Guernsey Energy Analysis and Strategy Recommendations

in co-operation with the Guernsey Renewable Energy Team

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RE | 2013

RE | 2013 | Motivation

Motivation

Quality of Life

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 & Licencing
- 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

- GeoTubes 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

(Openhydro, 2013)

- Planned for Brittany

SeaGen

(Siemens, 2013)

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

Andritz Hydro Hammerfest

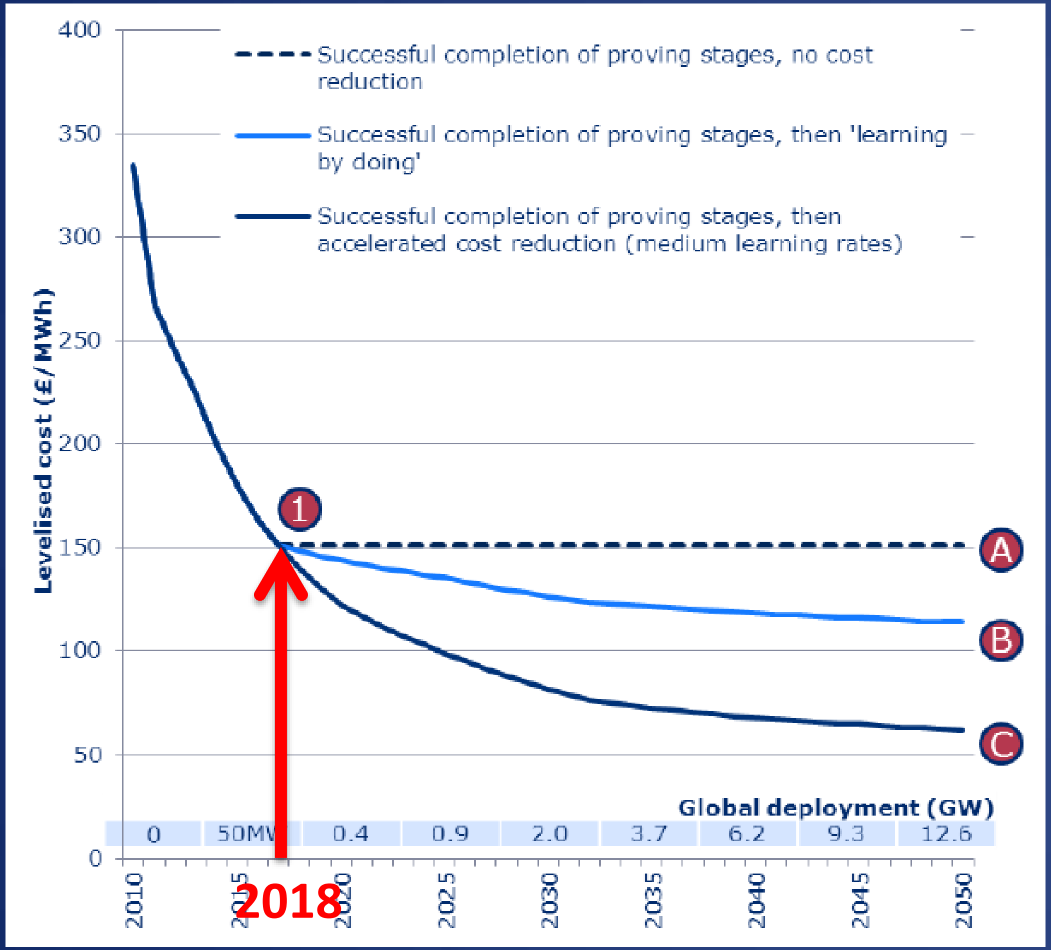
(Andritz, 2013)

- 17000 operating hours and planned 10,000kW array

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

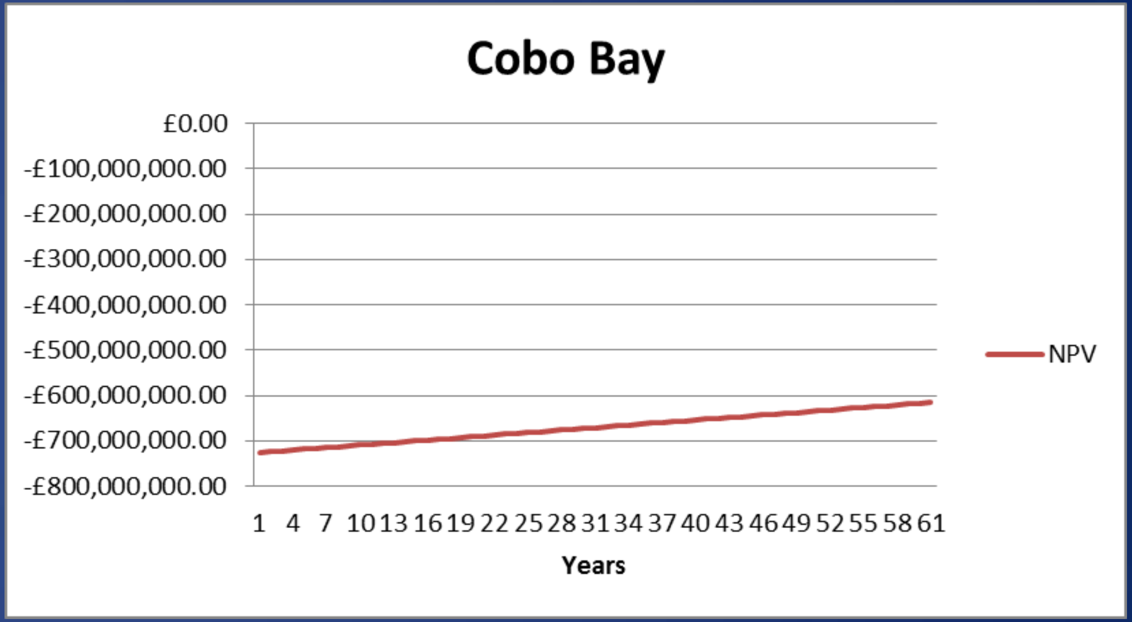


TINA predicted impact of innovation on levelised costs of tidal deployments

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

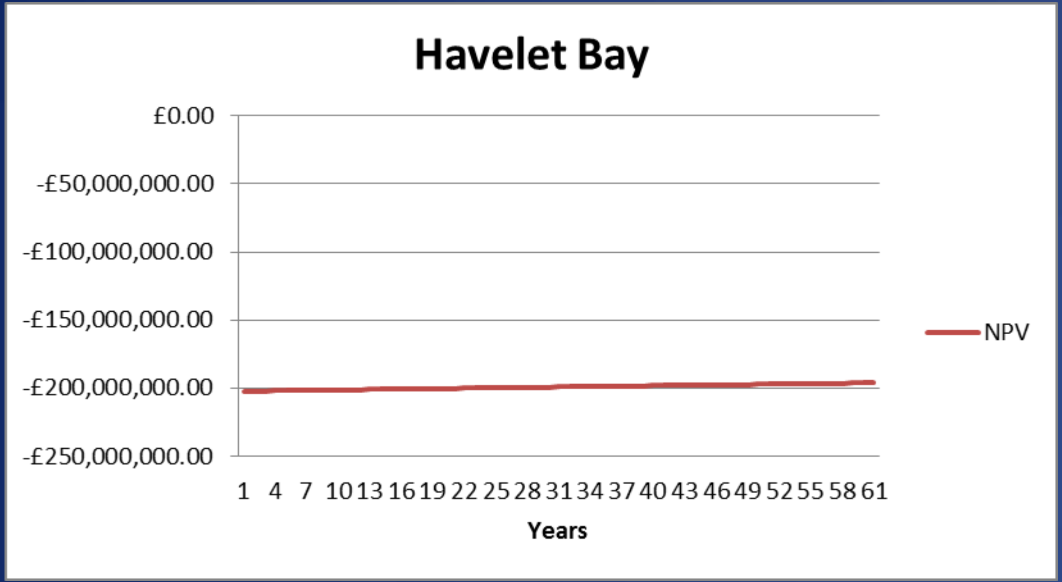


NEVER PAYS BACK!

Tidal Range Schemes – Havelet Bay

- 2.8km wall length
- 450,000m^2 with a volumetric flow rate of 62.5m^3/s (surface area equal to La Rance with 3125m^3/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

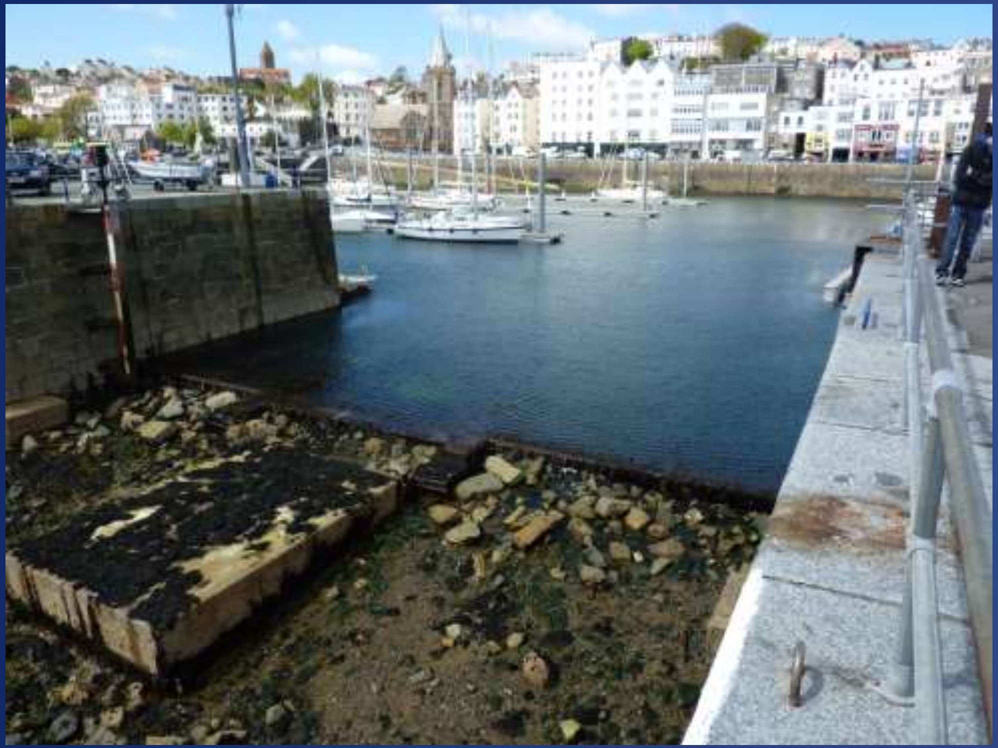
Tidal Range Schemes – Beaucette Marina

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

RE | 2013 | Offshore Wind

Presented by: Adam Campkin

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

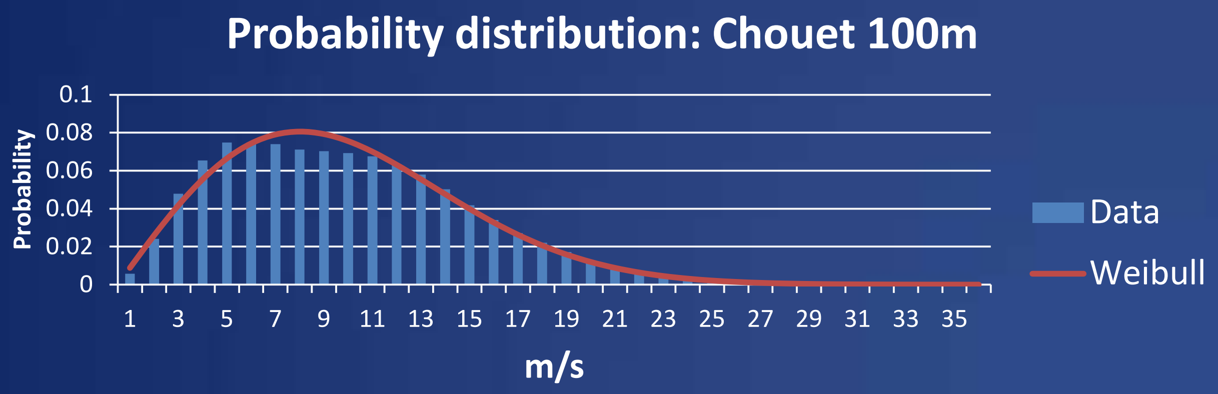
Opportunity

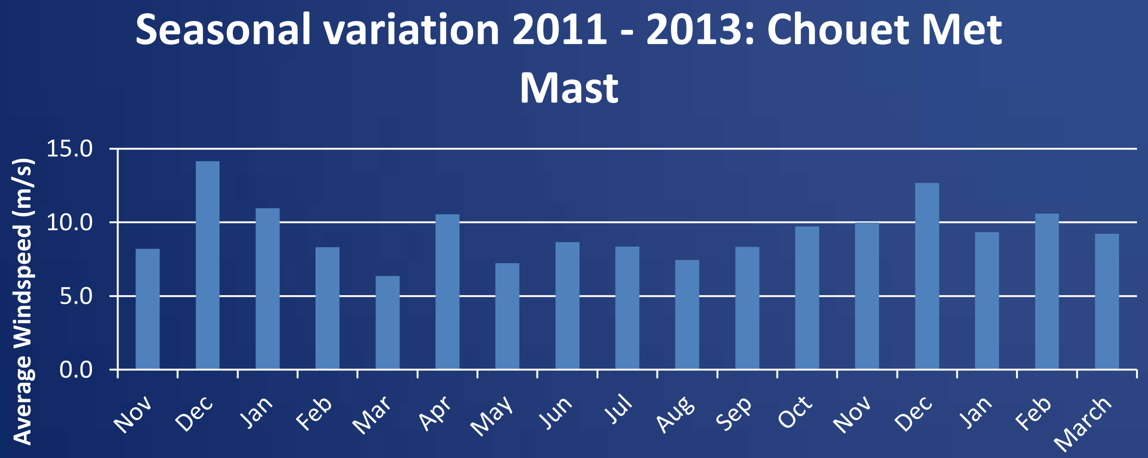
- Significant offshore wind resource
- Rapidly decreasing costs and increasing experience
- Promising 30MW and 100MW offshore wind sites already identified

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





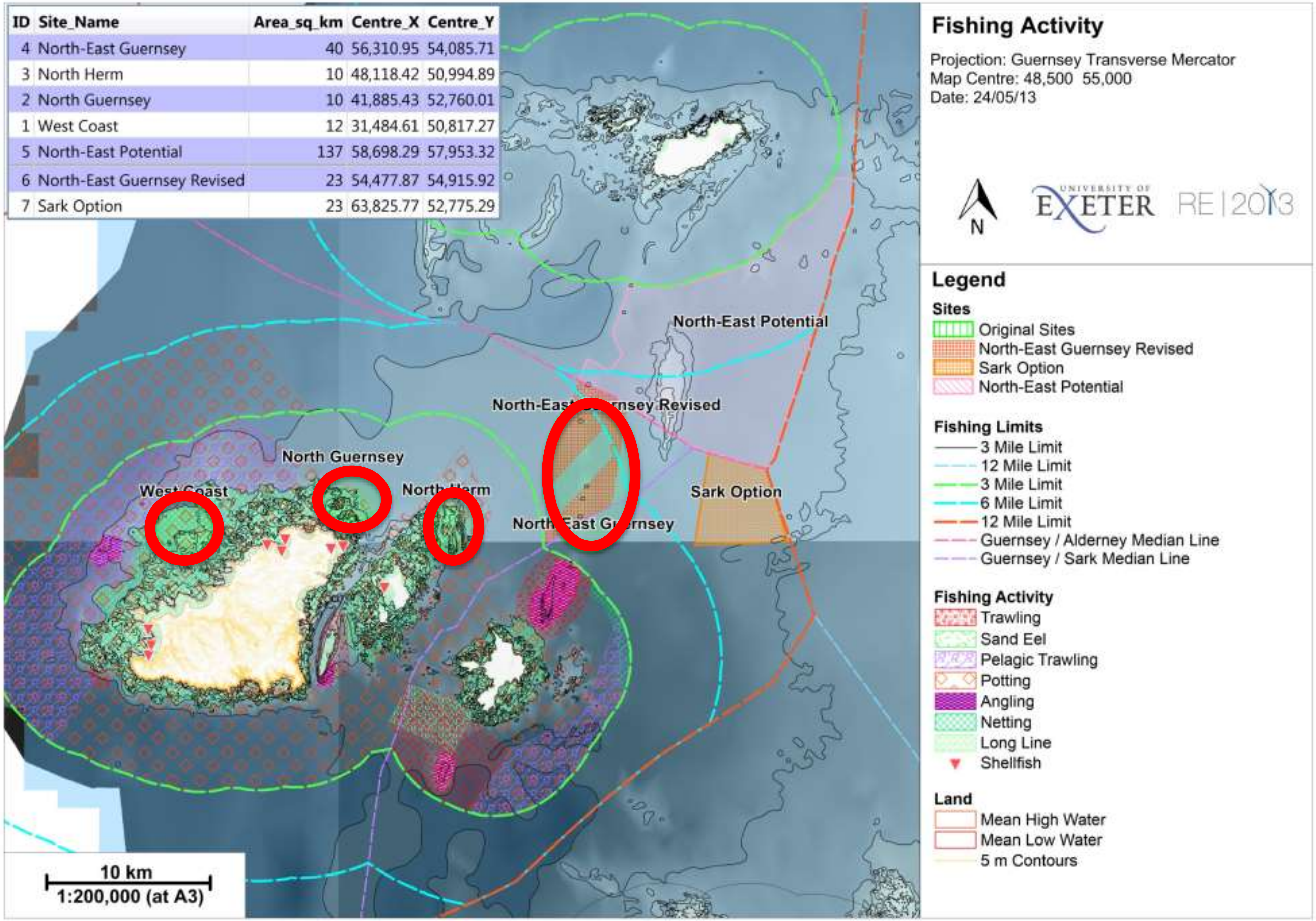
Average Wind Speed: 9.4 m/s @100m

Chouet Met Mast (Smith,2013)

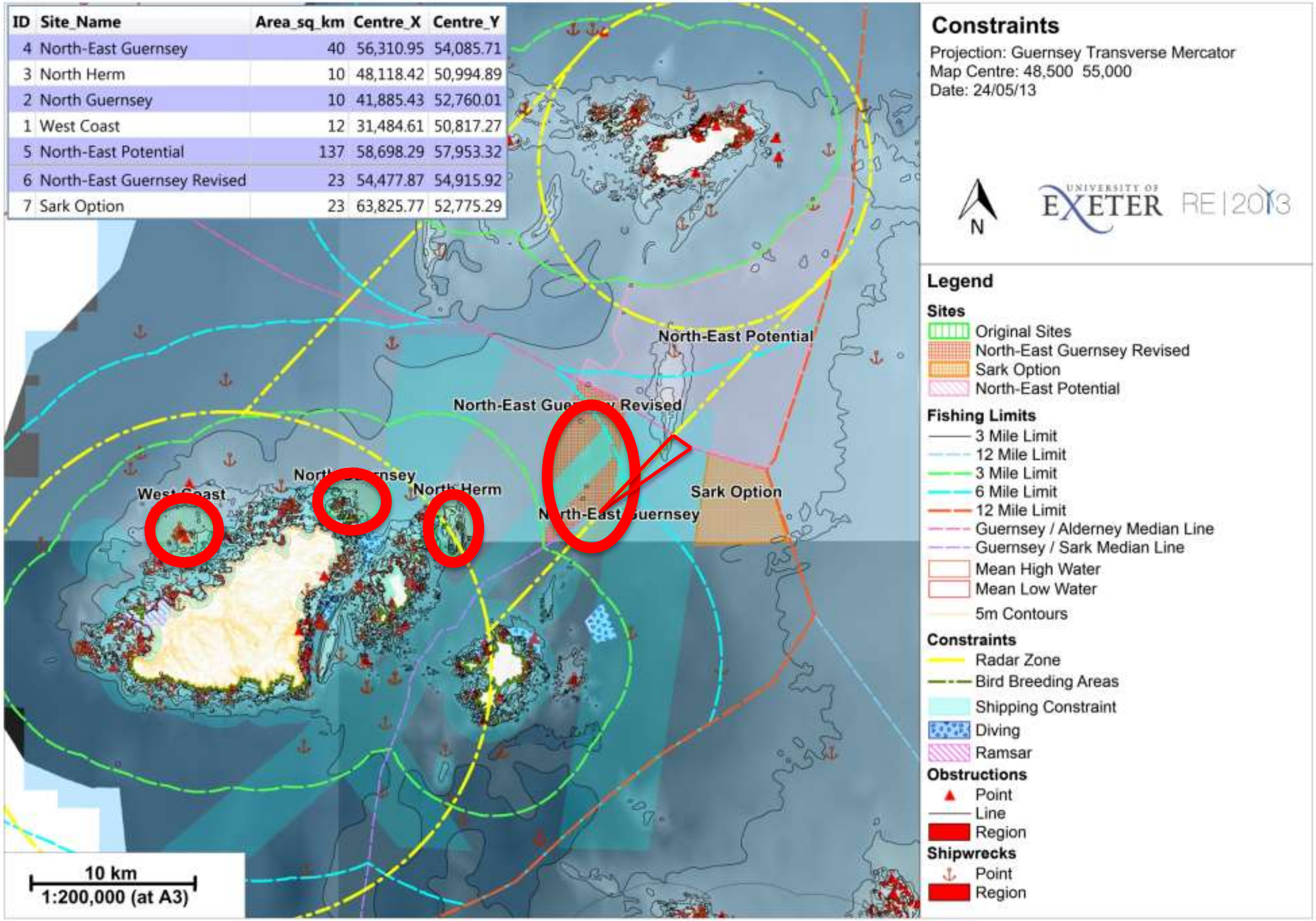
Turbine Selection & Output

- 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)



ID	Site_Name	Area_sq_km	Centre_X	Centre_Y
4	North-East Guernsey	40	56,310.95	54,085.71
3	North Herm	10	48,118.42	50,994.89
2	North Guernsey	10	41,885.43	52,760.01
1	West Coast	12	31,484.61	50,817.27
5	North-East Potential	137	58,698.29	57,953.32
6	North-East Guernsey Revised	23	54,477.87	54,915.92
7	Sark Option	23	63,825.77	52,775.29



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Business Case

Top down and bottom up considered

- **Bottom-up approach**

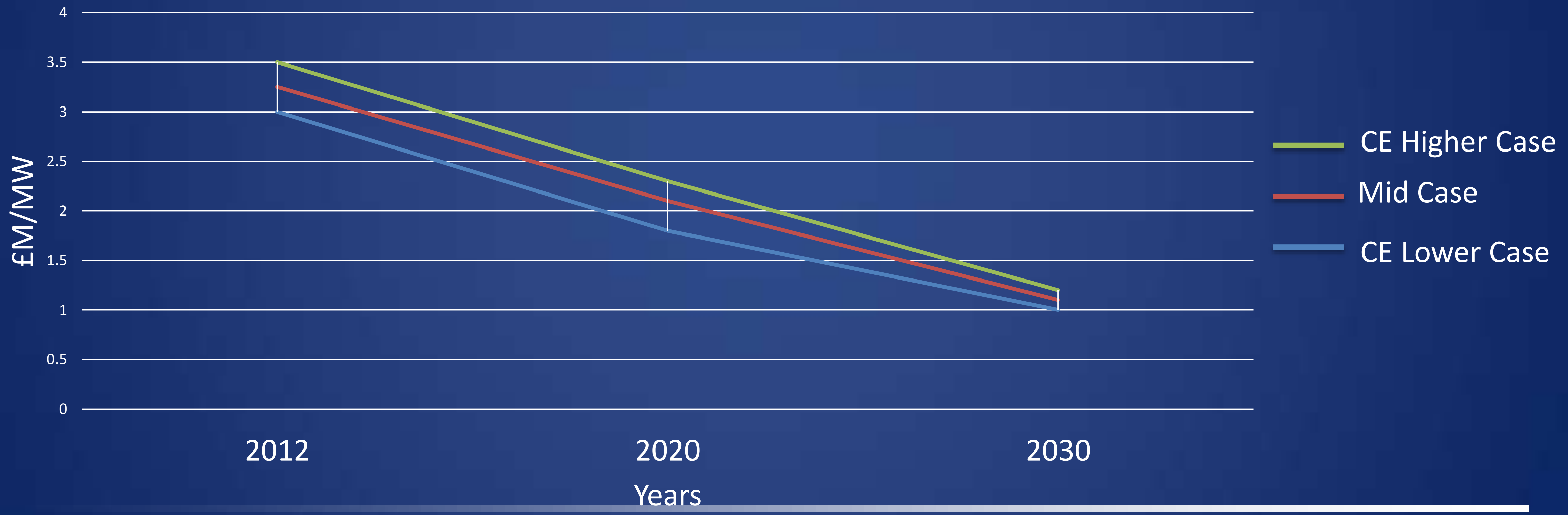
- Due to remarkable investment efforts high accuracy of investments cost required
- CAPEX estimation tool based on Dicorate et al (2011) general financial model
- Accurate estimates by providing a set of basic parameters of site & key technical features of the subsystems
- Based on average sea depth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

Projected Total CAPEX
30 MW = £66M
105 MW = £229M
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

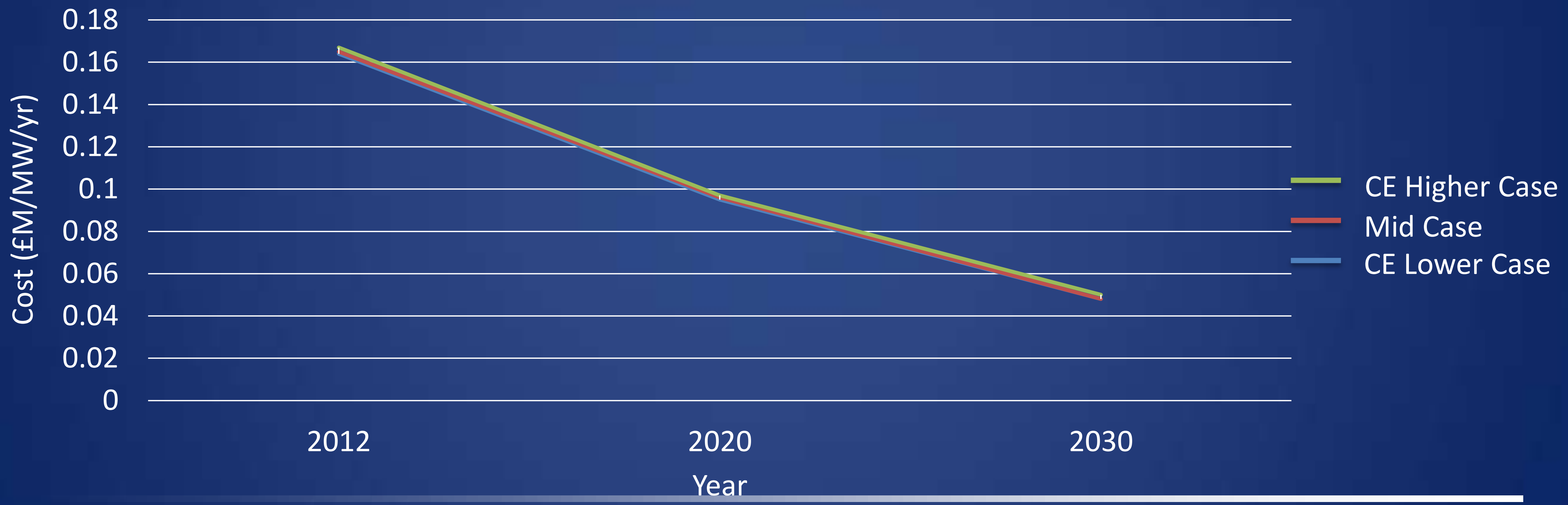
CAPEX (Mid Case)
30 MW = £69.3M
105 MW = £242.6M



OPEX Predictions

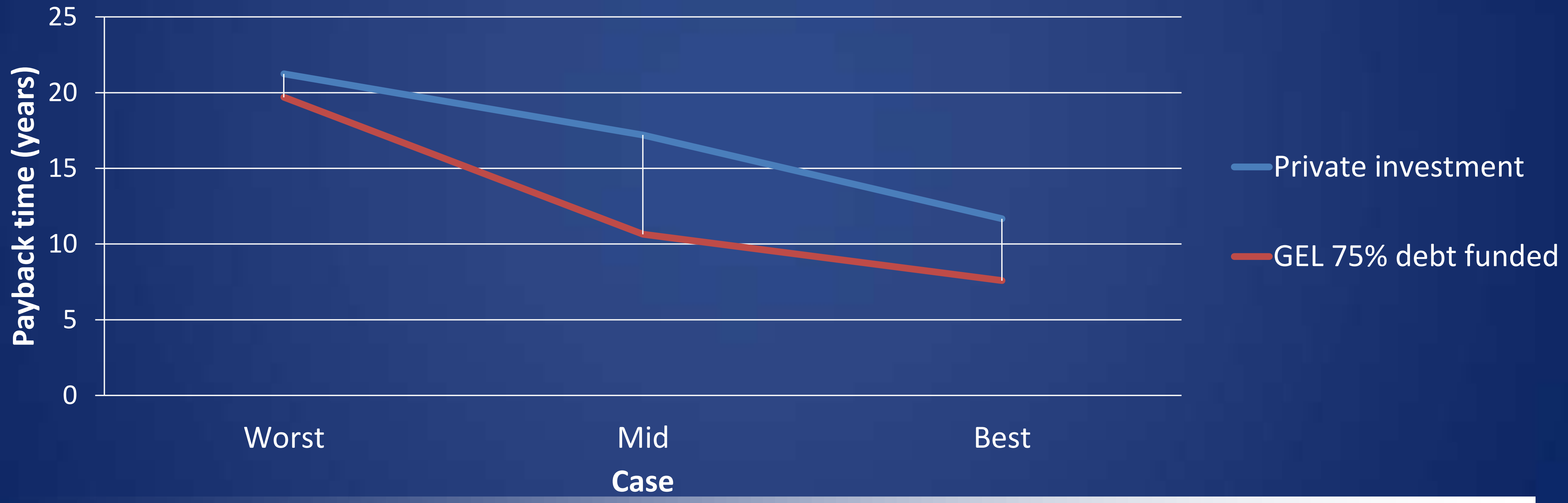
- OPEX costs expected to decrease by 39% by 2020 (Crown Estates, 2012)
- The trend was then projected forward to 2030

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

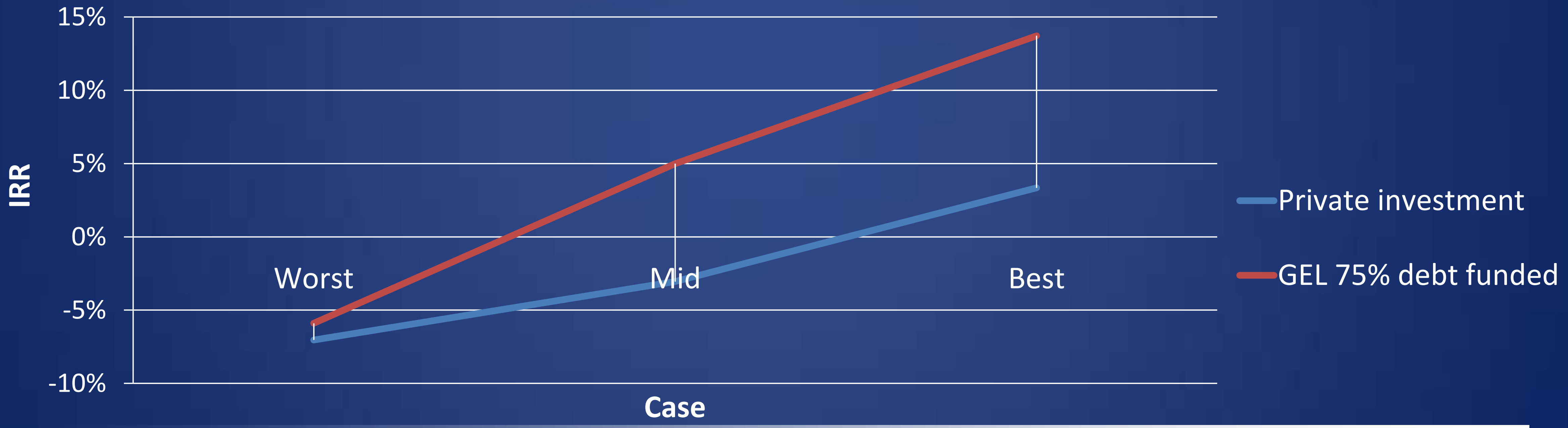
- If Guernsey wants to attract private investment there is a need for some form of subsidy

NPV (GEL finance)
30 MW = £45.6M
105 MW = £162M

IRR (GEL finance)
30 MW = 5 %
105 MW = 5.1 %

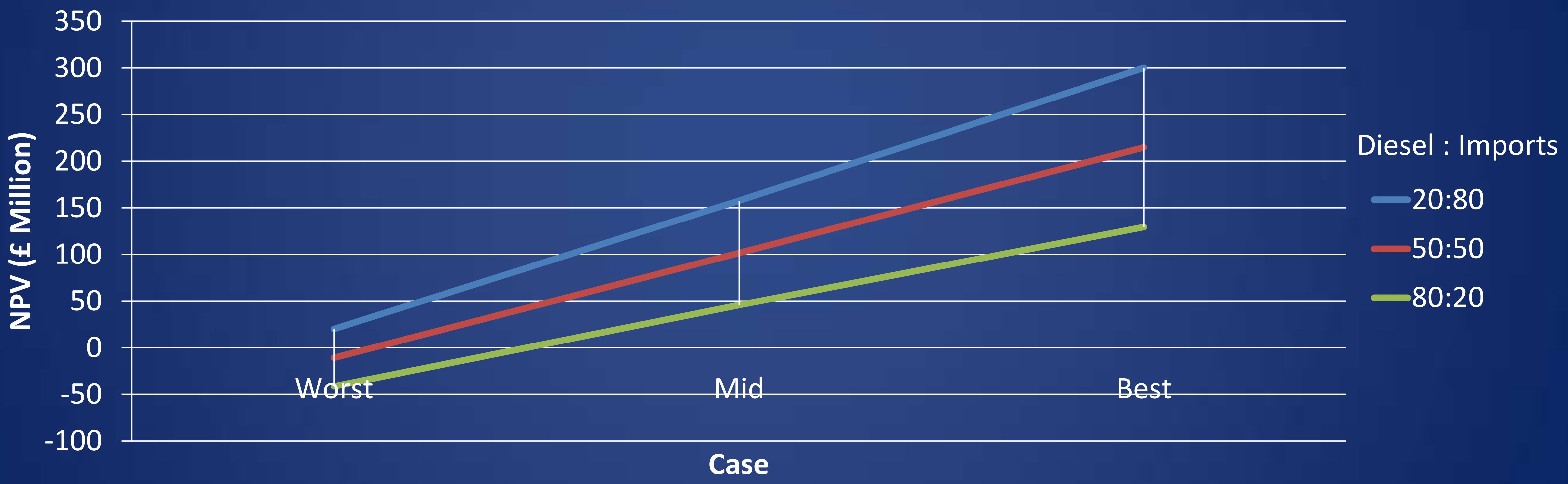
NPV (Private Finance)
30 MW = -£22.1M
105 MW = -£75.7M

IRR (Private Finance)
30 MW = -3.05 %
105 MW = -3 %



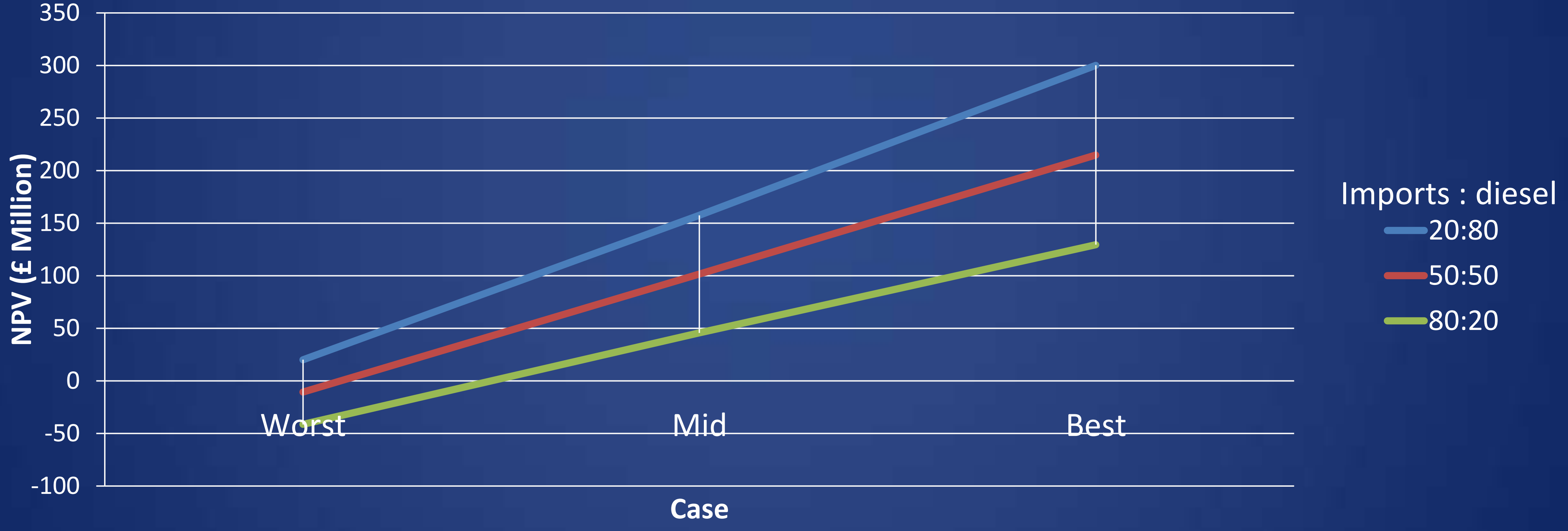
Effect on Tariff's – No Jump in French Energy Prices

- 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



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

RE | 2013 | Onshore Wind

Presented by: Emma Gerrard

Research Team: Joe Moon – Craig Siddons – Emma Gerrard

Opportunity

- Fantastic wind resource

- Mature and relatively low cost technology

Scope

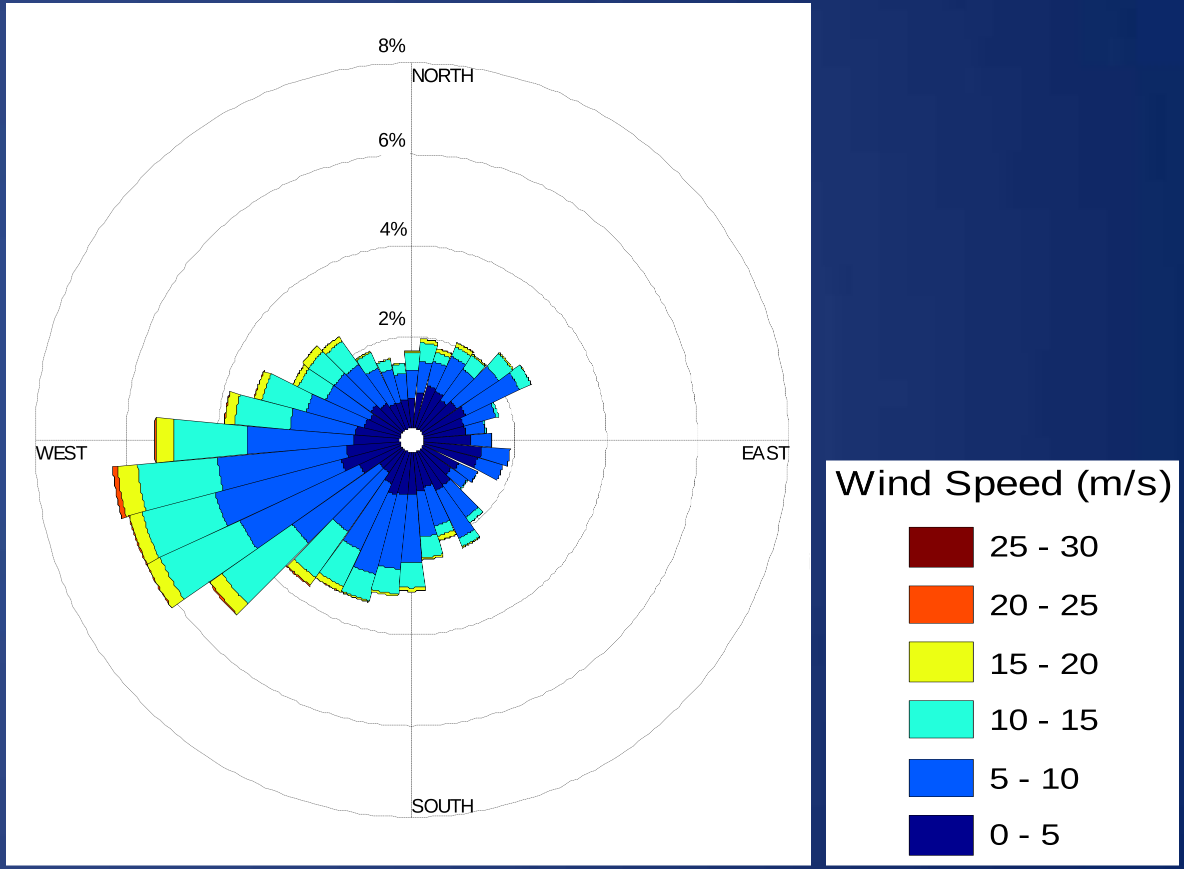
- Feasible options within constraints
- Enhance the public perception and acceptability of wind and other renewable energy technology

Wind Resource

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

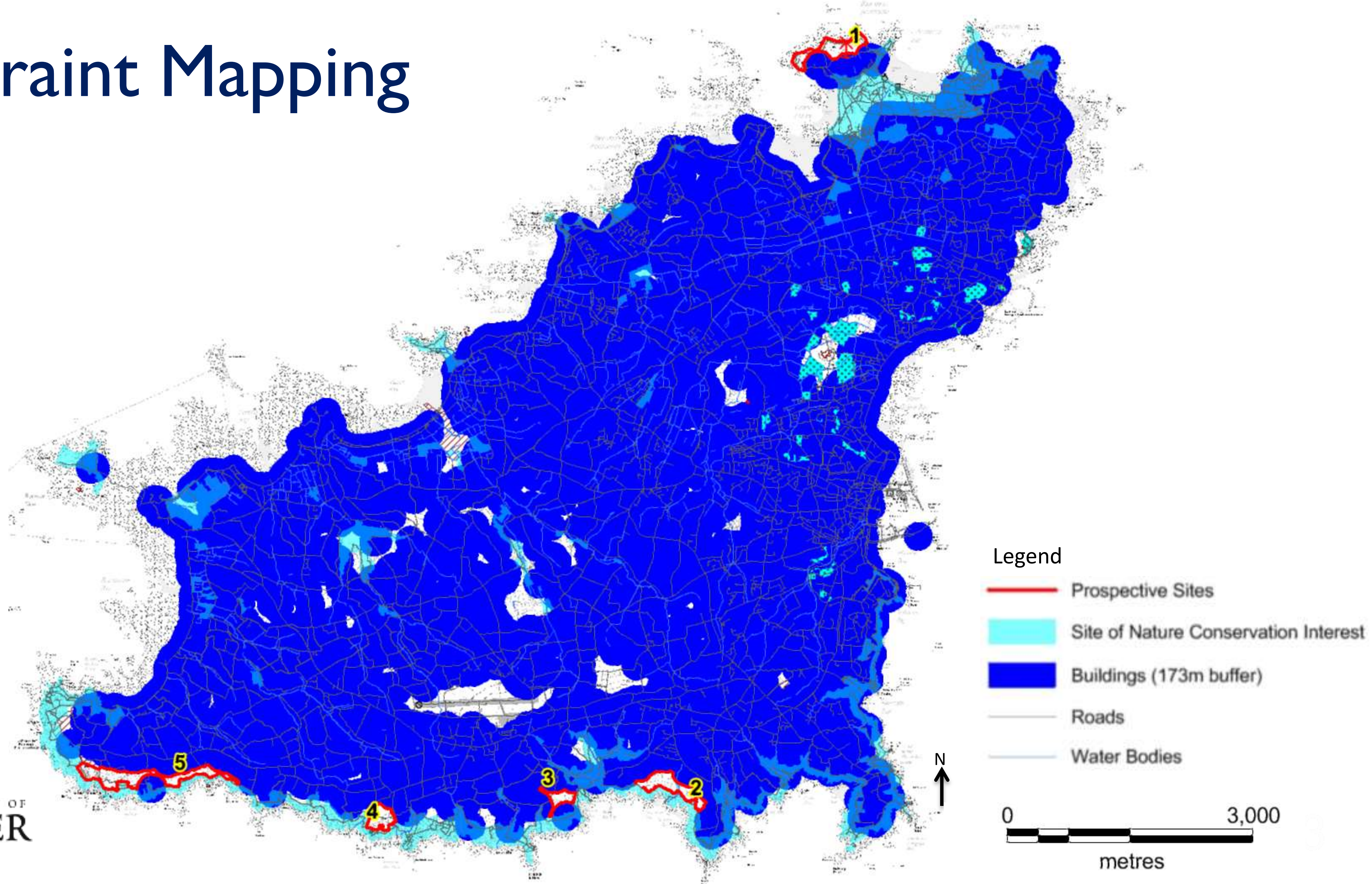
- South West prevailing wind

Wind Rose at 10m above ground level



Source: (Guernsey Met Office, 2013)

Constraint Mapping



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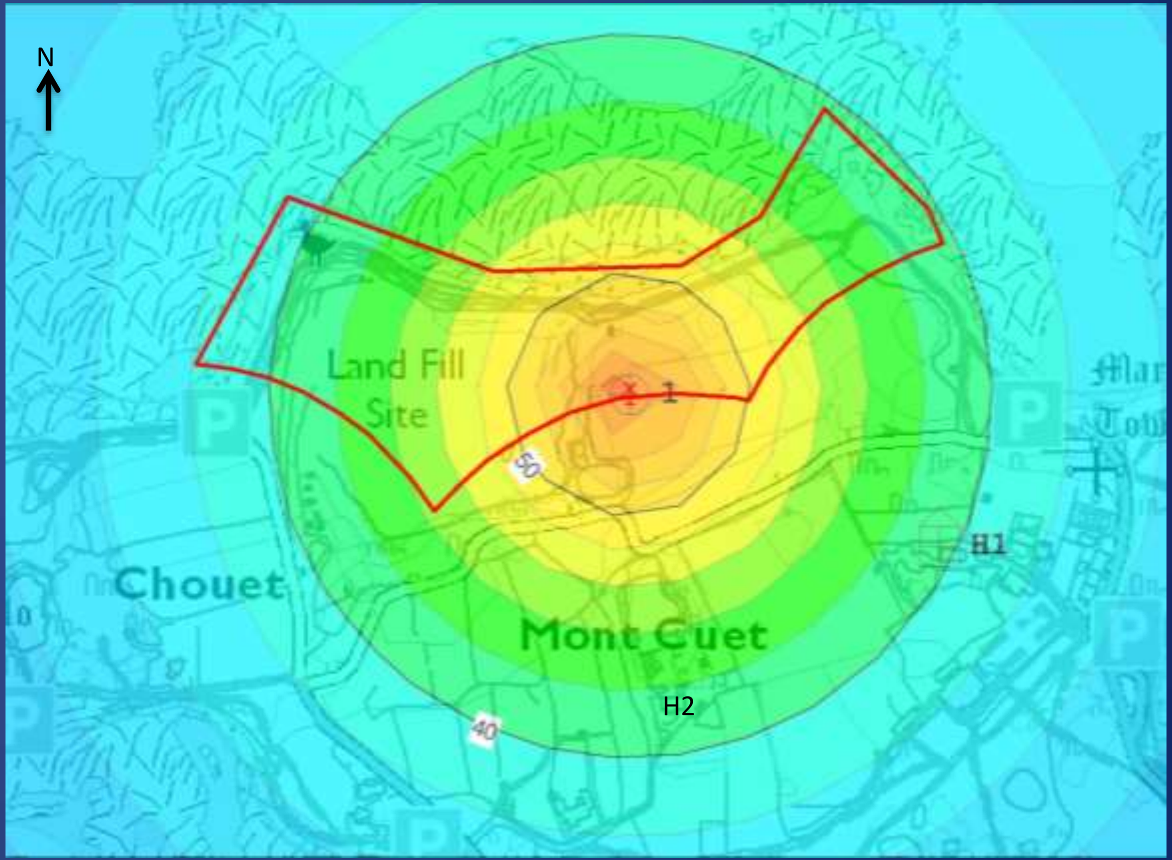
Chouet – Macro Wind

Specification Sheet	
Model	ACSA A27
Max. Power	225 kW
Hub Height	30 m
Tip Height	43.5 m
Annual Yield @ 8.4 m/s	872 MWh/year
Annual Carbon Savings	495 Tonnes
Noise	44.6 dBA at 5 m/s and 100 m
Method of installation	Crane

Source: (ACSA, 2011)

Noise Model for Acsa A27 225kW Turbine



Chouet – Macro Wind

Turbine scale is the best representation of the real world given the data constraints. Actual visuals may differ from that shown.

Chouet – Micro Wind

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

Noise Model for C&F 50kW Turbine

Source: (C&F, 2012)

Chouet – Micro Wind

Turbine scale is the best representation of the real world given the data constraints. Actual visuals may differ from that shown.

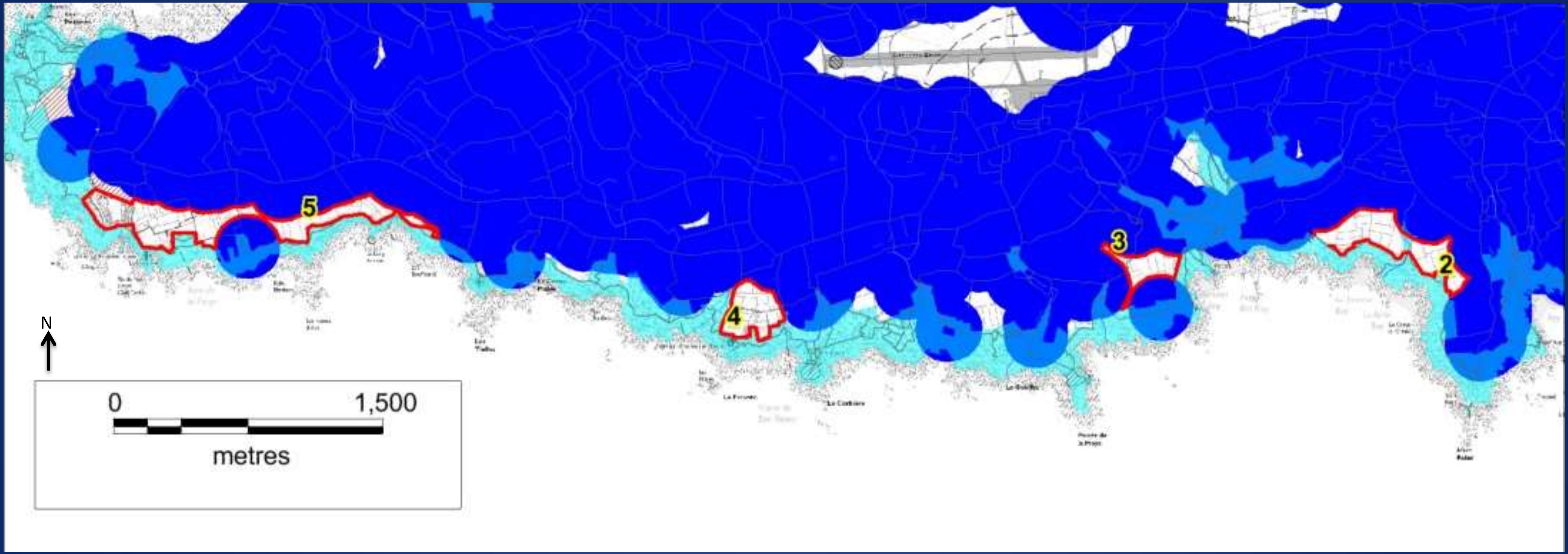
Economic Analysis

Source: (ACSA, 2011)

	225kW	50kW	20kW
Model	ASCA A27	C&F 50e	C&F 20
Capex	£1,000,000	£280,000	£120,000
IRR	8%	7%	7%
NPV @ 7.5%	£39,335	-£9,136	-£10,029

Source: (C&F 2012)

South Coast – Micro Wind



Educational and Community Projects

Falmouth School

- 6.1m tip height
- 7.7MWh/year
- 3 tonnes CO_2/year
- Student led
- Live display board

Source: (Falmouth Packet, 2009)

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

Further Opportunities

Source: (UGE, 2012)

Source: (UGE, 2012)

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

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

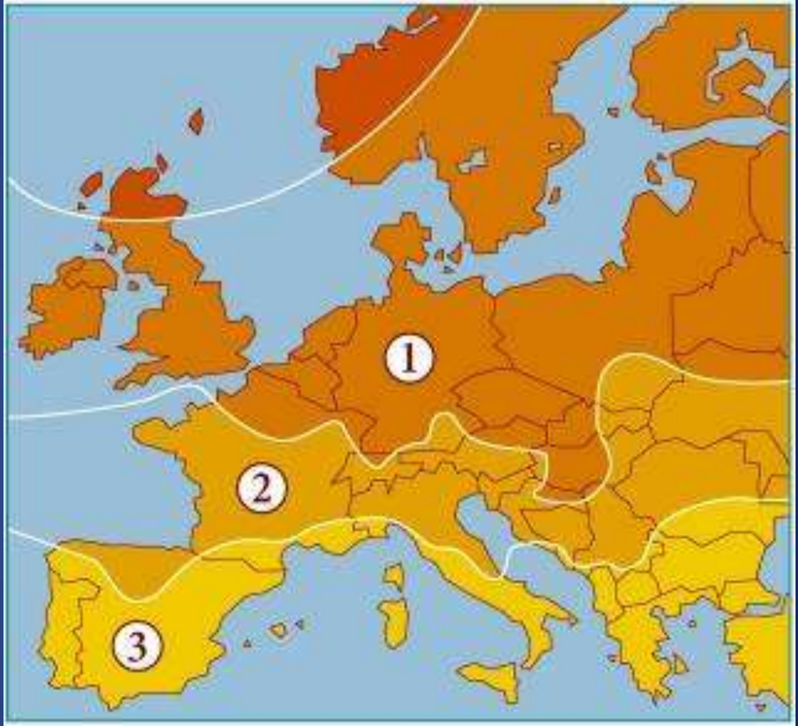
RE | 2013 | Solar Photovoltaics

Presented by: Paul Hardman

Research Team: Dan Duncan – Dan McGarvie – Ed Schofield – Nathan Collins – Paul Hardman

Opportunities

- 16% higher solar irradiation than London
- 4.15 kWh/m^2/day
- Contributes to security of supply



Zone	Average solar radiation on collector surface (kWh/m² day)
1	2.4 to 3.4
2	3.4 to 4.4
3	4.4 to 5.4

Scope

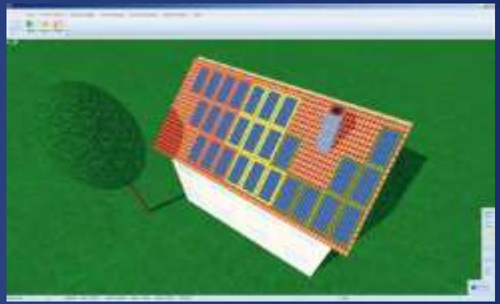
Solar PV in Guernsey can be split up into 3 main sections:

- Residential
- Commercial
- Macro

Balance of System

PV System

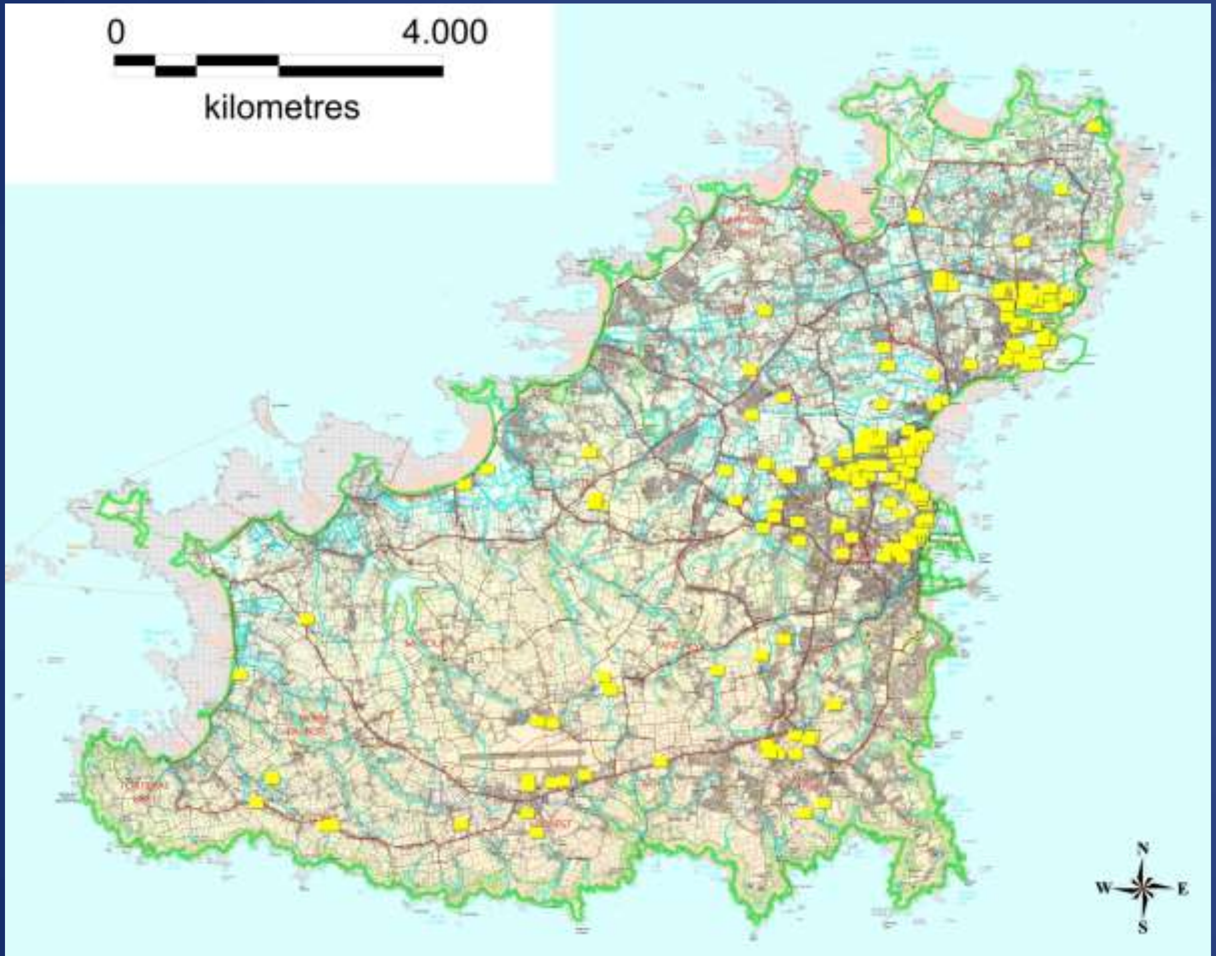
BoS



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

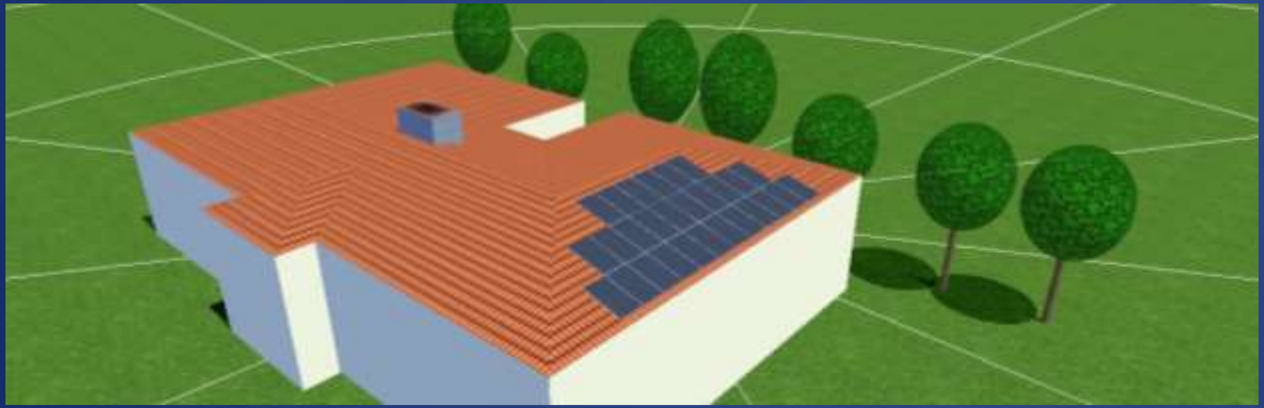
% of Commercial Buildings Identified	Number of Buildings	Total Power	Total energy p.a.	% of Total Electricity Demand	% of Commercial Electricity Demand
10%	23	780 kW	850 MWh	0.2%	0.4%
50%	114	3,900 kW	4,250 MWh	1.2%	2.2%
100%	227	7,800 kW	8,500 MWh	2.4%	4.3%

- 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

PrintsPlace

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



PV*SOL

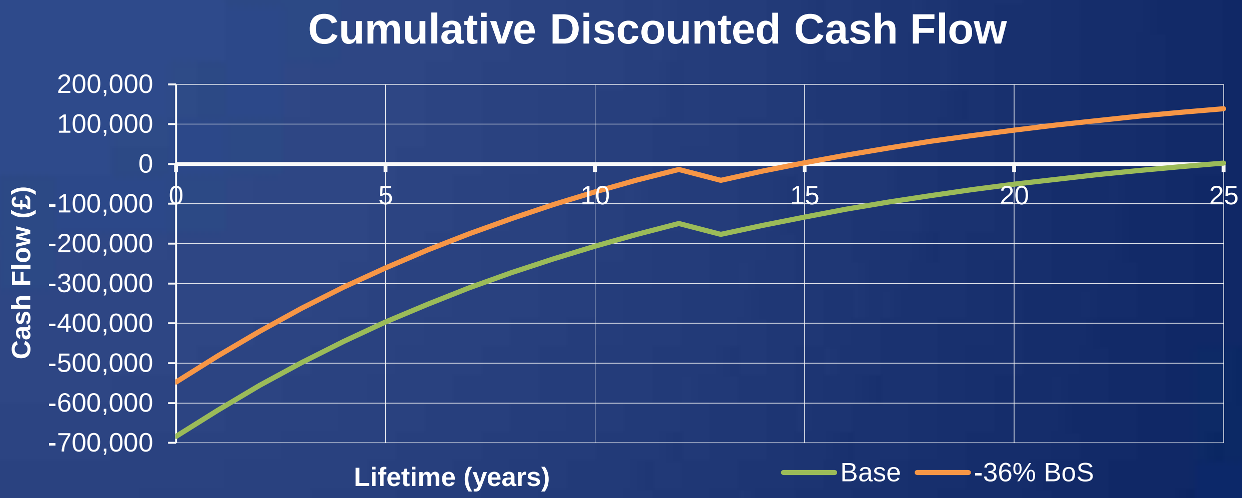
Lovell Ozanne

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

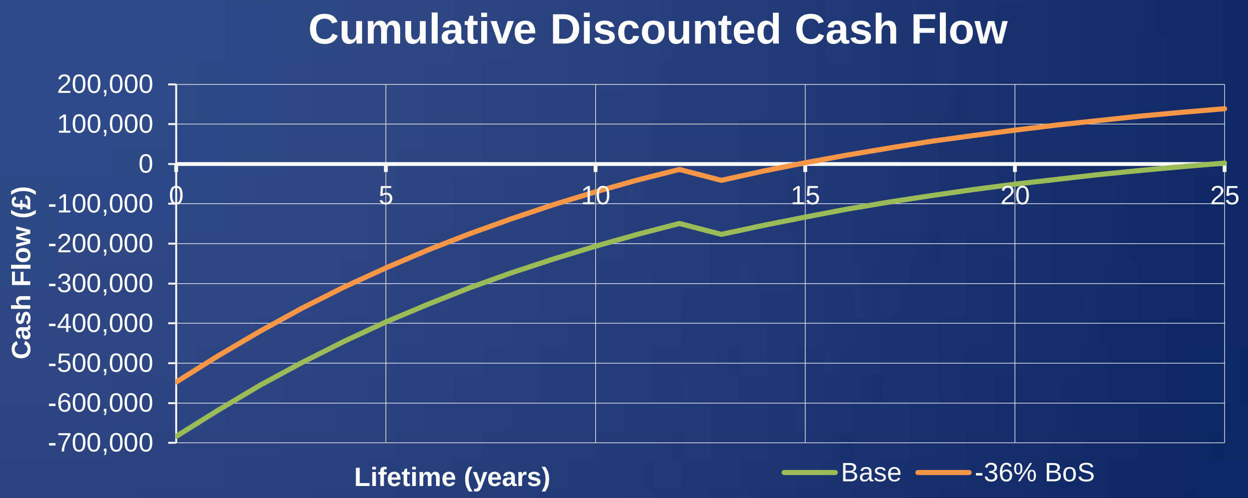
500kW Macro Case Study – Guernsey Airport

- 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

RE | 2013 | Electrification of Transport

Presented by: George King

Research Team: Shawn Brown - Anthony Vickers – George King

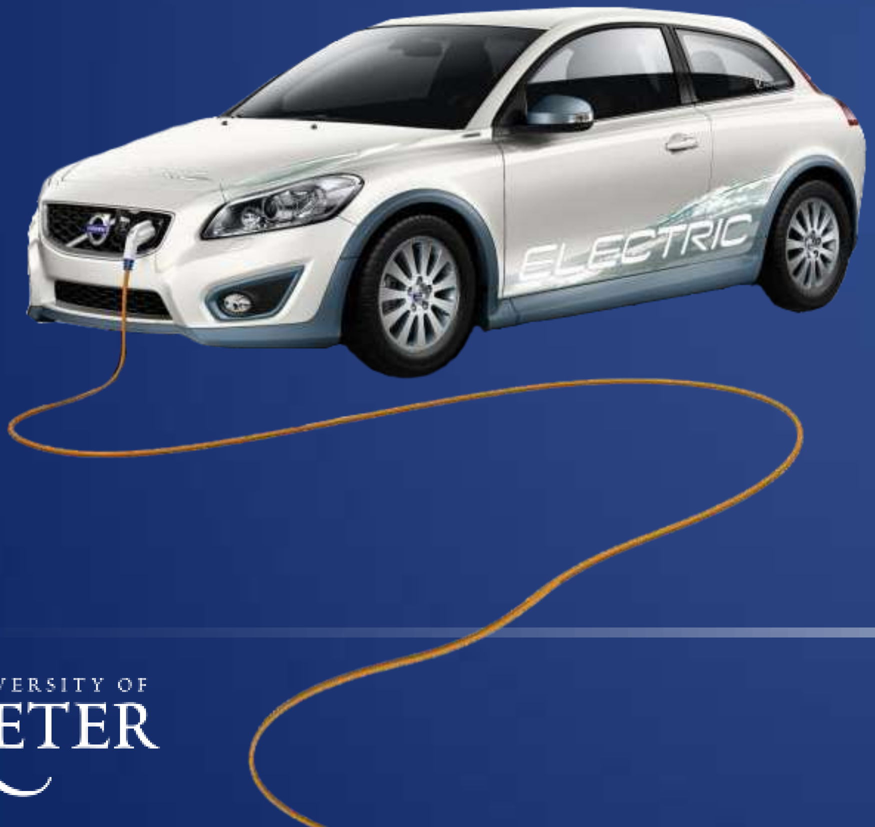
Opportunity

"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%

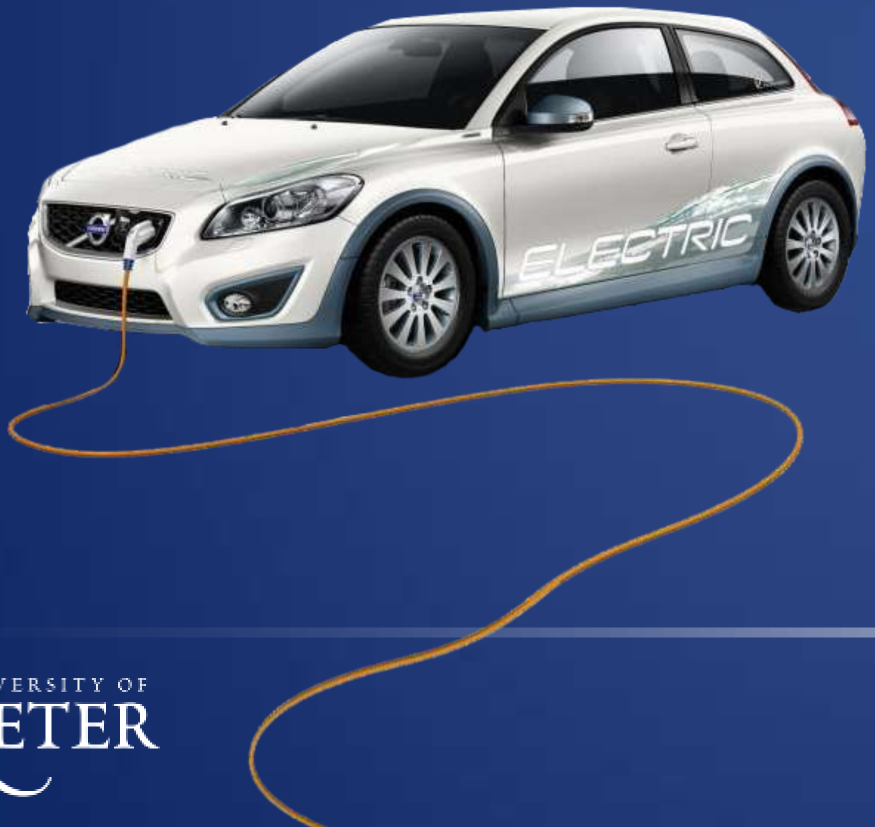


20-25%

Source: (POST, 2010)

Drivers for Change – Fuel Security

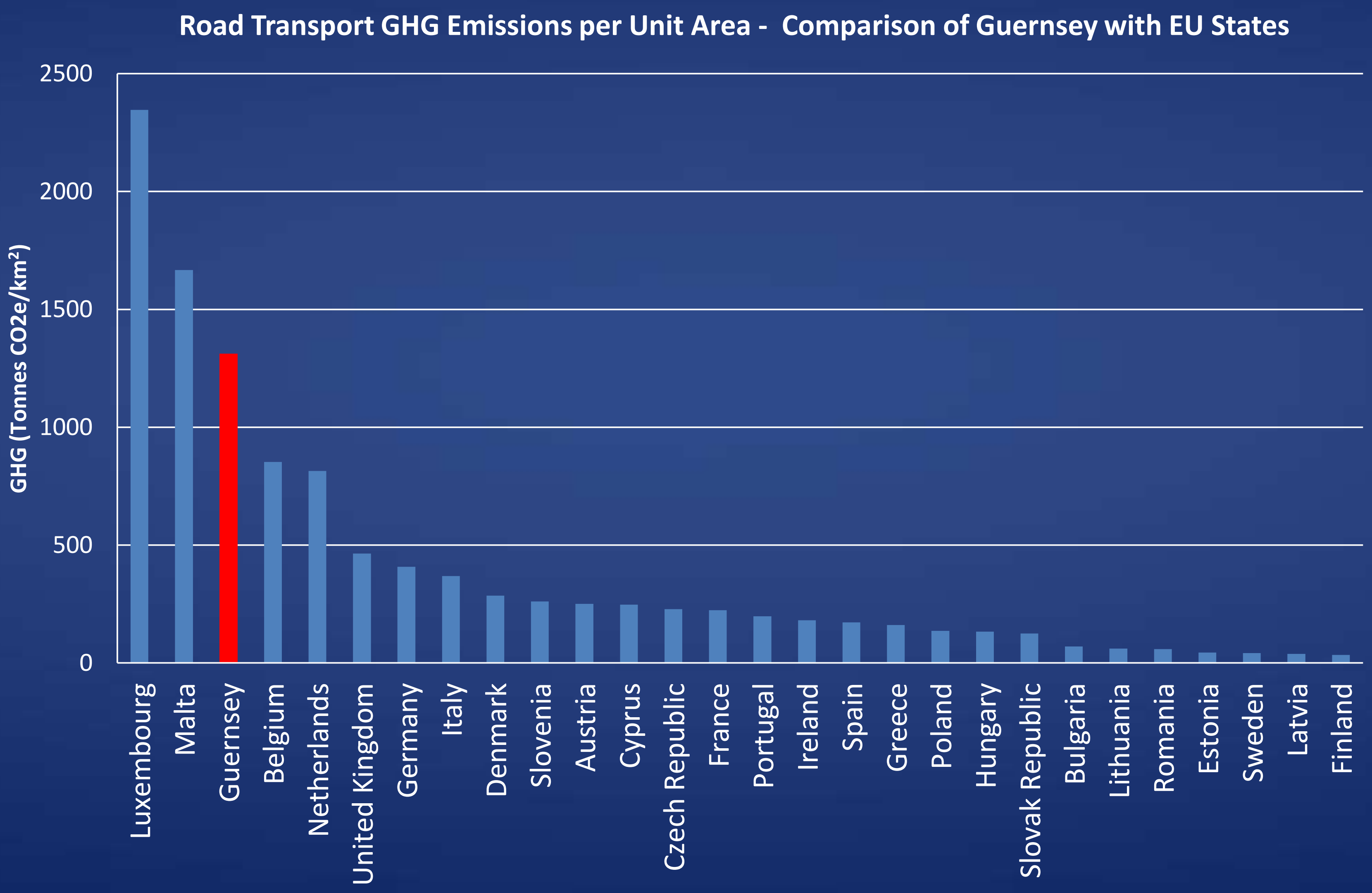
34 Vehicles



40,106 Vehicles

Source: (Environment Department, 2011)

Drivers for Change - Emissions



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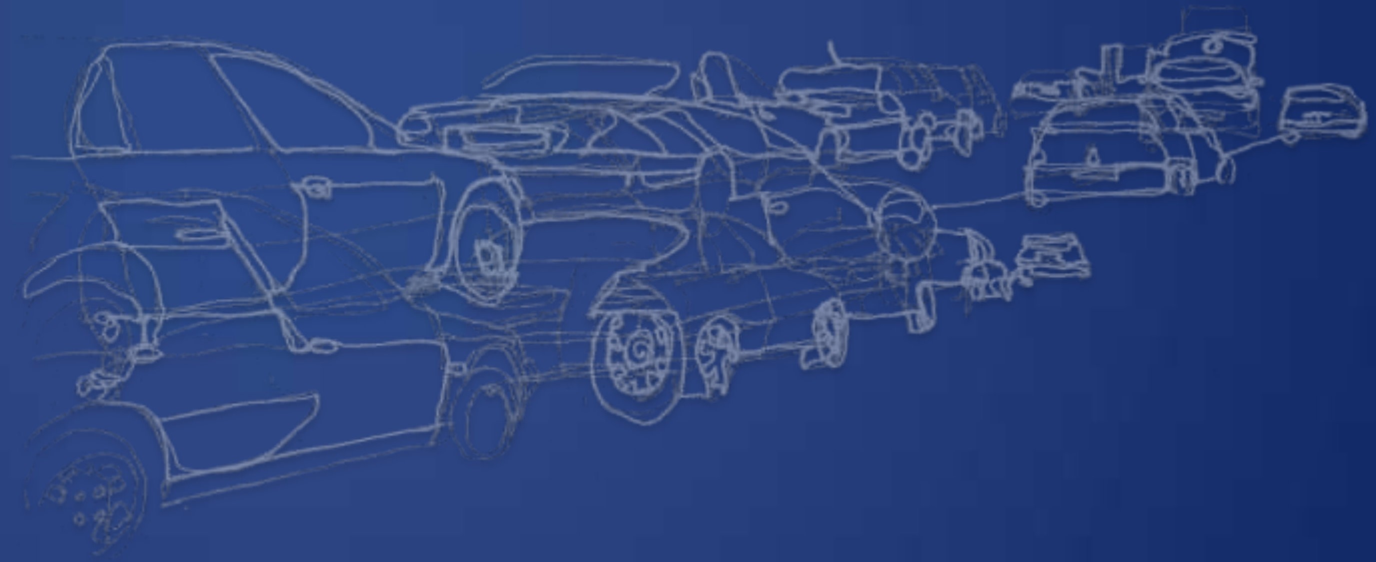
Source: European Commission, 2012; States of Guernsey, 2012

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

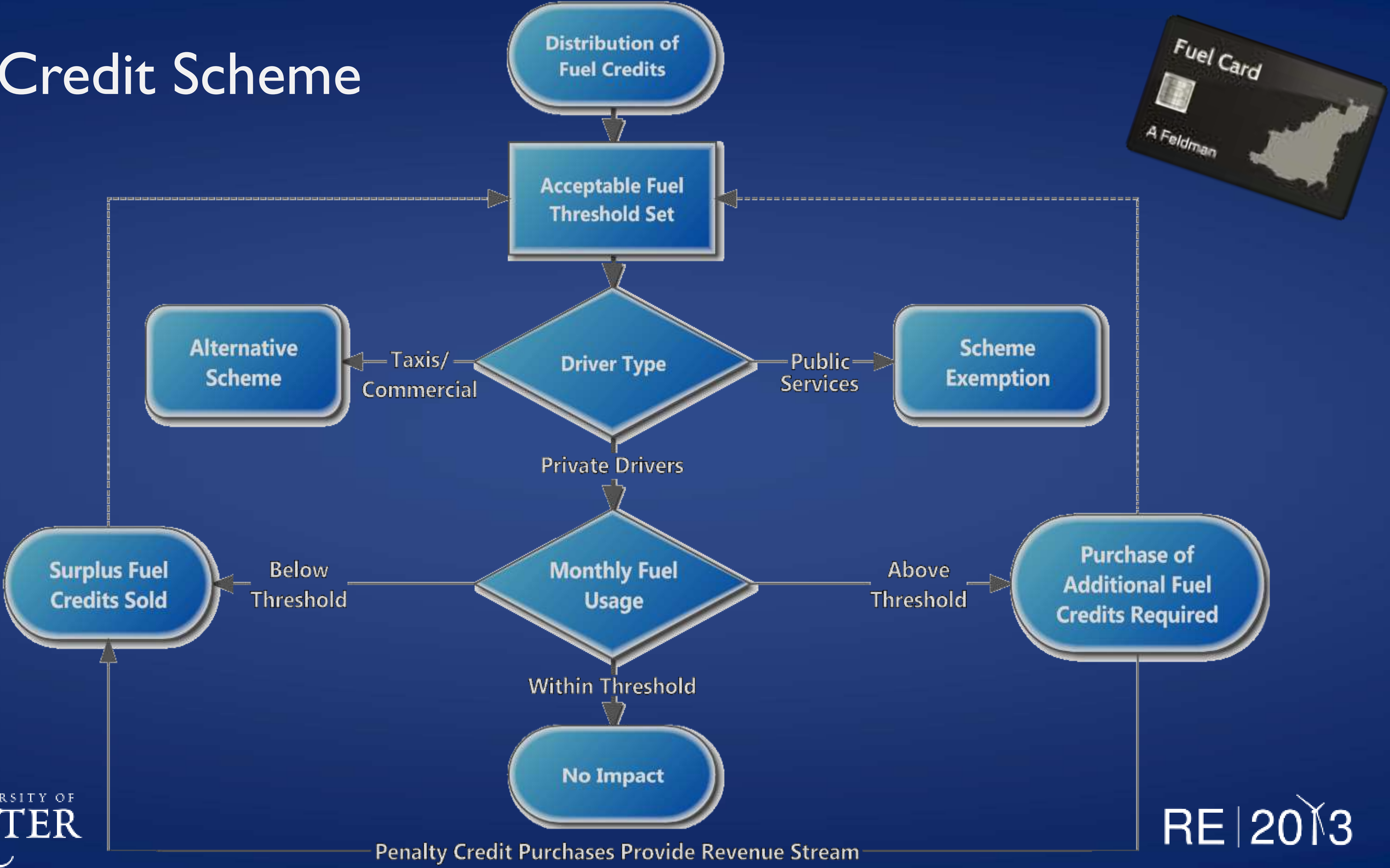



Source: Dragon Electric Vehicles, 2012

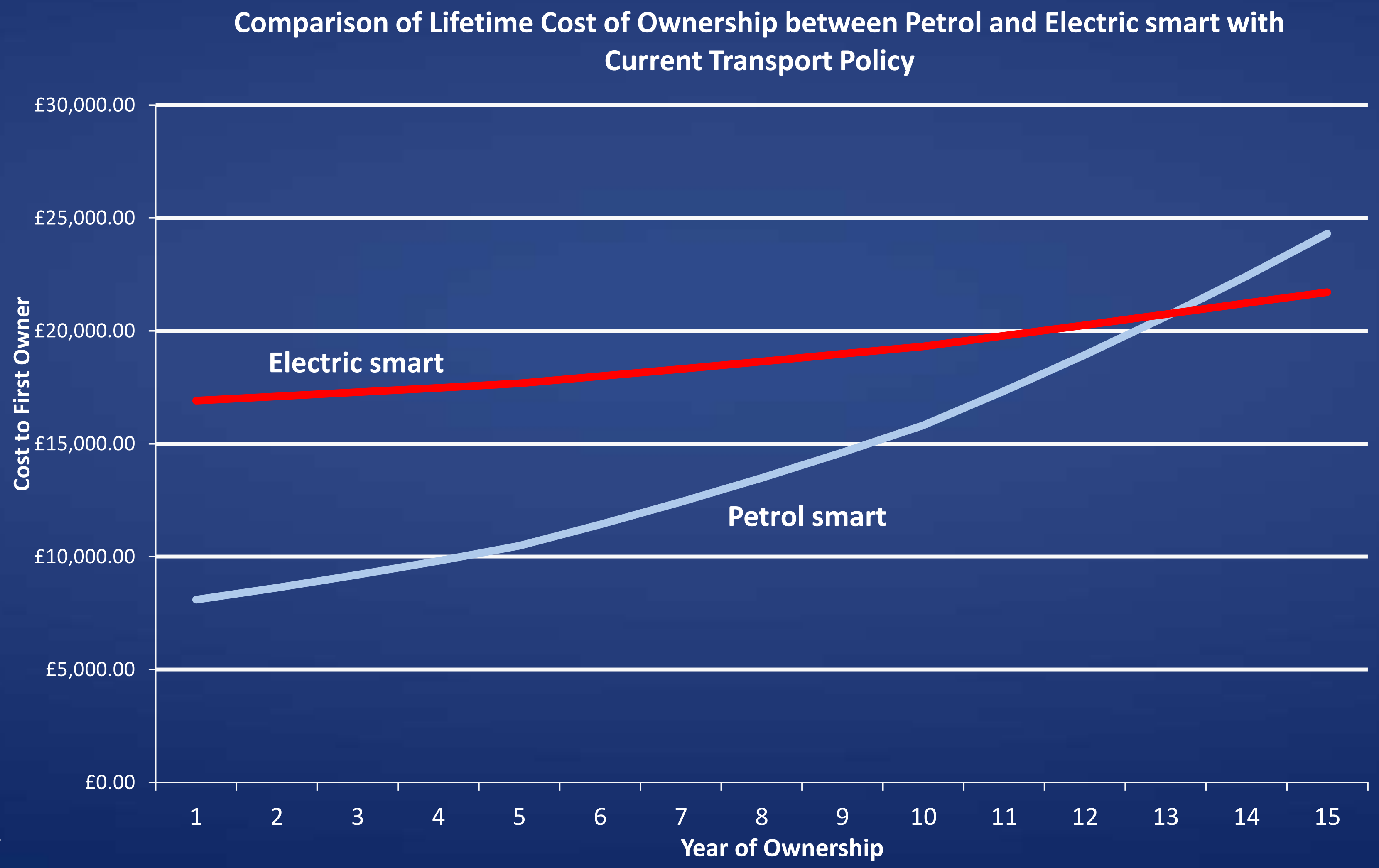
Proposed Policy Mechanisms

- 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



Case Study – smart vs smart electric



Source: smart, 2013

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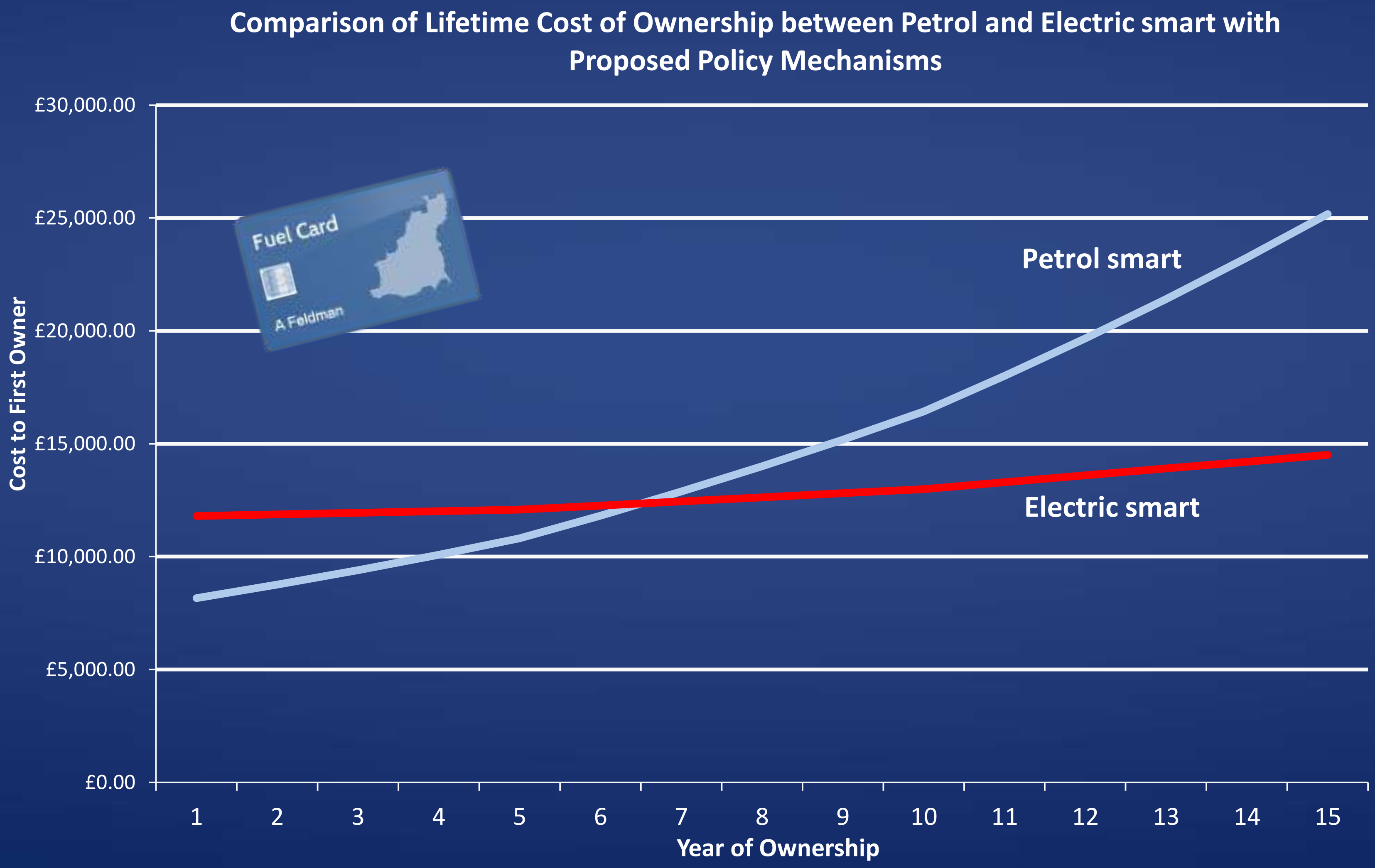
Case Study – smart vs smart electric



Source: smart, 2013

Summary

- 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

Conclusions

- Further work to establish emissions levels
- 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
- Incentivise car hire companies to provide EVs

RE | 2013 | Energy Storage

Presented by: Will Sandall

Research Team: Marcus Lynch – Guilherme Schmitz – Will Sandall

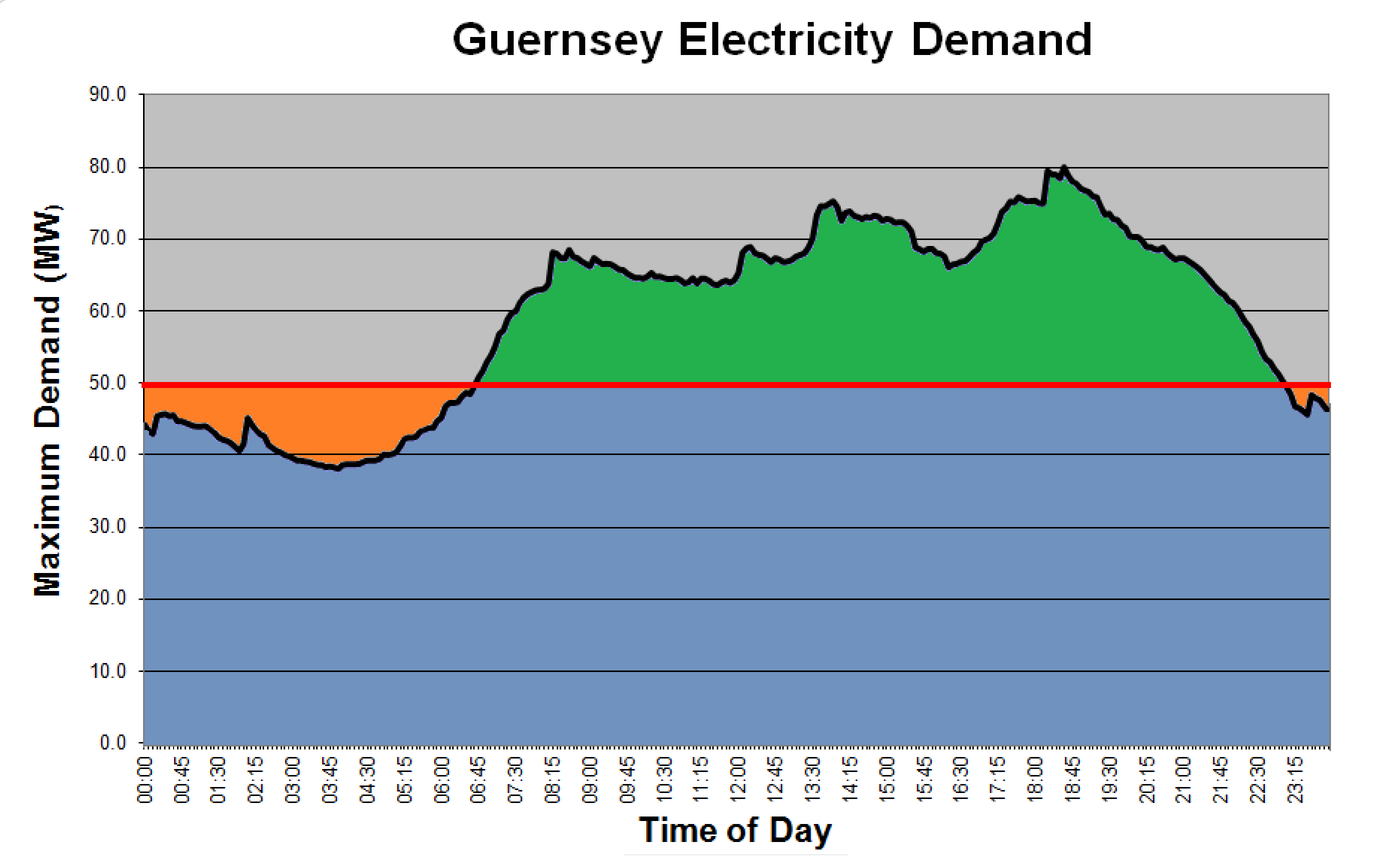
Opportunity

- 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?



Source: Guernsey Electricity Ltd

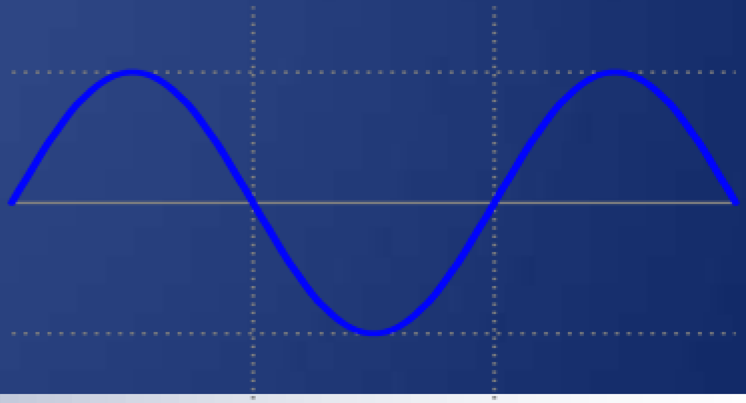
Energy storage applications

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

£

MW

%

kWh

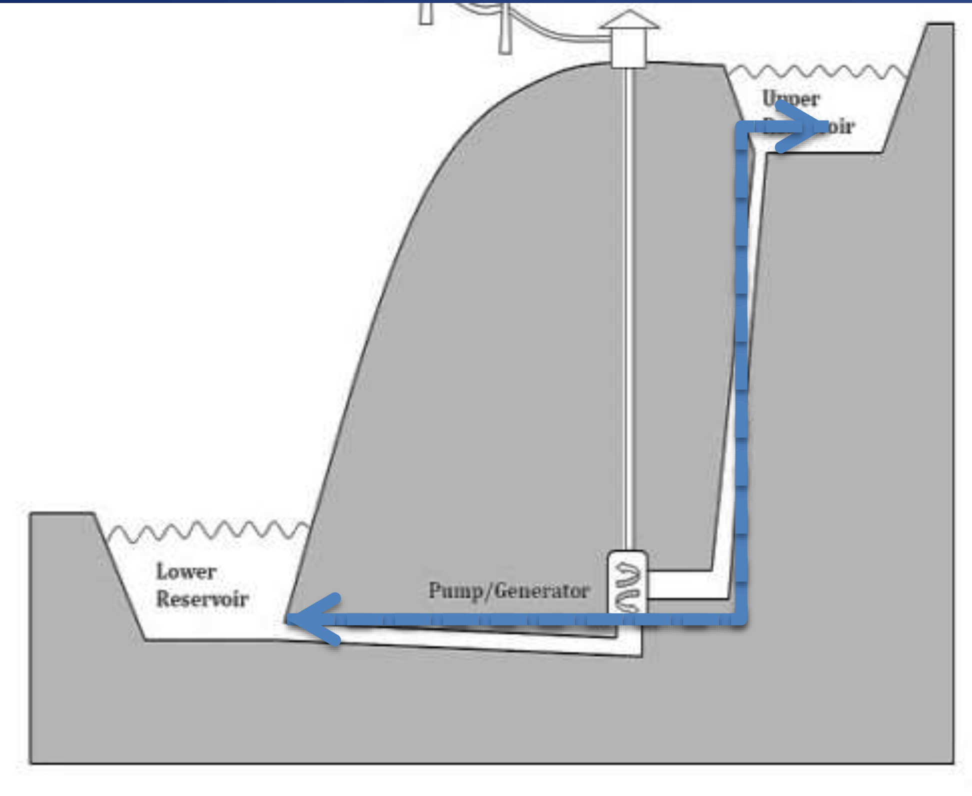
Main technologies covered

- 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

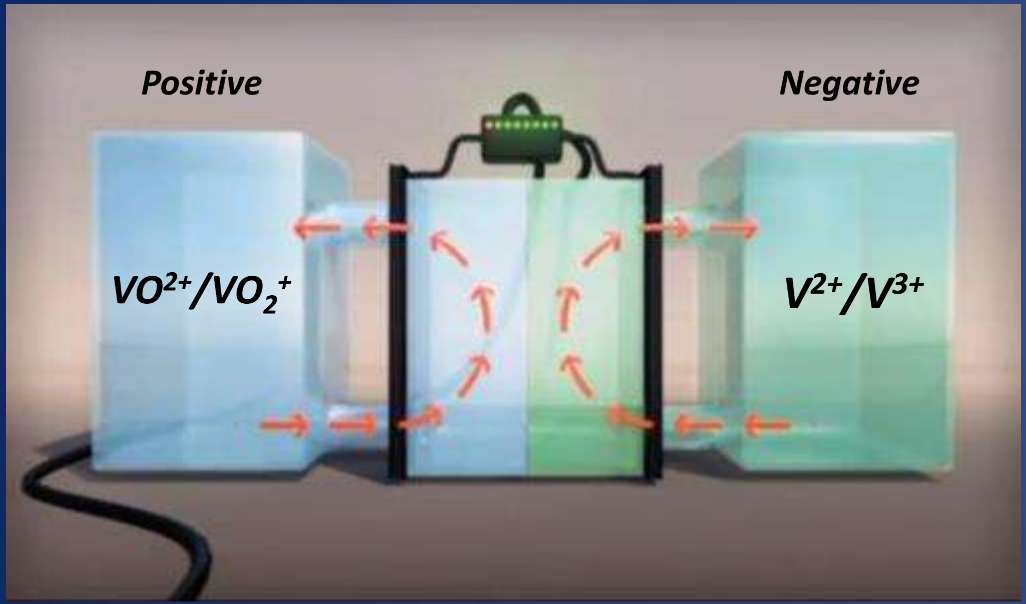
- Possible 0.15 MW capacity

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



(Pacific Ore, 2012)

- 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

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

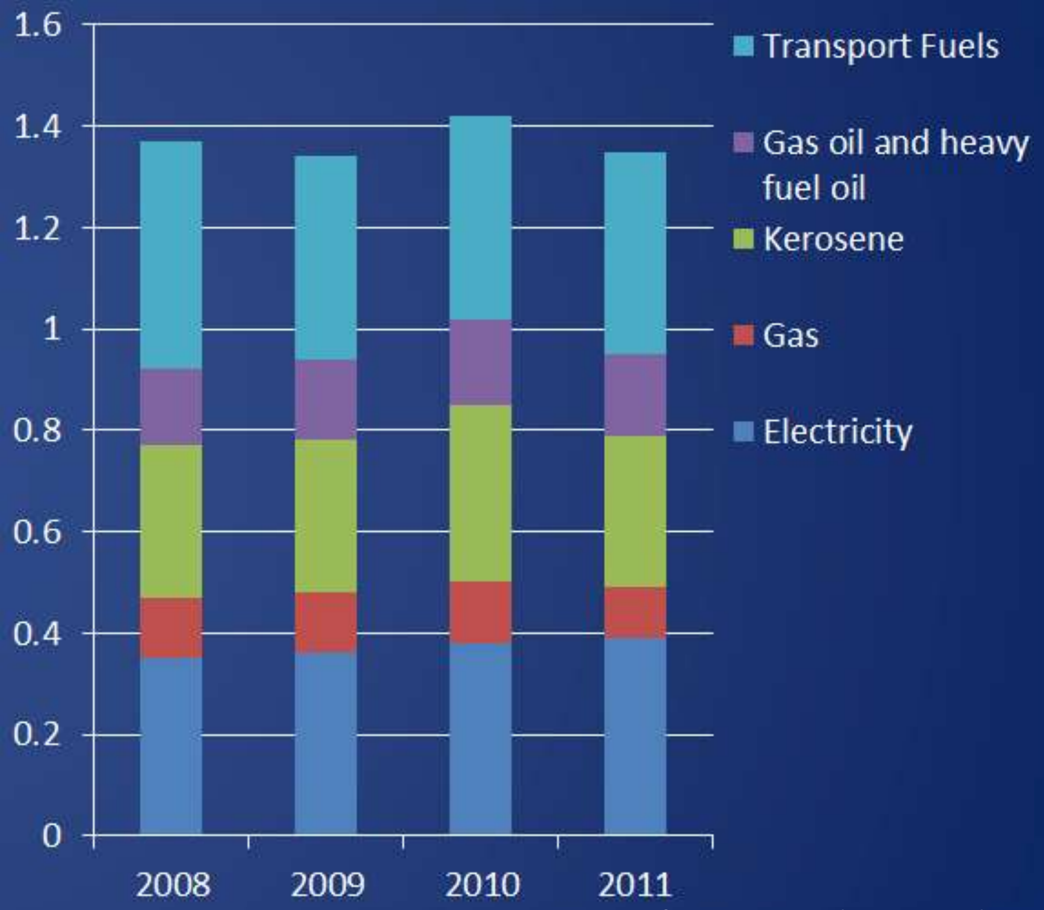
- High fuel costs
- Energy efficiency measures reduce the demand for heating fuels
- Guernsey has the potential to generate heat from indigenous, renewable sources

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

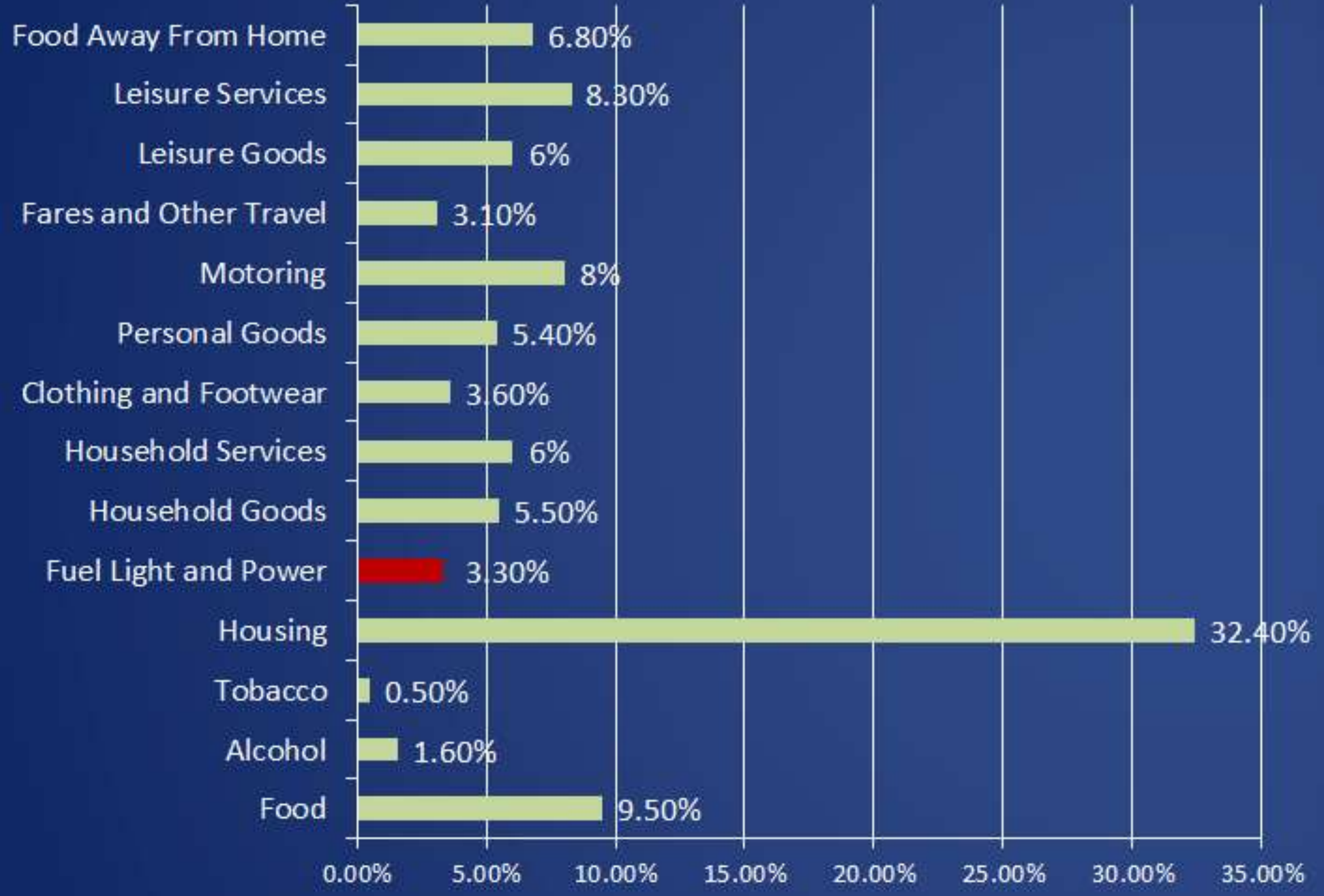
The Heating Fuel Mix of Guernsey

- 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



Household Expenditure Survey 2005/6. Source: States of Guernsey Policy Council

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

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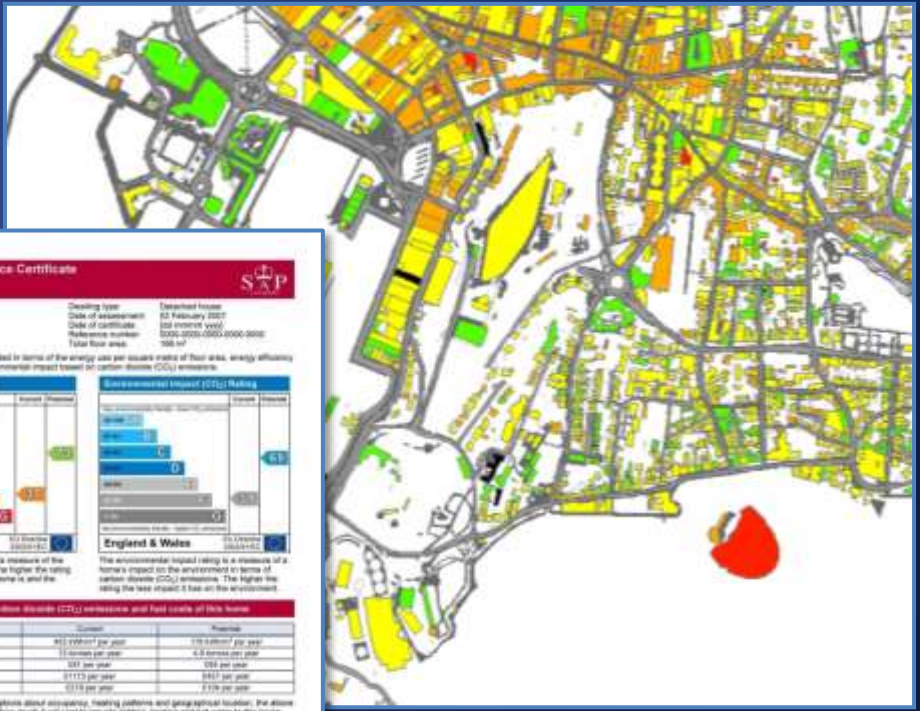
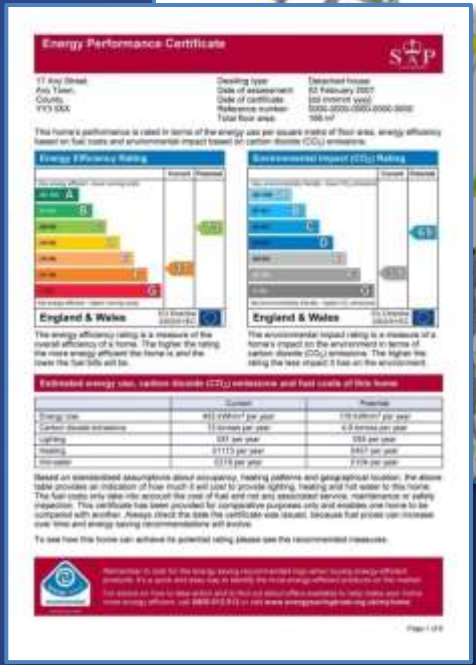
Energy Efficiency Measurement and Regulation

- 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



Source: Jersey Digimap



Source: Energy Saving Trust

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

Source: 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

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

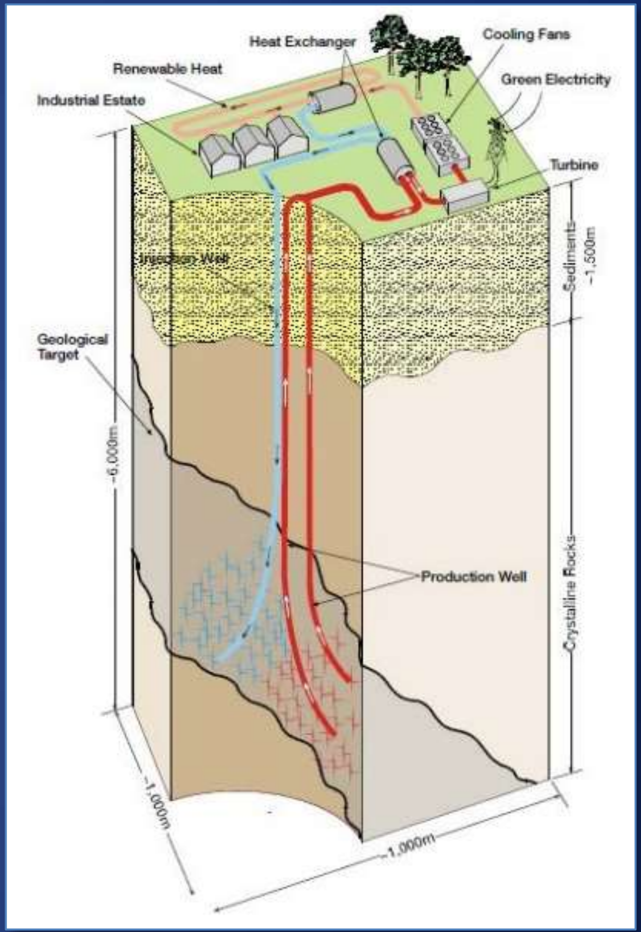
Solid Biomass

Source: FIL

- 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

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.

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Policy, Legislation, Regulation & Licencing

Presented by: Richard Baker

Research Team: Henry Crone – Michael O’Brien – Gabriel Rawlings – 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

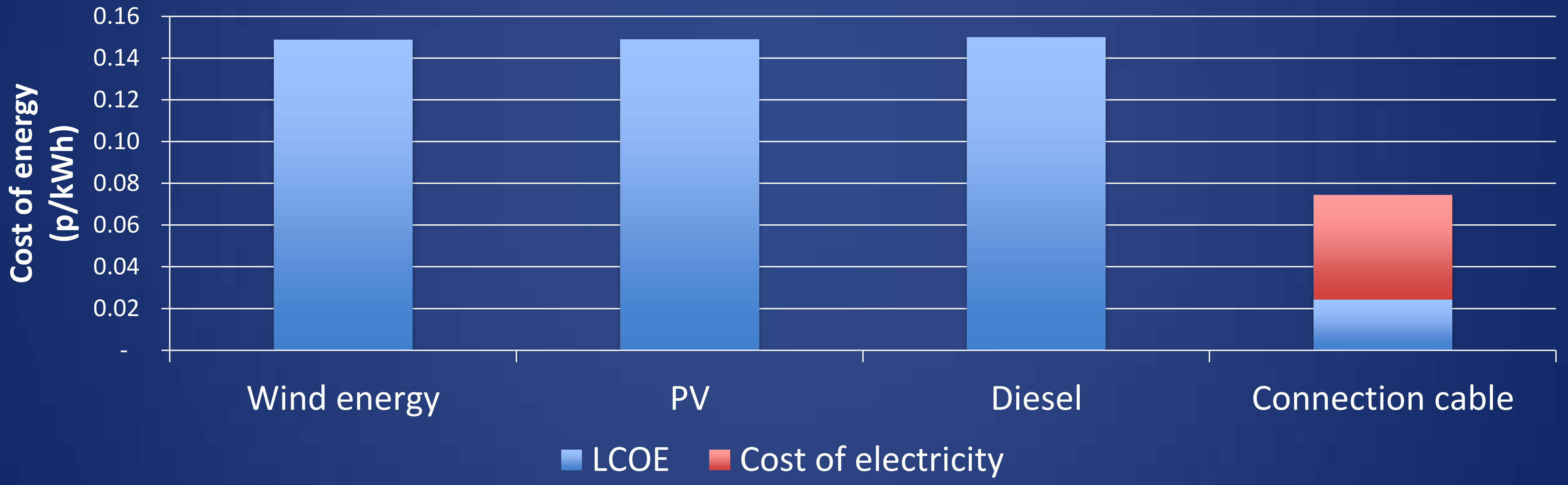
- Brownouts: drop in voltage impact data banks ability to store data
- Potential critical impacts on financial services
- Blackouts: *"30 minute power cut result in an average loss of £10,400 to medium and large industrial clients"* *(Allianz, 2010)*

Scope

- System analysis
  - 'N-2' secure
- Future large scale investment options:
  - Interconnector
  - Offshore Wind
  - Solar PV
  - Diesel generator

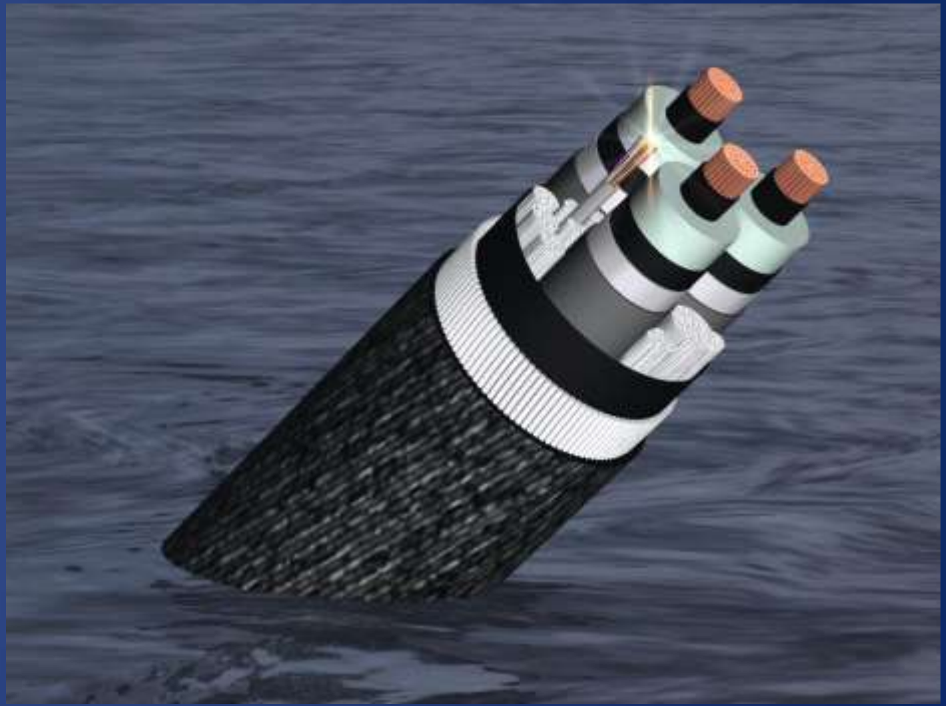
Levelised Costs of Energy

Comparison of technologies on a cost basis



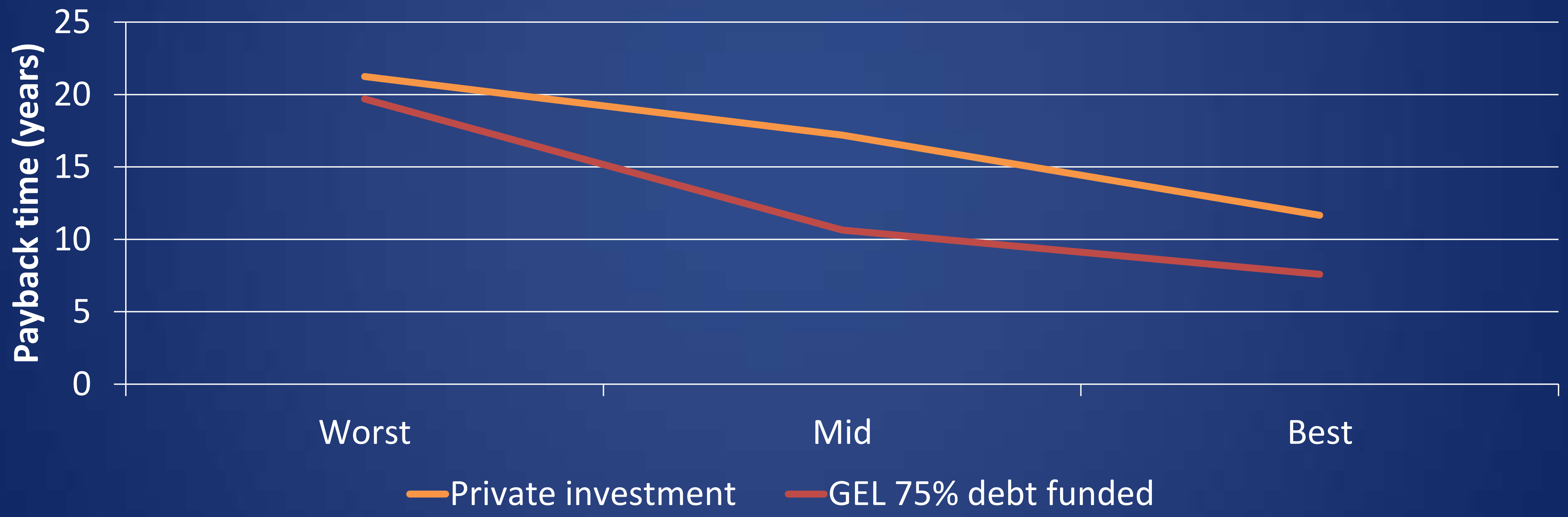
Interconnector to France

- 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



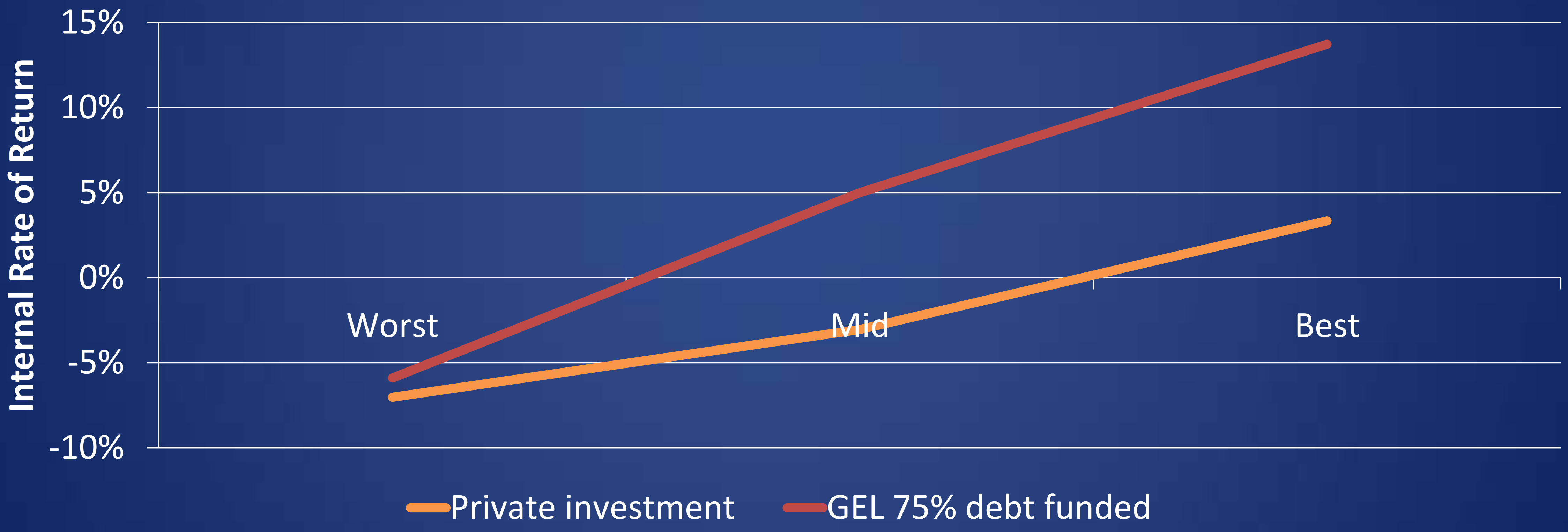
Offshore Wind: Who Pays? (1)

Changing the financing method influences the payback times



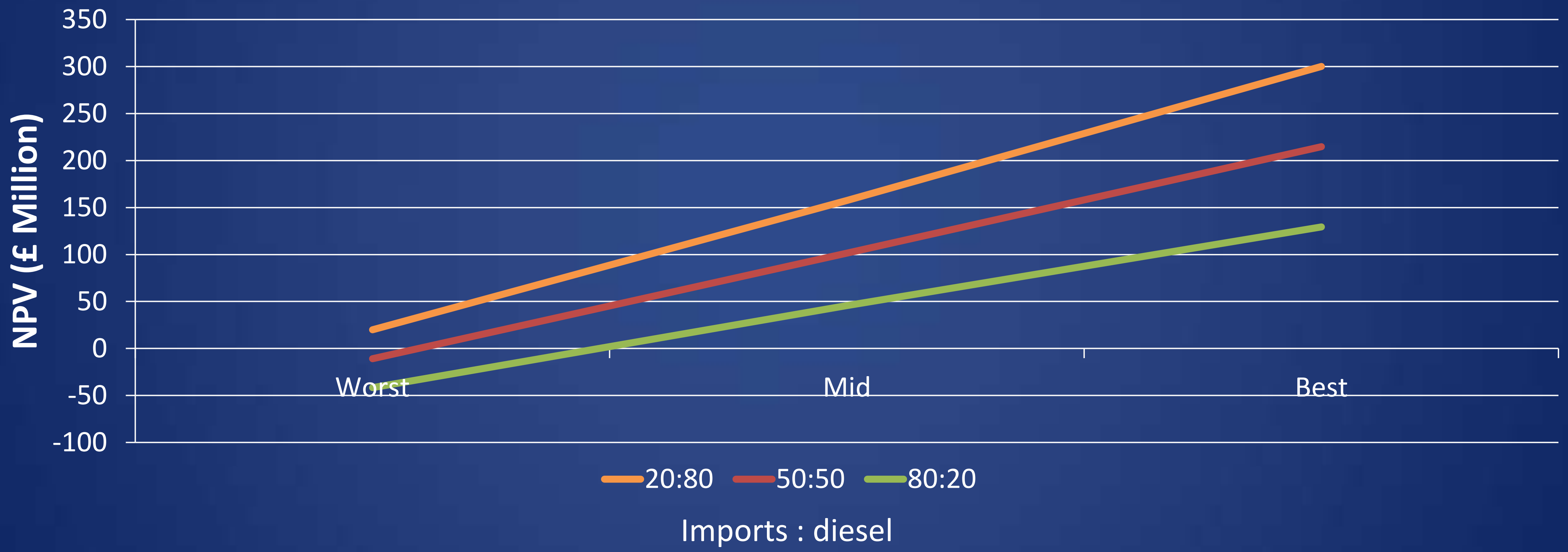
Offshore Wind: Who Pays? (II)

It also influences the IRR



Offshore Wind Energy

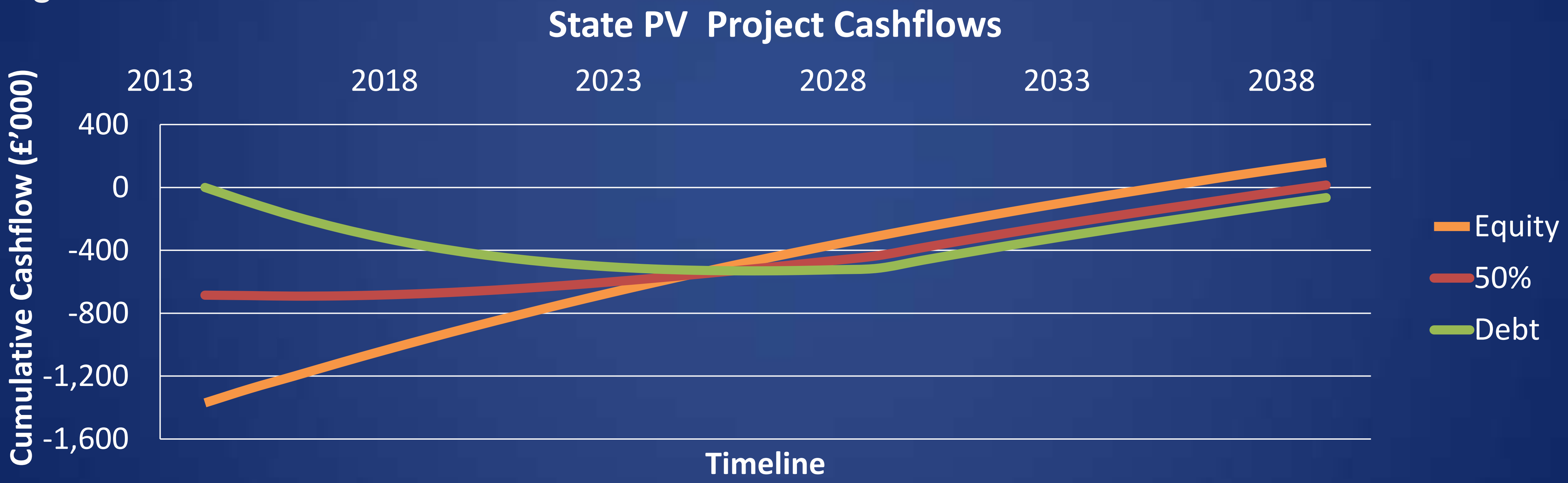
Ideally, wind generation should displace diesel generation



Solar Photovoltaics in Guernsey

State-owned projects:

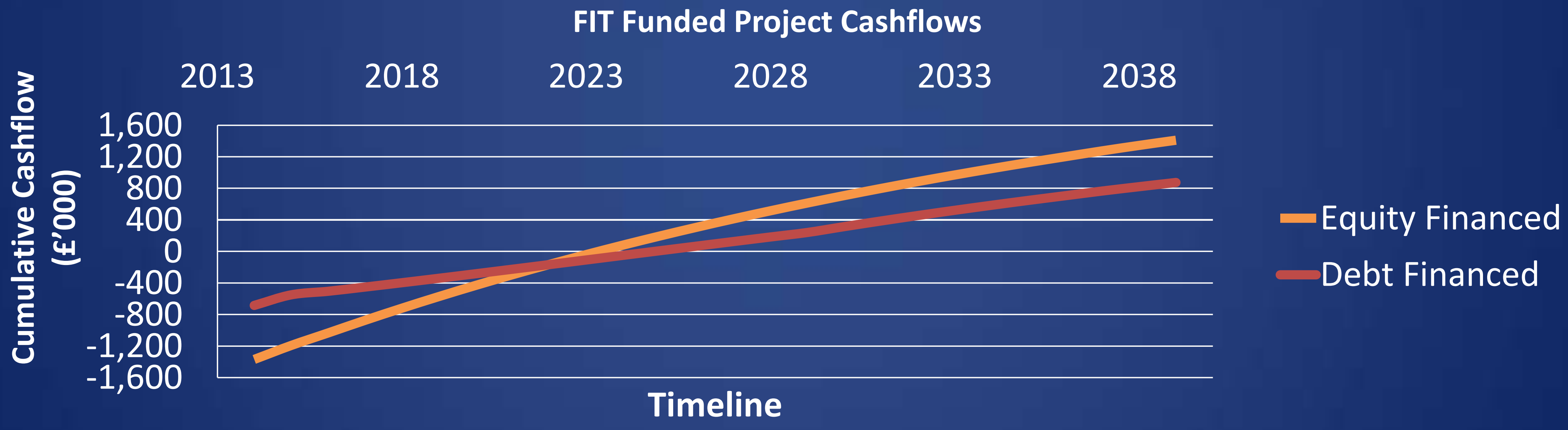
- Value of generated electricity considered equal to the cost of the displaced electrical generation



Solar Photovoltaics in Guernsey

Privately owned projects with FIT:

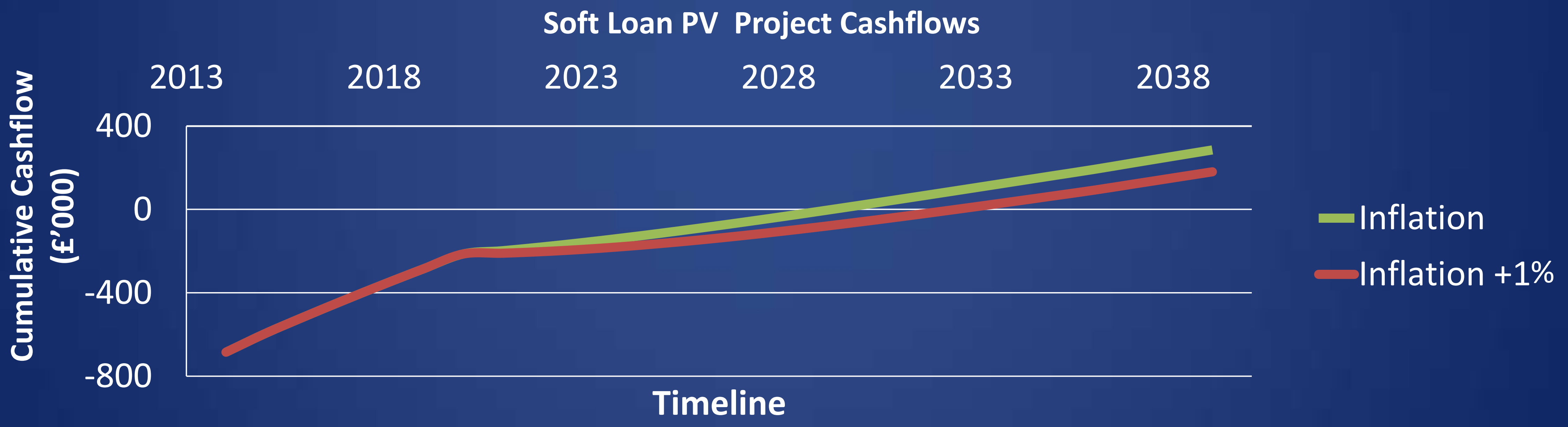
- Value of FIT found to give an attractive 8% IRR
- 8.7p/kWh needed for a Equity financed project but a 50% debt financed project required 4.4p/kWh



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



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

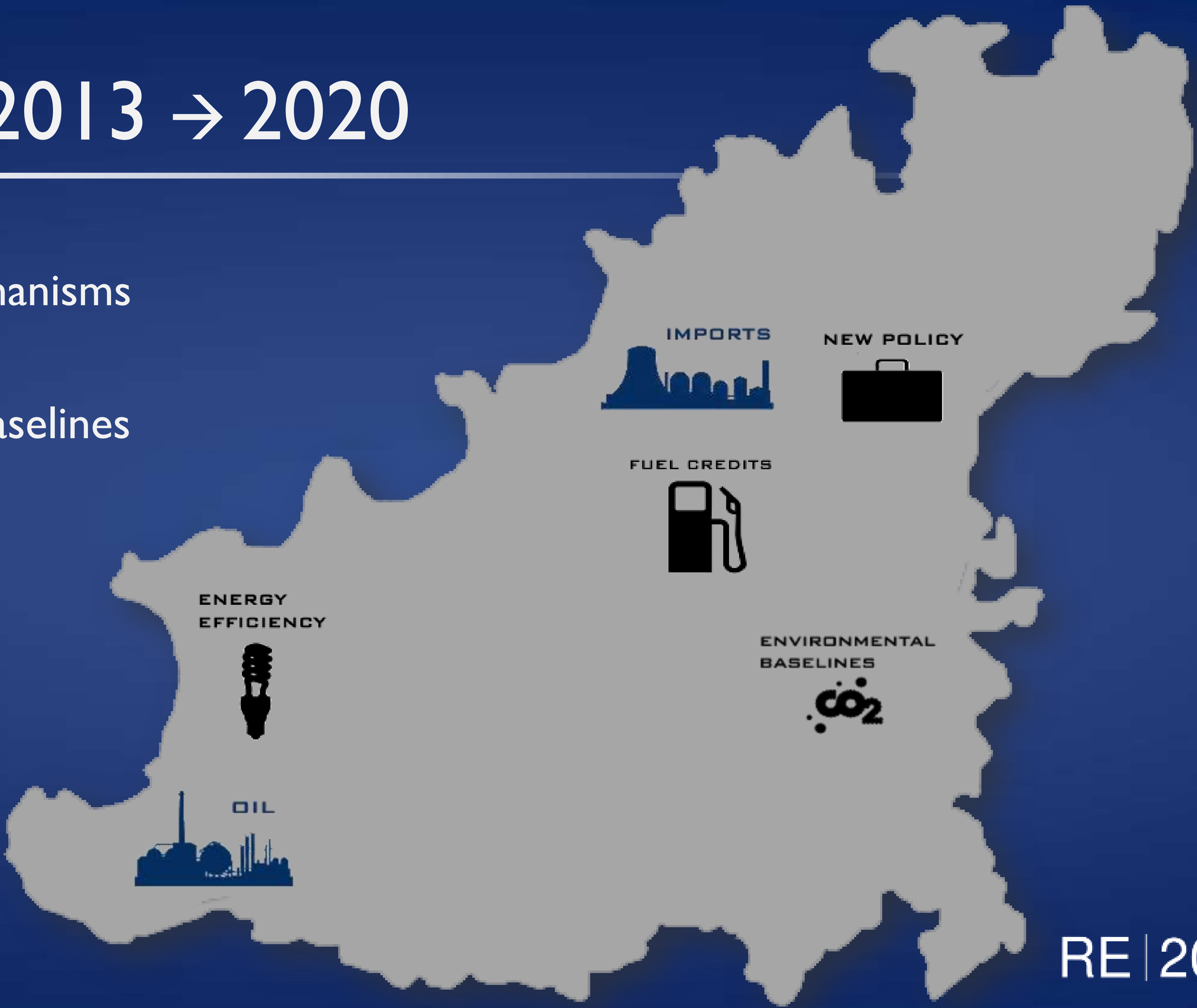
RE | 2013 | Energy Strategy to 2050

Presented by: Matt Fry

Research Team: Dan Sinclair – Robin Duval – Chich Lozano – Matt Fry

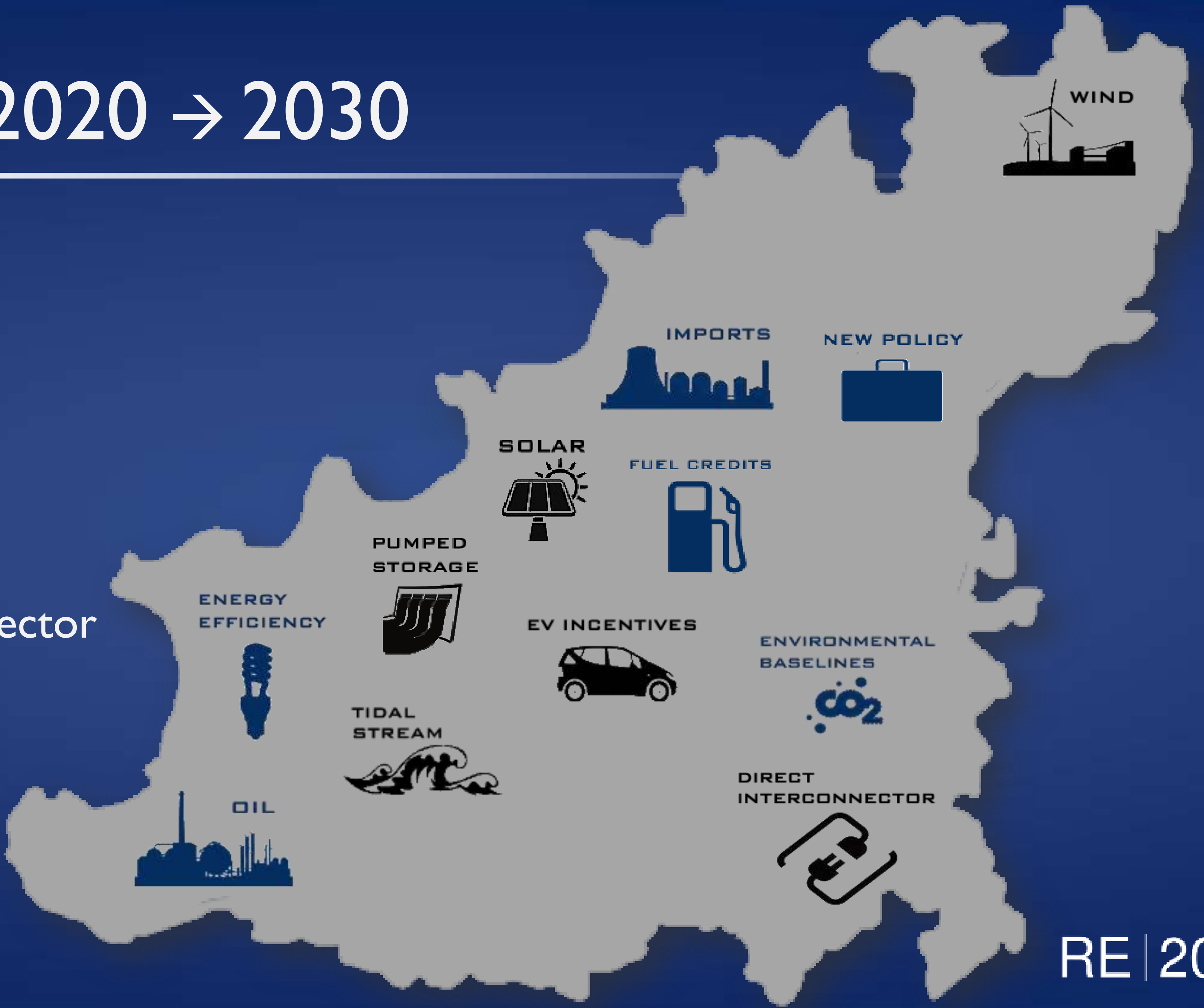
Strategy – 2013 → 2020

- 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



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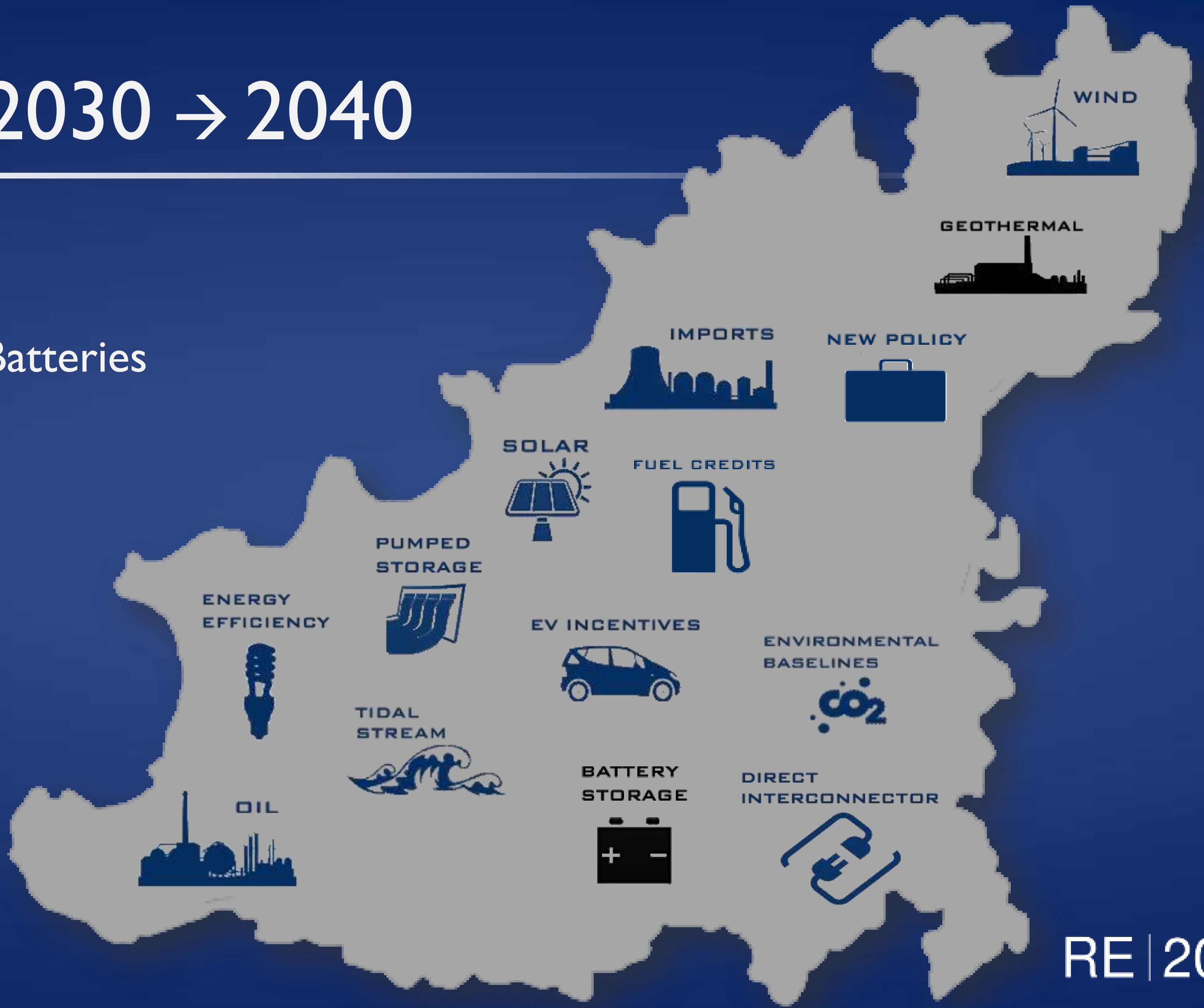
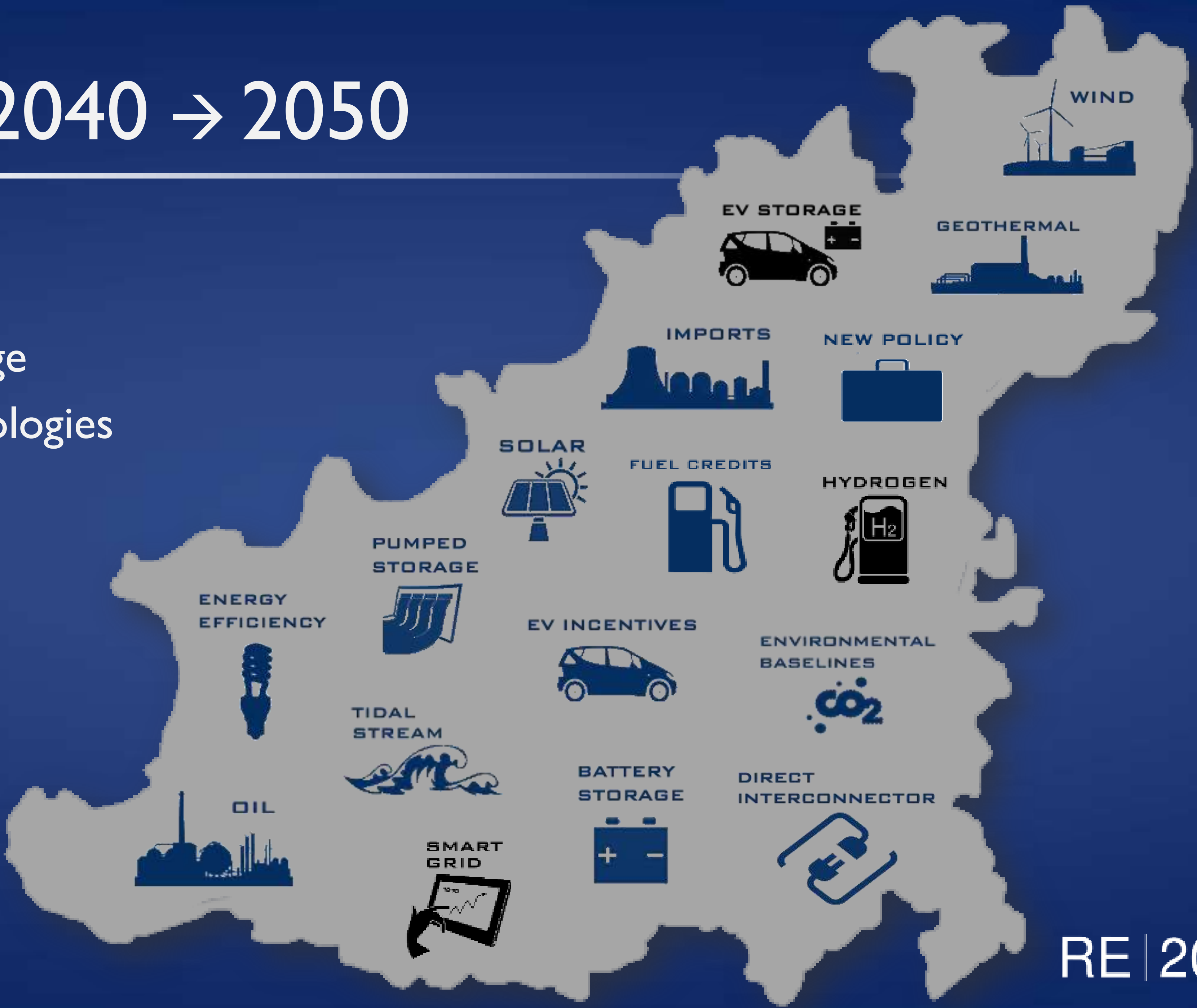
Strategy – 2030 → 2040

- Geothermal
- Vanadium Flow Batteries



Strategy – 2040 → 2050

- Smart Grid
- EV Energy Storage
- Hydrogen Technologies



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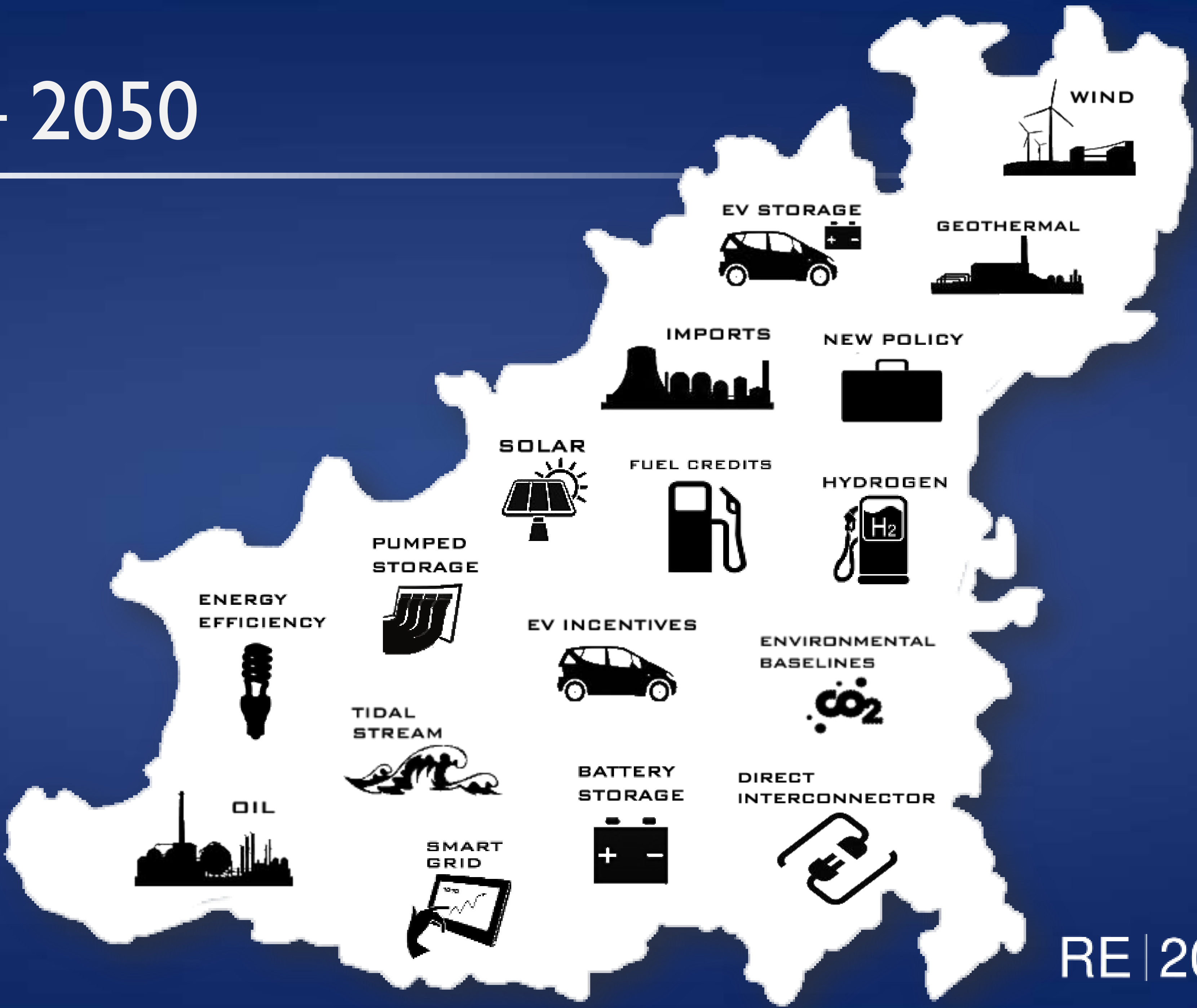
Guernsey – 2050

2050



RE | 2013 | Closing Remarks

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RE | 2013 | Acknowledgements

RE | 2013 | 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