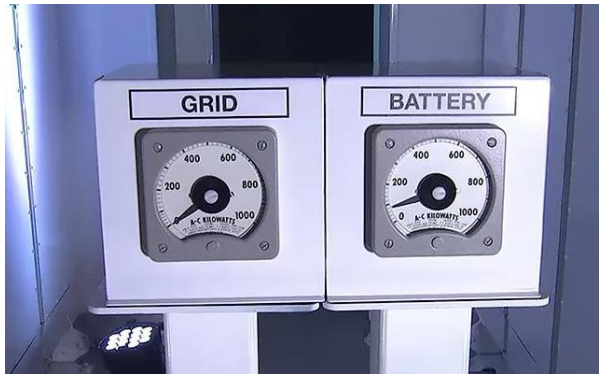
Battery storage



- Could be viable if;
- Energy price goes up
- Storage costs go down
- Energy profile at site maximises benefit of storage
- Used to avoid high peak time charges
- Emergency back up
- Short term demand response required

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Hydrogen production

- Hydrogen production by electrolysis
  - Can be stored on site or fed into the gas grid as storage for later conversion back to electricity or to provide carbon neutral gas
  - Can be used as a transport fuel in cars, buses, ferries and tractors?
    - Fuel cells can turn hydrogen back to electricity
    - or internal combustion engines running on hydrogen can be used

Picture courtesy of New Holland

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Green Hydrogen

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- Green H_2 market is currently limited but there is scope to develop
- Hydrogen production needs to be planned along with hydrogen uses
- Most promising initial market
  - Transport fuel (Taxed)
  - Large public and private sector organisations with Carbon reduction commitment (CRC)
- Vertical integration of the supply chain is required
- Production of fertilizer from green H_2 has potential to hugely reduce carbon inputs to agriculture

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Local demands

Opportunities exist to maximise the value of energy produced by supplying heat or power to third parties local to farm businesses e.g.

- Water treatment and sewerage works
- Public buildings
- Hotels
- Commercial properties
- Food processing businesses

Savings for the third party and increased income for the generator.

Integration with existing supplies needs careful consideration and close cooperation but mutual benefits are possible.

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Efficiency and demand management

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- Opportunities to increase the value of renewable generation by better integration with farm businesses exist
- Improving the efficiency of equipment and operations can allow a higher proportion of on-site demand to be met from renewables or leave more energy for export.
- Manage heating, cooling and processing operations to utilise wind or solar energy when it is available.
- Some operations can be easily automated to maximise the use of renewables, manual intervention will be required for others.

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Electric vehicles are coming!

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Jaguar I-PACE
0 – 60 mph in 4 seconds
310 miles range

Rapid charge point
80% charge in 30 mins

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Conclusion

- *Be aware of your energy costs*
- *Be aware of your renewable assets*
- *Use energy as efficiently as possible*
- *Add value to renewable generation where possible*
- *Be aware of developments in the energy industry including new business models*
- *Think long term*

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Want more information?

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Or via your local SAC Consulting office.

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Thank You

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