Guernsey Energy Analysis and Strategy Recommendations
in co-operation with the Guernsey Renewable Energy Team
Quality of Life

Motivation

**Threats**
- Imported Energy
- Energy Security
- Soaring Prices
- Climate Change

**Opportunities**
- Renewable Energy Resources
- Self-Sustaining
- Low Carbon
- Role Model
Contents

• Tidal
• Offshore Wind
• Onshore Wind
• Solar PV
• Electric Transportation
• Energy Storage

• Environmental Scoping
• Heating & Energy Efficiency
• Policy, Legislation, Regulation & Licensing
• Economic Modelling
• Energy Strategy
RE | 2013 | Tidal

**Presented by:** Graeme Steer

**Research Team:** Lyndon Smith – Ryan Pascoe – Graeme Steer
Opportunity

- One of the largest tidal ranges in the World
- Very high tidal stream flow rates
- Innovative synergy between tidal resources and sea defences
Scope

• Update on tidal technologies
  – Range
  – Stream

• Hypothetical examples and indicative financial analysis of tidal range solutions
Tidal - Update

- Geo Tubes will significantly reduce tidal range costs
- Tidal stream – steep learning curve reducing capital costs
- SeaGen and MeyGen - £20m from UK Government
- MeyGen – one step further towards an array in Gills Bay, Scotland
Tidal - Stream Devices

- **OpenHydro**
  - Planned for Brittany

- **SeaGen**
  - Strangford Lough since 2008 and a planned 10,000kW array at Skerries

- **Andritz Hydro Hammerfest**
  - 17000 operating hours and planned 10,000kW array

(Openhydro, 2013) (Siemens, 2013) (Andritz, 2013)
Tidal - Schemes

- Proposed site at Swansea UK (2017)
- 9 km wall, 9.2 square km area
- 240,000kW install £650m
- 400,000,000kWh anticipated
- Levelised Cost of electricity ~15p/kWh
- Correlates well with Technology Innovation Needs Assessment report (TINA)
Cost Reduction

TINA predicted impact of innovation on levelised costs of tidal deployments

[Graph showing levelised cost (€/MWh) vs. Global deployment (GW) with three scenarios: successful completion of proving stages, no cost reduction; successful completion of proving stages, then 'learning by doing'; successful completion of proving stages, then accelerated cost reduction (medium learning rates). The year 2018 is highlighted on the graph.]
Tidal Range Schemes – Cobo Bay

- 10.5km wall length
- 8,100,000m$^2$ area with 1100m$^3$/s volumetric flow rate
- 4.5p/kWh generates £1,900,000 per annum
Tidal Range Schemes – Cobo Bay

NEVER PAYS BACK!
Tidal Range Schemes – Havelet Bay

• 2.8km wall length

• 450,000m² with a volumetric flow rate of 62.5m³/s (surface area equal to La Rance with 3125m³/s flow rate)

• 4.5p/kWh generates £105,300 per annum
Tidal Range Schemes – Havelet Bay

NEVER PAYS BACK!
Tidal Range Schemes – Beaucette Marina

• Area 14,400m$^2$ volumetric flow rate of 2m$^3$/s
• Earns £3,375 per annum
• Lock gates alone £55,000
Tidal Range Schemes – Beaucette Marina

Lock gates 2 pairs: £55,000
Tidal Range Schemes – Victoria Marina

- Area 16,000m$^2$ and flow rate of 1.85m$^3$/s
- Earning £650/year
- Generation only during winter months
Tidal Range Schemes – Victoria Marina

- Currently, passive tidal energy prevents siltation by flushing the marina.
- Restricting the out-going tide will cause the silt to build up which may necessitate costly dredging.
Tidal - Fences and Reefs

• Investigation into suitability for sea defence application revealed that there is no evidence to suggest that tidal fences can contribute to sea defence strategy.

• Currently no direct testing of devices for this application.

• Tidal reefs have the potential to offer protection in a specific configuration state (generation not possible in this state).
Summary

• Update on technologies

• Explored hypothetical tidal range solutions
  – Cobo Bay
  – Havlet Bay
  – Beaucette Marina
  – Victoria Marina

• Considered synergies with sea defences
Conclusions

- Excellent tidal stream resource
- Areas with no slack water can give constant generation – more research
- Tidal stream costs estimated at 14p/kWh in 2018 (TINA)
- Insufficient area for tidal range so not economic
- Potential environmental impacts on fisheries, siltation, sewage outflows, navigation and amenity
- More research into sea defence synergies, environmental baselines
Presented by: Adam Campkin

Research Team: Andrew Foulkes – Thierry Reid – Istvan Nagy – Chris Barrel – Chris Smith – Adam Campkin
Opportunity

• Significant offshore wind resource
• Rapidly decreasing costs and increasing experience
• Promising 30MW and 100MW offshore wind sites already identified
Scope

• Further the study and reduce risk
  – Further analysis of wind data
  – Consultation with key stakeholders
  – Detailed and projected costs to 2020
  – Analysis of value
  – Finance options
Wind Resource Analysis

Seasonal variation 2011 - 2013: Chouet Met Mast
Average Wind Speed: 9.4 m/s @100m

Probability distribution: Chouet 100m
Probability

Average Windspeed (m/s)
Turbine Selection & Output

• Enercon E126 7.5MW
  – 100m tower
  – 9.4 m/s average wind speed

• 30 MW (4 turbines)
  – Output 115 GWh/y
  – Approximately 25% Guernsey's annual demand

• 105 MW (14 Turbines)
  – Output 401 GWh/y
  – Approximately 100% Guernsey's annual demand

(SeaJacks, 2013)
Business Case

Top down and bottom up considered

- **Bottom-up approach**
- Due to remarkable investment efforts high accuracy of investments cost required
- CAPEX estimation tool based on Dicorate et al (2011) general financial model
- Accurate estimates by providing a set of basic parameters of site & key technical features of the subsystems
- Based on average sea depth of proposed sites, number, rotor diameter, hub-height and rating of turbines

Projected Total CAPEX

\[
\begin{align*}
30 \text{ MW} & = £66M \\
105 \text{ MW} & = £229M
\end{align*}
\]

higher precision of estimates can achieved with more technical parameters
CAPEX Projections

- CAPEX costs expected to decrease by 39% by 2020 (Crown Estates, 2012)
- The trend was then projected forward to 2030

<table>
<thead>
<tr>
<th>Case</th>
<th>Capacity (MW)</th>
<th>CAPEX (£M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE Higher Case</td>
<td>30</td>
<td>£69.3M</td>
</tr>
<tr>
<td>Mid Case</td>
<td>105</td>
<td>£242.6M</td>
</tr>
</tbody>
</table>

CAPEX (Mid Case)

- CAPEX costs expected to decrease by 39% by 2020 (Crown Estates, 2012)
- The trend was then projected forward to 2030
• OPEX costs expected to decrease by 39% by 2020 (Crown Estates, 2012)
• The trend was then projected forward to 2030

OPEX (MID Case)
30 MW = £57.6M
105 MW = £201.6M
Project Payback

- GEL debt funded Scenario pays back quicker
- Due to displacement of oil fired generation
Finance Terminology

• Net Present Value ("NPV")
  – Models the time value of money using a ‘discount rate’

• Internal Rate of Return ("IRR")
  – The discount rate at which the Net Present Value is zero
  – Indicates the rate at which investment is paid back
Project Returns

- If Guernsey wants to attract private investment there is a need for some form of subsidy

<table>
<thead>
<tr>
<th>Case</th>
<th>IRR (GEL finance)</th>
<th>IRR (Private Finance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 MW</td>
<td>5 %</td>
<td>-3.05 %</td>
</tr>
<tr>
<td>105 MW</td>
<td>5.1 %</td>
<td>-3 %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Case</th>
<th>NPV (GEL finance)</th>
<th>NPV (Private Finance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 MW</td>
<td>£45.6M</td>
<td>-£22.1M</td>
</tr>
<tr>
<td>105 MW</td>
<td>£162M</td>
<td>-£75.7M</td>
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</tbody>
</table>
Effect on Tariff’s – No Jump in French Energy Prices

- Imported French electricity inflates at steady rate of 5%
- Positive NPV = no negative effects on tariffs.
- Negative NPV = need for costs to be socialised
Effect on Tariff’s – Jump in French Energy Prices

- Sharp increase in imported French electricity due to Nuclear decommissioning
- Positive NPV = no negative effects on tariffs.
- Negative NPV = need for costs to be socialised

**Chart Notes:**
- NPV in £ Million
- Cases: Worst, Mid, Best
- Imports: diesel

**Cases:**
- 20:80
- 50:50
- 80:20
Finance Options

• Currently perceived as risky

• Limits finance sources to
  • Original Equipment Manufacturers
  • Utilities
  • Offshore construction companies (PwC, 2012)

• Investors seeking
  – PPA
  – Support mechanism
Summary

• Fantastic wind resource
• Refined constraint mapping
• Investigated costs
• Calculated the project values
• Explored financing options
Conclusions

• Chouet Met mast is a valuable and relatively low cost asset
  – planning permission should be extended beyond October 2013

• Need for detailed consultation with the Guernsey airport to negotiate radar mitigation
  – Other stakeholders are also important

• Deploy offshore met mast or floating LIDAR to accurately record onsite wind speeds
Presented by: Emma Gerrard

Research Team: Joe Moon – Craig Siddons – Emma Gerrard
Opportunity

- Fantastic wind resource
- Mature and relatively low cost technology
Scope

- Feasible options within constraints
- Enhance the public perception and acceptability of wind and other renewable energy technology
Wind Resource

- Average wind speed = 6.3 – 7.2 m/s 10m above ground level
- South West prevailing wind

Source: (Guernsey Met Office, 2013)
Constraint Mapping

Legend

- Prospective Sites
- Site of Nature Conservation Interest
- Buildings (173m buffer)
- Roads
- Water Bodies

UNIVERSITY OF EXETER

0  3,000
metres
### Specification Sheet

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model</strong></td>
<td>ACSA A27</td>
</tr>
<tr>
<td><strong>Max. Power</strong></td>
<td>225 kW</td>
</tr>
<tr>
<td><strong>Hub Height</strong></td>
<td>30 m</td>
</tr>
<tr>
<td><strong>Tip Height</strong></td>
<td>43.5 m</td>
</tr>
<tr>
<td><strong>Annual Yield @ 8.4 m/s</strong></td>
<td>872 MWh/year</td>
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<tr>
<td><strong>Annual Carbon Savings</strong></td>
<td>495 Tonnes</td>
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<tr>
<td><strong>Noise</strong></td>
<td>44.6 dBA at 5 m/s and 100 m</td>
</tr>
<tr>
<td><strong>Method of installation</strong></td>
<td>Crane</td>
</tr>
</tbody>
</table>

Source: (ACSA, 2011)
Turbine scale is the best representation of the real world given the data constraints. Actual visuals may differ from that shown.
# Chouet – Micro Wind

<table>
<thead>
<tr>
<th>Specification Sheet</th>
<th>Option 1</th>
<th>Option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>C&amp;F 50e</td>
<td>C&amp;F 20</td>
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<tr>
<td>Max. Power</td>
<td>50 kW</td>
<td>20 kW</td>
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<tr>
<td>Hub Height</td>
<td>25 m</td>
<td>20 m</td>
</tr>
<tr>
<td>Tip Height</td>
<td>35 m</td>
<td>26.6 m</td>
</tr>
<tr>
<td>Annual Yield @ 8 m/s</td>
<td>228 MWh/year</td>
<td>93 MWh/year</td>
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<tr>
<td>Annual Carbon Savings</td>
<td>135 Tonnes</td>
<td>56 Tonnes</td>
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<tr>
<td>Noise</td>
<td>37 dBA at 5 m/s and 60m</td>
<td>35 dBA at 5 m/s and 60m</td>
</tr>
<tr>
<td>Method of installation</td>
<td>Crane</td>
<td>Hydraulic Tilt Installation</td>
</tr>
</tbody>
</table>

Source: (C&F, 2012)
Turbine scale is the best representation of the real world given the data constraints. Actual visuals may differ from that shown.
## Economic Analysis

<table>
<thead>
<tr>
<th></th>
<th>225kW</th>
<th>50kW</th>
<th>20kW</th>
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</thead>
<tbody>
<tr>
<td>Model</td>
<td>ASCA A27</td>
<td>C&amp;F 50e</td>
<td>C&amp;F 20</td>
</tr>
<tr>
<td>Capex</td>
<td>£1,000,000</td>
<td>£280,000</td>
<td>£120,000</td>
</tr>
<tr>
<td>IRR</td>
<td>8%</td>
<td>7%</td>
<td>7%</td>
</tr>
<tr>
<td>NPV @ 7.5%</td>
<td>£39,335</td>
<td>-£9,136</td>
<td>-£10,029</td>
</tr>
</tbody>
</table>

Source: (ACSA, 2011)
Source: (C&F 2012)
South Coast – Micro Wind
Educational and Community Projects

Falmouth School

- 6.1m tip height
- 7.7MWh/year
- 3 tonnes CO₂/year
- Student led
- Live display board

- Community involvement
- Awareness of renewable energy
- Educational tool
- Small vertical axis turbines

Source: (Falmouth Packet, 2009)
Further Opportunities

- Street lighting
- Car parking facilities
- Awareness of renewable energy technologies

Source: (UGE, 2012)
Summary

• Used GIS to map constraints of onshore wind

• Identified 5 potential sites with a range of options for the integration of wind technologies

• Chouet has potential to be the most viable site

• Enhancement of demonstration and educational projects
Conclusion

• A 225kW wind turbine at Chouet best economic returns
• Micro wind for community and educational facilities
• Restrictive current planning regulations
• New proposals due in 2015 could drive change
RE | 2013 | Solar Photovoltaics

Presented by: Paul Hardman
Opportunities

- 16% higher solar irradiation than London
- 4.15 kWh/m²/day
- Contributes to security of supply
Solar PV in Guernsey can be split up into 3 main sections:

- Residential
- Commercial
- Macro
Balance of System

PV System

BoS

[Images of solar panels, wires, inverters,支架s, and a person working on a roof with solar panels]
Residential

- Low demand for residential systems
- 4kW system
  - 25 year payback and negligible return
- No incentives other than 9.89p/kWh export rate
  - If replaced with UK FiT: 10-year payback and £8k NPV
- Planning for PV needs review
Commercial – GIS Analysis

- Potential is difficult to define accurately
- Average commercial system size estimated as 34.5kWp
## Commercial

<table>
<thead>
<tr>
<th>% of Commercial Buildings Identified</th>
<th>Number of Buildings</th>
<th>Total Power</th>
<th>Total energy p.a.</th>
<th>% of Total Electricity Demand</th>
<th>% of Commercial Electricity Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>23</td>
<td>780 kW</td>
<td>850 MWh</td>
<td>0.2%</td>
<td>0.4%</td>
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<tr>
<td>50%</td>
<td>114</td>
<td>3,900 kW</td>
<td>4,250 MWh</td>
<td>1.2%</td>
<td>2.2%</td>
</tr>
<tr>
<td>100%</td>
<td>227</td>
<td>7,800 kW</td>
<td>8,500 MWh</td>
<td>2.4%</td>
<td>4.3%</td>
</tr>
</tbody>
</table>

- Small but not insignificant
- Glasshouses - change of land use policies
  - Other uses could be more lucrative than PV
- Best when user consumes all generation output
- Landlords are a target area but have no incentives
Commercial Case Study – Raymond Falla House

- 7kWp system for the RET building will complement the energy efficiency and heating scheme
- 28 panels with an annual output of 7600kWh
- Good returns when coupled with heat pump
500kW Macro Case Study – Guernsey Airport

- Ideal location
  - Large area without changing land use
  - High electricity demand
  - PR opportunity

- System design
  - Spatial constraints
  - Glint and glare
  - Modular
500kW Macro Case Study – Guernsey Airport

- Output
  - 20% of airport consumption
  - Savings of £71,500 per year

- Cash flow – £683,000 Capex
  - 7.5% discount rate
  - Payback: 25 years
  - NPV: £2,500
  - Not advisable unless costs reduced
500kW Macro Case Study – Guernsey Airport

- **Recommendations**
  - BoS costs – key variable, easily reduced
  - With 36% reduction on BoS
    - 15-year payback
    - £550,000 Capex
Summary

• Residential, commercial and macro
• Evaluate barriers
• System design
  • Raymond Falla
  • Airport
Conclusions

• Public awareness, education
• Planning and legislation
• Lack of PV incentives
• Installation costs
  • If subsidy to be avoided, BoS needs to be reduced
  • Potential for new industry and job creation
Electrification of Transport

Presented by: George King
Research Team: Shawn Brown - Anthony Vickers – George King
Opportunity

“Ideal situation for electrified transport”

• Identify barriers to electric vehicle deployment

• Highlight ways in which these can be overcome

• Present a methodology to ensure the success of electric vehicles in Guernsey
Drivers for Change - Efficiency

80-95%

20-25%

Source: (POST, 2010)
Drivers for Change – Fuel Security

34 Vehicles

40,106 Vehicles

Source: (Environment Department, 2011)
Drivers for Change - Emissions

Road Transport GHG Emissions per Unit Area - Comparison of Guernsey with EU States

Source: European Commission, 2012; States of Guernsey, 2012
Drivers for Change - Society

States of Guernsey consultation major public concerns:

- Vehicle Numbers
- Vehicle Size
- Congestion

Source: Environment Department, 2013
Infrastructure

- Energy Mix
- Electrical Grid
- Vehicle Supply
- Charging Points

Source: Nissan, 2013; smart, 2013
Key Barriers

- Capital Cost
- Perceived Performance
- Grid Upgrades

Source: Dragon Electric Vehicles, 2012
Proposed Policy Mechanisms

• Capital incentives for EVs
• Subsidised domestic fast chargers and commercial charging points
• Government procurement of electric and plug-in hybrid vehicles
• Congestion zones with preferential access for EVs and small vehicles
• Subsidised on-demand vehicle hire for EV owners
• Reintroduction of banded vehicle excise duty
• Preferential parking for EVs
Fuel Credit Scheme

Distribution of Fuel Credits

Acceptable Fuel Threshold Set

Alternative Scheme

Driver Type

Public Services

Scheme Exemption

Private Drivers

Taxis/Commercial

Surplus Fuel Credits Sold

Monthly Fuel Usage

Below Threshold

Within Threshold

No Impact

Above Threshold

Purchase of Additional Fuel Credits Required

Penalty Credit Purchases Provide Revenue Stream
Case Study – smart vs smart electric

Comparison of Lifetime Cost of Ownership between Petrol and Electric smart with Current Transport Policy

Source: smart, 2013
Case Study – smart vs smart electric

Comparison of Lifetime Cost of Ownership between Petrol and Electric smart with Proposed Policy Mechanisms

Source: smart, 2013
Conclusions

- Further work to establish emissions levels
- Researched transport issues
- Undertook stakeholder consultation
- Consideration of EV perception
- Determined EV supply and infrastructure
- Compiled informed EV policy framework
- Developed key case studies
- Delivery of an all-encompassing strategy
- Incentivise car hire companies to provide EVs
- Re-introduce vehicle excise duty
- Establish a credit-based fuel trading scheme
- Introduce a capital grant scheme for EVs
- Decarbonise electricity mix and reduce imports
- Address the barrier of perceived performance
- Introduce a high efficiency diesel car pool
- Priority parking for EVs in urban areas
RE 2013 | Energy Storage

Presented by: Will Sandall

Research Team: Marcus Lynch – Guilherme Schmitz – Will Sandall
Opportunity

• Renewable energy can be intermittent – increase penetration

• Reduced infrastructure costs for excess generation and distribution capacity

• More flexible, reliable grid
Scope

- Evaluate the technologies currently available
- Consider unexplored potential
- Future trends
How does Energy Storage work?

Guernsey Electricity Demand

Source: Guernsey Electricity Ltd
Energy storage applications

Large-scale applications:
- Bulk storage and load levelling

Small-scale applications:
- Frequency and voltage regulation
- Distributed storage
- Renewables integration
Important Characteristics

- Energy capacity and density
- Charge and discharge rates – determine power
- Round-trip efficiency
- Cost
- Impacts – environmental and social
Main technologies covered

- Pumped hydroelectricity storage (PHS)
- Cryogenic Energy Storage (CES)
- Vanadium Flow Batteries
- Electric Car batteries
- Hydrogen solutions
Pumped Hydroelectricity - Overview

• Most mature technology

• Accounts for 99% of bulk storage worldwide

• Only large scale commercial ES method available

• Fast Response ~ 10 seconds to full power

• Capital Cost: £ 2,000-£3,000/kW
Pumped Hydroelectricity - Basic Operation

- Water pumped to upper reservoir using excess electricity
- Water can be released back through turbine to generate
Pumped Hydroelectricity - Potential Sites

Site 1 and 2
• Possible 0.7 MW and 1 MW capacity

Site 3
• Possible 0.15 MW capacity

TOTAL: 1MW-2MW
Energy Storage: ~15MWh
Cryogenic Energy Storage (CES)

- Nitrogen cooled and expanded through conventional turbines
- Reliable, easy to maintain and integrates with existing infrastructure
- Currently 300kW demonstration plant, multi-MW plants in development
Vanadium Flow Batteries – Technical Performance

- Highly scalable – tank volume / stack size
- Several commercial demonstration and pilot plants from kW to MW scale
- Fast response time (<0.001 seconds)
- 70-80% efficient
- Capital cost indicated: £2,200+/kW

(Pacific Ore, 2012)
Vanadium Flow Batteries – Applications for Guernsey

- Uninterrupted Power Supply for vital services i.e. Princess Elizabeth Hospital
- Output leveling for onshore wind and commercial PV
- RED-T collaboration with Guernsey based wind turbine manufacturer Kessel Ltd
Electric car battery storage

• Ideal for Guernsey – high availability of cars with short driving distances

• 6000 cars = 10MW of capacity

• 150MWh = 14.4 hours of supply

• Capital cost distributed between car owners

• Smart grid still required for charging
Hydrogen Solutions

- Hydrogen produced from water in PEM electrolyser
- Clean and abundant – used in fuel cells or for creating synthetic fuels
- Opportunity to integrate with heating, transport and electricity sectors
- Many technical issues – long term solution
Summary

• Limitations and opportunities for:
  – Pumped hydroelectricity
  – Cryogenic Energy Storage
  – Vanadium flow batteries
  – Electric car battery
  – Hydrogen solutions

• Timescales for deployment
Conclusions

• Possible small scale solution with pumped hydro
  – South coast
  – Requires studies in public opinion and environmental impact

• Follow advances in the technologies outlined
  – Potential for GEL to link with CES and VRB developers
RE | 2013 | Environmental Scoping

Presented by: Charlie Baker

Research Team: Ioanna Stavridi – Max Fenn – Matt Pitman – Charlie Baker
Opportunity

- Establish baselines before any development takes place
- Protect the visual amenity so highly valued by Guernsey
Scope

• Establish baseline environment
• Identify most sensitive receptors
• Recommended surveys & impact assessment
Initial Assessment

- Met with appropriate consultees
- Current environmental legislation is limited
- Carry out surveys now so that data is available for 2015 regulations

States of Guernsey
Physical Environment

- Hydrographical and hydrodynamic surveys
- Surface and ground water surveys
- Emission testing and air quality monitoring stations
Biological Environmental

- Habitat survey
- Ornithological and mammal surveys
- Ecological surveys
- Noise & vibration assessment
Human Environment

- Landscape/Seascape character assessment
- Designated site locations – desktop studies
- Traffic surveys & swept path analysis
- Identify key employment sectors and land use
- Nautical surveys
Summary

- Identified key stakeholders

- Considered a range of environments:
  - Physical
  - Biological
  - Human
Conclusions

• Consult with relevant bodies

• Human environment is main barrier

• Establish baseline environment

• Ease and enhance development process
RE 2013 | Heat & Energy Efficiency

Presented by: Jess Howell
Research Team: Matt Landick – Alec Mason – Jess Howell
Opportunities

• High fuel costs

• Energy efficiency measures reduce the demand for heating fuels

• Guernsey has the potential to generate heat from indigenous, renewable sources
Scope

• Research fuel poverty and household expenditure in Guernsey

• Identify and seek to improve the legislative, regulatory and fiscal policies in the States that influence the development of renewable heat generation and energy efficiency measures

• To investigate other resources the island possesses that could be utilised for heat generation
The Heating Fuel Mix of Guernsey

- 36% of Guernsey’s energy mix in 2011 accounted for by heating fuels
- Electricity consumption also rising due to uptake of electrical heating
- Gas has a low share due to higher cost than oils
- Extensive mains gas infrastructure in place since 19th Century

Source: States of Guernsey Policy Council
Fuel Poverty and Household Expenditure

No specific fuel poverty indicator in Guernsey

2005/6 household expenditure survey showed 3.3% of spending accounted for by fuel, light and power

Rising fuel bills increases susceptibility to becoming fuel poor
Energy Efficiency Measurement and Regulation

- No formal measure of building energy efficiency included in Guernsey law
- Building regulations based on 2002 UK standards
- UK uses Energy Performance Certificates to grade efficiency of housing stock
- Jersey commissioned heat loss map of all buildings on the island
Incentivising Energy Efficiency and Renewable Heat

• Currently no policies regarding energy efficiency and renewable heat

• Energy efficiency should be prioritised over generation technologies

• High cost efficiency measures need incentivising to boost uptake

• Government backed loan-based model (Sarnia Scheme)

Source: Isothane
Case Study: Guernsey Housing Association

- Independent social housing organisation, part-funded by the States of Guernsey
- Very thermally efficient developments with recent construction to Passivhaus standards
- Integration of solar thermal technologies and ergonomic control systems
- These measures only add ~3% to construction costs

Source: Guernsey Housing Association
Case Study: The States of Guernsey

• Raymond Falla House is the site of Guernsey Renewable Energy Team

• Heating system of main building is entirely electrical

• Installing a 30kW GSHP alongside solar PV would reduce total energy spend by ~£10,500 per year (66%) with a total payback period of 5 years

• Further energy savings could be made through improving thermal efficiency
Solid Biomass

- Guernsey produces around 9000 tonnes of wood waste per year
- Waste wood disposed of through “controlled open burning” until June 2010
- If 50% of this wood was suitable for chipping and combustion it could offset around 25% of heating oil and gas consumption

Source: FIL
Large Scale Geothermal Heating

- Comparable geology to Cornwall, UK
- Requires in-depth geological study of Guernsey to determine its potential
- Economically attractive if resource exists
- Requires a large capital investment
- Would require an extensive district heating infrastructure

Source: Geothermal Engineering
Summary

• No fuel poverty indicator
• No energy efficiency indicator
• No policies or incentives for efficiency measures or renewable heat
• Increased fuel prices lead to increased susceptibility to fuel poverty
• Certain biomass resource
• Possible geothermal resource
Conclusions

• Energy efficiency measures prioritised over generation.
• Incentives to develop energy efficiency and renewable heat industries.
• Comprehensive and future-proof building regulations to guarantee the thermal quality of new developments.
• The States of Guernsey leading by example
• Further geological assessment to examine the possibility of large-scale Geothermal heat generation.
• Resolve Guernsey’s extensive waste-wood issue by producing wood-chips for use in biomass heating systems
• Reduce dependency on imported fuels for heating and general combustion.
Policy, Legislation, Regulation & Licencing

Presented by: Richard Baker

Opportunity

• Complete flexibility regarding support mechanisms compatible with Guernsey’s economy

• Learn from experience of policy implementations elsewhere
Scope

- Marine Ordnance
- Access to EU subsidies
- Energy management incentives
Drivers

- Guernsey Economy in Flux
- Visual Impact and Land Use
- State Subsidies for Renewables Incompatible
Balanced Renewable Support

• Marine Licensing (Ordinance)

• Access to EU Renewable Energy Support Mechanisms

• Energy Management Incentives
Marine licencing

• Adoption of Legislation

• Navigation & Safety

• Experiences in Other Countries
Access to EU Subsidy: Joint Projects Eligibility

- Qualifying Generation
- Suitable Partners
Energy Efficiency Incentives

The Sarnia Scheme

- Similar concept to UK Green Deal
- Implemented by Guernsey Electricity
- Endorsement Required from OUR
- Energy Performance Banding & Landlords
Summary

• Marine licensing is the first step towards attracting renewable energy developers for offshore projects

• Access to EU support mechanisms is possible as joint projects with the UK

• Energy management opportunities for business and domestic applications at no capital cost
Conclusion

• Marine Ordinance drafting should continue, observing lessons learned in other jurisdictions

• An agreement needs to be in place between Guernsey and UK to develop a joint offshore wind project

• To enable Guernsey Electricity to facilitate the Sarnia Deal, the regulator would need to approve change of mandate
RE | 2013 | Economic Modelling

Presented by: Seb McClay
Research Team: Kate Simpson – Josh Charnley – Jie Tan – Seb McClay
Opportunity

• Brownouts: drop in voltage impact data banks ability to store data

• Potential critical impacts on financial services

• Blackouts: “30 minute power cut result in an average loss of £10,400 to medium and large industrial clients” (Allianz, 2010)
Scope

• System analysis
  – ‘N-2’ secure

• Future large scale investment options:
  – Interconnector
  – Offshore Wind
  – Solar PV
  – Diesel generator
Levelised Costs of Energy

Comparison of technologies on a cost basis

- Wind energy
- PV
- Diesel
- Connection cable

Cost of energy (p/kWh)

LCOE  Cost of electricity
Interconnector to France

• 100 MW would meet 100% of demand

• Cost between £70-100 million

• ‘Transport cost’ between 1.45p and 1.06p per kWh depending on 25 or 50 year time horizon

• Cost of electricity currently 5-6p, but likely to inflate

• Cheaper and more long term than other options
Offshore Wind: Who Pays? (1)

Changing the financing method influences the payback times

![Graph showing payback times for different financing methods.]

- Private investment
- GEL 75% debt funded
It also influences the IRR

Internal Rate of Return

Worst  Mid  Best

Private investment  GEL 75% debt funded
Offshore Wind Energy

Ideally, wind generation should displace diesel generation.
Solar Photovoltaics in Guernsey

State-owned projects:

- Value of generated electricity considered equal to the cost of the displaced electrical generation

State PV Project Cashflows

<table>
<thead>
<tr>
<th>Timeline</th>
<th>2013</th>
<th>2018</th>
<th>2023</th>
<th>2028</th>
<th>2033</th>
<th>2038</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative Cashflow (£'000)</td>
<td>-1,600</td>
<td>-1,200</td>
<td>-800</td>
<td>-400</td>
<td>0</td>
<td>400</td>
</tr>
</tbody>
</table>

- Equity
- 50%
- Debt
Solar Photovoltaics in Guernsey

Privately owned projects with FIT:
- Value of FIT found to give an attractive 8% IRR
- 8.7p/kWh needed for an equity financed project but a 50% debt financed project required 4.4p/kWh

FIT Funded Project Cashflows

<table>
<thead>
<tr>
<th>Year</th>
<th>Equity Financed</th>
<th>Debt Financed</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>-1,600</td>
<td>-1,200</td>
</tr>
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<td>2018</td>
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</tr>
<tr>
<td>2038</td>
<td>800</td>
<td>1,200</td>
</tr>
</tbody>
</table>
Solar Photovoltaics in Guernsey

Privately owned projects with soft loans:

- Value of generated electricity considered as buyback tariff with inflation
- A soft loan of 50% repayable after equity payback period

Timeline

Cumulative Cashflow (£'000)

2013 2018 2023 2028 2033 2038

-800 -400 0 400

Soft Loan PV Project Cashflows

Inflation

Inflation +1%
Summary

• System security
• Levelised costs of energy
• Financing methods
• Support mechanisms / Soft loan procurement
Conclusions

- Return on non debt-funded RES projects currently not worth the financial risk

- Subsidies reduce risk but distribute costs to limited consumers

- Incentivising uptake may require diminishing investor CAPEX through soft loans

- Successful implementation hinges on appropriate policy
RE | 2013 | Energy Strategy to 2050

Presented by: Matt Fry

Research Team: Dan Sinclair – Robin Duval – Chich Lozano – Matt Fry
Strategy – 2013 → 2020

- New Policy Mechanisms
- Energy Efficiency
- Environmental Baselines
- Fuel Credits
Strategy – 2020 → 2030

- Tidal Stream
- Offshore Wind
- Onshore Wind
- EV Incentives
- Pumped Storage
- Direct Interconnector
- Large PV
Strategy – 2030 → 2040

- Geothermal
- Vanadium Flow Batteries
Strategy – 2040 → 2050

- Smart Grid
- EV Energy Storage
- Hydrogen Technologies
RE 2013 | Closing Remarks
Thank you for listening
Questions

• Tidal
• Offshore Wind
• Onshore Wind
• Solar PV
• Electric Transportation
• Energy Storage

• Environmental Scoping
• Heating & Energy Efficiency
• Policy, Legislation, Regulation & Licencing
• Economic Modelling
• Energy Strategy to 2050