GUERNSEY ELECTRICITY SUPPLY - FUTURE STRATEGY

The Chief Minister
Policy Council
Sir Charles Frossard House
La Charroterie
St Peter Port

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Dear Sir

1. Executive summary

1.1 For any developed and sophisticated economy the provision of a secure, reliable and reasonably priced electricity supply is essential. Such a supply can only be furnished if, amongst other things, the infrastructure involved is well planned, well maintained and replaced and enhanced as necessary to meet demand.

1.2 Guernsey Electricity is entering a key strategic period when it will need to make decisions about major investment in the replacement of ageing local plant and/or the enhancement of the island's power cable connectivity and requires appropriate policy direction of the States to be able to make far reaching decisions in the middle of 2014.

1.3 The purpose of this report is to ensure that the States has an appropriate policy in place to guide Guernsey Electricity in making investment decisions which are appropriate for the island's aspirations, bearing in mind that all islanders will bear the cost of those investments in some way.

1.4 The provision of electricity requires the assessment and balancing of three main factors:

- **Cost**
- **Security**
- **Environmental impact**

1.5 Each of these will affect the other and there is unlikely to be a perfect solution. Consequently, the report considers a number of key questions:

- **Are States members willing to consider a future where all electricity is imported or do they wish to retain local generation?**

- **If it is decided that local generation should be retained, how much is required and what type of generation is appropriate?**
- **How should the infrastructure costs required for electricity supply be met?**

1.6 The report presents information and analysis which is intended to assist the States to consider these questions and to then frame appropriate policy to act as guidance for the industry.

1.7 This report notes that the Island has dependencies on Europe, and France in particular, for imported electricity and on the international fuel supply system for supplies of fuel for local fossil fuelled generation.

1.8 The nature of the electricity supply industry in Europe makes forecasting the sufficiency, or otherwise, of power generation and transmission infrastructure extremely difficult. However, there are significant uncertainties facing the industry. In particular

1.9 The decision to phase out nuclear generation in Germany and the present French government's stated desire to reduce nuclear generation to 50% of its electricity requirement, creates a situation where many observers are wondering how the continent will succeed in maintaining supplies.

1.10 Similarly, in the UK, the recent deal struck between the government and potential supplier Electricite de France for a new nuclear power station has been challenged by the European Commission, leading to further uncertainty.

1.11 Uncertainty also surrounds the development both of shale gas and of coal gasification; two new technologies that might offer significant increases in European indigenous fuel.

1.12 The report contains a review of renewable generation options. The review concludes that renewables are unlikely to make a major impact upon local supplies until the next decade at the earliest, but recognises that the island has significant renewable resources. The report therefore focusses on local fossil fuelled generation which, for the time being, provides the island with security and diversifies its risk, since the principal risk associated with local fossil fuelled generation is in obtaining the fuel itself.

1.13 Against this background of uncertainty, the report **recommends that the States should require local generation and that cable links to other jurisdictions should be added to and strengthened.**

1.14 It further **recommends that the infrastructure for electricity supply should continue to be paid for by electricity customers, without recourse to taxpayers.**

1.15 The report also **recommends the continuance of the "N-2" security criterion and the adoption of an additional criterion to govern the type of generation to be installed.**

1.16 With regard to renewable energy, the report **recommends that the mandate for the Commerce and Employment Department to investigate and prepare for the adoption of local renewable energy should be continued.**

1.17 It is suggested that the objective of minimising atmospheric emissions, contained within the Energy Resource Plan, can best be met for the time being, within a policy which anticipates the strengthening of connectivity to Europe and the expectation that such connectivity will become the principal source of electricity supply to islanders.

2. Explanation of terms and relevant statistics

2.1 Explanation of terms

2.1.1 Energy – is the ability of any fuel to do useful work. In this report energy values are stated in kilowatt hours, abbreviation kWh, which is the unit of energy used on electricity accounts.

2.1.2 Power – is the measure of a devices immediate ability to convert the energy of its fuel into a quantity useful to human activity. In this report power is measured in kilowatts – abbreviation kW and in megawatts – abbreviation MW. A megawatt is a thousand kilowatts. As an example a domestic kettle with a 1kW element will use one kWh of energy in heating water if it were switched on continuously for an hour.

2.1.3 Similarly a 3kW immersion heater would use 3kWh of energy when heating water continuously for an hour.

2.2 Relevant statistics for Guernsey's electricity industry

2.2.1 Annual total energy requirement – approximately 400 million kWh

2.2.2 Maximum demand (2010/11) 85MW *(maximum demand usually occurs at approximately 17.30 on a weekday evening in January or February and is associated with cold weather)*

2.2.3 Minimum demand circa 23MW *(minimum demand usually occurs in the early hours of the morning in the summer months)*

2.2.4 GEL annual revenue from electricity sales circa £53million (2012/13)

2.2.5 Percentage of Guernsey's energy requirement supplied by electricity – circa 30%.

3. The establishment of policy for electricity

3.1 Since 2002 electricity has been delivered to islanders under a commercialised model, where Guernsey Electricity Limited (GEL) is effectively a monopoly supplier wholly owned by the States subject to regulation with both GEL and its regulator operating within a policy framework established by the States.

3.2 In this model the States exercises its policy making function by:

1. Providing directions to the regulator in the exercise of its legal responsibilities through the medium of the Commerce and Employment Department.
2. Providing directions to Guernsey Electricity through the role of shareholder exercised by the Treasury and Resources Department.
3. By the creation of overarching policy documents, such as the Energy Resource Plan, which sets out the States aspirations for the energy sector as a whole.

3.3 The ability to direct the regulator in the exercise of its powers is contained in law, the consolidated text of the Regulation of Utilities (Bailiwick of Guernsey) Law, 2001, contains the following wording at clause 1A:

The States may, on the recommendation of the Commerce and Employment Department made after consultation with the Authority (CICRA), and without prejudice to the provisions of sub-section (1), by Ordinance give the Authority directions of a strategic or general nature including, without limitation, directions concerning the priorities to be taken account of by it in the exercise of its functions and powers under this law and any Sector Law in respect of any utility service.

3.4 States members will be aware that the form of regulation is currently under review and that a report on this from the Commerce and Employment Department is expected in the near future. Whilst such a review may change the mechanisms which provide for oversight of the electricity industry, it will not alter the need for appropriate States policy on the provision of electricity.

3.5 With regard to shareholder guidance, in 2001 (Billet XV111, September 2001, annex 3) the States provided, amongst other things, the following guidance to the then Advisory and Finance Committee, predecessors to Treasury and Resources as shareholder:

"*However electricity services are provided in future, they are to be provided within a policy of retaining sufficient on-Island generating plant to meet the total long term demand, to cover for the possibility of interruption or unavailability of power through the cable link to France"*

3.6 The States refined this policy direction in November 2005 (Billet XX November 2005) when it considered a report from the Commerce and Employment Department discussing the Electricity Generation Investment Options for Guernsey.

3.7 The recommendations of that report, adopted by the States, were as follows:

The Commerce and Employment Department, therefore, recommends the States to:-

1) *Confirm its commitment to the existing policy of retaining sufficient sources of electricity to meet requirements, in any circumstances where two such sources (on-Island generators or the CIEG cable link to France) were unavailable at the same time (the N-2 policy, see 4.2 below);*
2) *Agree that electricity pricing policies should be based on the assumption that, over the coming 25 years, generation requirements will be met by a combination of replacing on-Island generating plant and increasing the guaranteed capacity available to Guernsey through the CIEG cable link to France via Jersey;*
3) *Agree that the above assumptions should be reviewed prior to any decision being taken on major expenditure on generating plant and/or increasing the guaranteed capacity available through the CIEG cable link to France via Jersey;*
4) *Agree that the Policy Council should initiate an Energy Policy Review Group to assess Energy Policy in general and possible future sources of renewable energy, including tidal power;*
5) *Agree that the Policy Council should report back to the States on energy policy, including what investment should be made to assess renewable energy sources and how such investment should be funded.*

3.8 The creation of these resolutions effectively provided guidance to both GEL and the regulator as to the investment to be made into the island's electricity system and the manner in which the costs of these investments should be recovered from customers.

3.9 In January 2012 (Billet III) the States considered and adopted the Energy Resource Plan. Amongst other things, the plan contains the following strategic objectives:

- *Maintaining the safety, security, affordability and sustainability of the Island's Energy Supplies*
- *Reducing the environmental impacts locally as part of our contribution to international initiatives as part of the global community*

3.10 Taken collectively these resolutions and policy directions underpin the present arrangements for electricity supply and form the framework against which to consider the future strategy.

4. Security criteria - definitions

4.1 Throughout this report there are references to "N-2" and "N-1" security criteria.

4.2 An "N-2" security criterion requires that the supplier should maintain sufficient plant and importation facilities such that the island maximum demand can still be met with the two largest sources of electricity simultaneously unavailable.

4.3 Similarly, an "N-1" security criterion requires that the supplier should maintain sufficient plant and importation facilities such that island maximum demand can still be met with the single largest source of electricity unavailable.

4.4 The arithmetic and implications of these criteria are discussed further in section19.

5. The timing of this report

5.1 It is nine years since the States last gave detailed consideration to matters pertaining to electricity supply. The nature of electricity utilities is that they must invest in expensive capital plant which is expected to last for many years. It is, therefore, essential that any strategic direction set by the States has a lifetime similar to the lifetime of the capital assets, which is expected to be between 25 and 40 years.

5.2 Increasing electricity demand, the ageing of the bulk of the on-Island fleet of generators and the interconnection cable failures of 2012 have all created a situation where GEL is faced with a need to invest substantial sums in the very near future, with any decisions required on cable reinforcements by the middle of 2014.

5.3 It is, therefore, appropriate for the States to again consider the strategic direction of the island's electricity industry, whilst recognising that implementing this direction is the function of the company and its regulators.

6. Objectives in electricity supply

6.1 The overriding objective of any electricity supply system is to ensure that electricity is available to customers when and where they wish to use it. Beneath this top level requirement, undertakings strive to achieve a number of objectives in meeting the demand for electricity:

6.2 *Economy* – publically owned electricity undertakings normally seek to set prices at levels which are consistent with providing for their continuing operations and making such returns as their shareholder requires, allowing for continuous improvement in efficiency. Given the ownership structure of GEL, there is little motivation for excess profits to be made.

6.3 *Security and reliability* – undertakings seek to ensure that the supply is as secure as can reasonably be afforded. The requirement for security may well entail additional cost and is frequently a matter of discussion, if not dispute, between undertakings and regulators.

6.4 Similarly the definition of what constitutes acceptable reliability and the potential additional costs of providing it is also a matter of debate.

6.5 To a significant extent the definition of acceptable reliability depends both on what a territory has become accustomed to and on the importance of electricity supply reliability to users of that supply. Guernsey has become accustomed to high reliability and has sophisticated industries, so it is reasonable to expect that the island would not be well served by a reduction in this reliability.

6.6 *Environmental performance* – in past times this measure of an undertaking's achievement was given little consideration. However, undertakings now expect to have performance targets in this area. Such targets usually involve increased costs for the undertaking. For instance it is technically possible to remove many of the pollutants from diesel engine exhaust fumes, but there are significant capital and operating cost implications which must be paid for, almost inevitably by higher charges to customers.

6.7 **Given that these three objectives are all, to some extent, in conflict, it is essential that the States decide where the balance should be struck.**

6.8 In considering the issues, it may be convenient to keep in mind that the outcome desired from these considerations is a suitable balance of the three desirable qualities of electricity supply – **security/reliability, cost & environmental performance**.

7. Present sources of electricity

7.1 GEL currently has three main sources of electricity, each having a different blend of economy, security/reliability and environmental performance and also with differing technical characteristics which have an impact on how the sources may best be used:

7.2 The cable link to Jersey & France

7.2.1 This has costs directly related to European electricity markets. At the electricity and oil prices currently prevailing, it is the lowest cost source of supply for GEL. From an environmental point of view, the electricity purchased has a low carbon content because it is sourced, contractually and with a small price premium, from nuclear or hydroelectric power stations. From a technical perspective the electricity is delivered by a network which is not currently diverse, there being only a single power cable between Guernsey and Jersey, so its security and reliability are compromised. From a political perspective the electricity is sourced in another jurisdiction and transmitted through a third, which may also be factors relevant to its security and reliability.

7.2.2 Whilst the addition of more cables can reduce the technical risk, the political risk of sourcing from another jurisdiction remains unchanged.

7.2.3 A simplified map of the present and potential future cable routes appears as Appendix 1.

7.3 Diesel engines

7.3.1 GEL operates a fleet of six large diesel engines, normally fuelled by heavy fuel oil. Their operating costs are heavily influenced by the price of that fuel oil, a cost which has been notoriously variable in recent years.

7.3.2 In present pricing terms the cost of electricity produced by a diesel engine is approximately 20 to 30% higher than importation.

7.3.3 In security terms the diesel engines are reliable devices, controlled locally and they can be expected to be available for service provided they are properly maintained and have fuel. The security risk for this plant is largely attributable to the risks associated with maintaining a supply of fuel.

7.3.4 From an environmental perspective the machines are major producers of carbon dioxide and also of oxides of nitrogen and sulphur, all gasses whose atmospheric concentrations developed economies are generally seeking to reduce.

7.3.5 A requirement to improve the environmental performance, by reducing some of the exhaust emissions, would cause significant increases in costs which would need to be recovered.

7.3.6 On a localised basis, the diesel engines are also sources of noise and vibration which can affect neighbouring properties.

7.4.7 Of the six diesel engines currently in service, three are already over thirty years old, collectively representing some 45% of the available diesel capacity. Guidelines for similar heavy diesels of somewhat different design suggest a life of 25 years. Unfortunately there is little relevant external information to assist in determining the life of this particular plant, but it is reasonable to expect that plant of this age will suffer decreasing reliability and increasing maintenance costs as time goes by, ultimately leading to a position where it becomes unreasonable to expect continuing economic service.

7.4.8 The latest addition to GEL's fleet of diesel engines is of a different design to its immediate predecessors and offers an improved emissions performance and lower capital costs, making it more suitable for the intermittent running expected when the majority of island electricity is imported over the cable link.

7.5 Gas-turbines

7.5.1 GEL operates a fleet of three gas turbines, fuelled by diesel oil. These machines exist to provide a quick start ability to recover electricity supplies in the event of technical failures and as a last line of defence when other sources are not available for any reason.

7.5.2 They are characterised by high operating costs. Typically, based on current electricity prices, GEL loses money on every unit of electricity produced by these machines. The high costs are caused both by relatively expensive fuel and by poor efficiency of conversion from fuel to electricity – roughly half as efficient as a diesel engine. They are, however, significantly cheaper in capital cost terms than diesel engines, a new gas-turbine will cost something like 70% of the capital cost of an equivalent diesel engine.

7.5.3 In current cost terms the cost of electricity produced by a gas-turbine is approximately 350% higher than imported electricity.

7.5.4 From an environmental perspective, for each unit of electricity produced, the gas turbine produces even larger amounts of carbon dioxide than the diesel engine, but lesser amounts of oxides of nitrogen and sulphur.

7.5.5 A greater use of gas-turbines for power generation than today would probably result in an increased need for diesel oil storage on the power station site, since present storage only allows for these machines to operate for relatively short periods with replacement diesel being obtained from stocks held by local suppliers.

7.6 The balance of economy, security/reliability and environmental performance for each of the current sources.

7.6.1 Each of the current sources has a different balance of these three desirable characteristics.

7.6.2 The balance for each can be summarised in the simplistic "traffic light" display below, with green implying a desirable performance and red undesirable.

CRITERION	IMPORTATION	DIESEL	GAS-TURBINE
LIFECYCLE COST			
SECURE/RELIABLE			
ENVIRONMENT			

7.6.3 Whilst it is hoped that this display is helpful in explaining the issues, it should be appreciated that the cost of electricity from each of these sources changes significantly over time. The cost of imported electricity has dependencies on European market price and the exchange rate with the Euro. Local generation from diesel plant has cost dependencies particularly on the price of fuel oil and the exchange rate with the US dollar.

7.6.4 The 2012/13 annual report from GEL which comments on the events of 2012 contains the following paragraph:

"There have unfortunately been consequences of the cable failures and the reduction of imported electricity supplies for our customers. There has been a significant increase in our costs this year as a result of the change in the source of electricity we have supplied. Whilst the damage caused to the Guernsey-Jersey cable was insured, the costs of on-island generation during the period of its repair were over £6m higher than would have been the case if imports were available. Imports of electricity have been restored but as we are currently generating approximately two thirds of our power requirements costs are also significantly higher this year. Whilst the costs associated with the cable link repair have been recovered and accounted for in these accounts, we are exploring all avenues to recover the additional £6m costs incurred as a result of on-island generation following the failure of the Guernsey-Jersey cable".

7.6.5 This statement demonstrates all too clearly the differing costs of the various sources of electricity.

7.7 Present performance

7.7.1 In considering future policy, it may be appropriate to understand how well Guernsey's present electricity supply arrangements are performing. Three key criteria as performance measurements are the cost of the supply to users, its reliability and its environmental impact.

7.7.2 Information on Guernsey Electricity's performance on these key criteria is available in Appendix 2.

8. Local generation and importation

8.1 From section 7 above it will be recognised that each of the present sources of electricity has a different balance of desirable characteristics. It would be technically quite feasible for the island to seek to achieve a position where all electricity was imported. Similarly, if the States so wished, it would be equally feasible for the island to return to being dependent on local generation for all, or the vast majority of local consumption.

8.2 The present position can reasonably be described as "mixed" since the island has the ability to both import electricity and generate its own as circumstances may require. This position is in accordance with the wishes of the States expressed in 2005 and with the existing security policy adopted by the States. The position, however, may not be the cheapest solution to the provision of local electricity over a long period, since the need for local plant as well as importation facilities may entail capital and operating costs which exceed the lowest achievable.

8.3 The failure and repair of the link between Guernsey & Jersey in 2012 and the subsequent failure of the original Jersey to France cable have caused both Jersey and Guernsey Electricity to become acutely aware for the need to consider options for cable capacity going forward.

8.4 A project to install a third cable between Jersey and France was already underway in 2012 and is expected to complete in early 2015, providing Jersey with much enhanced security and Guernsey with some additional capacity, owing to the fact that all cable-derived electricity is currently supplied via Jersey.

8.5 It should be noted that the failure of the first Jersey/France cable, installed in 1986, has resulted in both islands having inadequate import capacity and has reduced the amount of electricity that Guernsey has been able to import well below levels seen in the period 2001 to 2011. This reduced importation has had to be replaced by increased running of local plant and atmospheric emissions have increased as a result.

8.6 Whilst completion of the additional Jersey/France cable will provide Guernsey with welcome increased capacity, Guernsey is still faced with having a single cable connection to Jersey unless further investment is made.

8.7 In considering the value of both local plant and importation it is sensible to consider the characteristics of a supply system which is either wholly dependent on imports or wholly dependent on local generation, as set out in the following sections.

9. The "all-import" option

9.1 Under this option, GEL would be guided towards making all future investments in cables to allow **all** of the island's electricity to be imported. The regulator would respond accordingly.

9.2 The advantages of such an approach are:

1. The carbon content of the electricity supplied (the amount of fossil fuel burnt in generating it) would be at least as good as the European grid, and better provided GEL can continue to contract for low carbon supplies as it currently does.
2. The "footprint" of GEL's operation on the island would be much reduced – less land, less people and no noise, vibration and emissions since there would ultimately be no island power station.
3. The island would no longer need to import heavy fuel oil, which would have an effect on future harbour provision. There would also be less risk of pollution within the harbour areas and surrounding seas.
4. The price of electricity on the island would be wholly dependent on European market prices and direct dependence on oil prices would end.
5. In the long term, the capital employed for electricity provision would probably be minimised since transmission cables may be expected to have long useful lives.
6. All costs associated with operating the local power station would be removed

9.3 The disadvantages of such an approach would be:

1. The island would be completely dependent on supplies from and through other jurisdictions and potentially open to risk of influence by this dependence.
2. There would be no bargaining counter from local production to assist with price negotiations with suppliers in Europe.
3. In the event of a continental shortage of supply, the island would be at the end of a long supply chain. Whilst such a shortage of supply may be improbable, an incident affecting France's nuclear capacity would cause major disruption across Europe.

10. The "all local" option

10.1 Section 17 below indicates that it is unlikely that widespread use of local renewables can happen before the early years of the next decade at the soonest. Accordingly in the following paragraphs it is assumed that local plant will continue to be fossil fuelled for the time being.

10.2 Under this option GEL would be guided to discontinue any plans to invest in further cables to Europe and to invest in local generation only. The regulator would respond accordingly.

10.3 The advantages of such an approach would be:

1. The island would continue to have a local power station and security of supply could be wholly governed locally, albeit with major dependence on supplies of fuel.
2. Power station expansion would be required, creating employment.

10.4 The disadvantages of such an approach would be:

1. The cost of local electricity would depend largely on the international fuel markets, over which GEL has no control.
2. Power station noise and emissions would increase, the "footprint" of the organisation on the island would also increase.
3. Reliable deliveries of fuel through harbours, or other means, would be required. A failure in the oil supply chain for any reason would immediately begin depleting oil stocks and would ultimately result in a failure of electricity supply. It is probable that increased oil storage would be required to reduce this risk. The risk of pollution would increase in proportion to the increased fuel burn.
4. As well as the physical risks leading to a failure of oil supplies, dependency on oil would also entail a risk from external legislation, such that the grades and quality of oil available might change to the island's disadvantage.
5. A need to meet some form of internationally agreed emissions limits might result in the need for the installation of expensive emissions control equipment.
6. Manpower requirements for GEL would rise, leading to increased operating costs.
7. Electricity would be a high carbon fuel – a situation which would not be in accordance with the objectives of the Energy Resource Plan.
8. The reliability of supply would deteriorate compared to the current position, since local generation failures would immediately impact on customers. Note that the average time a Guernsey customer is without electricity supply each year typically runs at about 25% of the figure before connection of the first cable link, see Appendix 2.
9. The capital employed for electricity provision would probably be higher than for the all import option since plant and machinery, used on a like for like basis, has a shorter life than cable assets.

11 The "mixed" option

11.1 The present position, as required by the 2005 States resolutions, is that GEL has both an import ability and a local generation ability.

11.2 The strengths of this option are:

1. GEL can reasonably choose which source to use according to its immediate cost
2. Unavailability of a source for whatever reason can be substituted by another within technical constraints
3. Sudden failure of a piece of local plant is unlikely to be noticed by customers because the importation system provides additional compensating power.
4. Emissions from local plant are limited by importation
5. Noise and vibration from the power station site is minimised by use of imported power
6. The existence of local generation can provide both a bargaining counter in negotiations with suppliers of imported electricity and an opportunity to supply the European markets at times of high demand and consequent high prices.
7. Dependency is spread between fuel and electricity markets and between fuel and European electricity suppliers.
8. The availability of imported power, particularly during the summer months, may assist both the scheduling and the provision of the necessary skilled labour for maintenance work on local plant.
9. The existence of local plant enables GEL to respond more quickly to sudden increases in demand – as might be caused by the commencement of a new local industry – since importation networks may be expected to have long lead times of between five and seven years whereas the lead time for local plant can be quicker.

11.3 The weaknesses of this option are:

1. Significant capital must be employed in building both importation and local generation facilities, with the certainty that one source or the other will be underutilised for much of the time.
2. The footprint and resourcing of GEL must continue at a level sufficient to ensure reliability of the local generation fleet, even if seldom used.
3. Whilst the volumes of fuel imported are much lower than for the "all-local" option, fuel importation facilities must still be available and risks associated with fuel delivery remain, albeit at the lower levels consistent with the lower volumes.
4. The importation of low volumes of fuel may lead to a lack of interest from commercial oil suppliers, with the potential result of higher prices.

12 The significance of maximum demand

12.1 Any debate about future electricity supply and consideration of options must have some view as to the likely course of maximum demand, since it is the level of maximum demand which ultimately determines the infrastructure required to maintain supply. Forecasting maximum demand many years into the future is far from simple, since electricity demand is affected by numerous features of island life. It is normally the case that increased economic activity leads to greater demand, but with the recognition that increased efficiency in usage can reduce this effect. Since the financial turbulence of 2008, the demand for electricity in the EU has dropped along with economic activity.

12.2 The maximum demand forecast currently in use by GEL and its consultants for plant and importation planning purposes is shown in Fig 1 below.

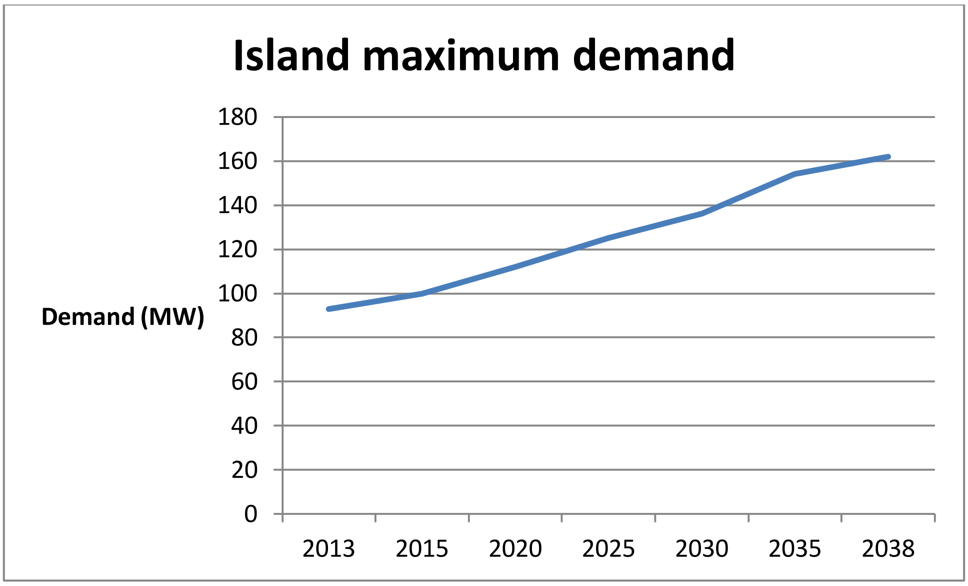


Fig. 1 Island maximum demand forecast 2013- 2038

12.3 This forecast represents the upper boundary of an uncertainty range, which is prudent for plant planning purposes, but development of maximum demand is monitored continually to ensure that investments are timed as appropriately as possible.

12.4 It does not allow for the increased demand that might be associated with the advent of a major new industry, such as a significant data centre. It does allow for normal organic growth in demand and for some switching from other fossil fuels as has been a feature of recent years. It also allows for the adoption of some electric vehicles requiring charging from the grid, albeit that this is not expected to have a major effect on maximum demand since charging is anticipated to take place mainly overnight when other demand is low.

12.5 It should be appreciated that the major influence of actual levels of demand and forecasts of future demand is on the **timing** of infrastructure investment. The present investment needs, however, are being driven by a need to replace ageing plant, coupled with the desire for increased security from additional interconnections. In these circumstances, the forecast levels of maximum demand are less significant that might otherwise be the case.

12.6 In considering the need for future local planting, it may be relevant to examine what increases in local planting could be achieved within the existing footprint of the power station at the Vale. Whilst plant types and outputs may change, there is a reasonable expectation that additional diesel plant with an output of approximately 50MW could be fitted within the existing power station buildings, albeit with a possible need for temporary housings elsewhere on the site whilst existing plant is removed and replacement plant built. This figure could probably be enhanced to 70MW with extensions to the existing buildings.

12.7 These numbers would be increased if the plant type chosen was gas-turbine, rather than diesel, since gas turbine plant has a lower space requirement.

12.8 Whilst this may or may not be adequate to meet actual levels of maximum demand towards the end of the 25 year planning horizon, it is clear that there is no immediate space problem.

13 The role of energy efficiency and demand control

13.1 Consideration of future infrastructure needs often leads to debate about the cost-effectiveness of demand reduction techniques. In countries which have a large industrial base, very heavy users of electricity may well be able to turn off plant or schedule it to run outside peak demand periods, producing a useful contribution to managing peak demand. For Guernsey, however, where most demand is domestic or light commercial, the potential for this sort of activity is limited.

13.2 An alternative technique which assists with demand control, is the use of tariff structures which incentivise users to move demand to times of the day when demand may otherwise be expected to be low, such as overnight. The time of day tariffs in use in Guernsey have been notably successful at improving the overall utilisation of the electricity infrastructure and restricting the growth in maximum demand that might otherwise have occurred.

13.3 It remains the case, however, that peak demands in the island are generated by particularly cold weather and in these circumstances customers must be expected and allowed to keep warm, so the infrastructure must exist to provide for this expectation.

13.4 Notwithstanding these issues of demand control, it is the case that improvements in energy efficiency normally present a compelling logic both on economic and environmental grounds. Given that most observers believe that energy prices will tend to increase at a faster rate than the retail prices index, energy efficiency measures will show even better economic performance as time goes by. Their effect, in infrastructure planning terms, will tend to be to reduce the rate of increase in maximum demand over time, which will quite naturally produce benefits in terms of reduced infrastructure costs and delayed investments.

13.5 A focus on energy efficiency was one of the features of the Energy Resource Plan approved by the States in 2012 and is a matter currently under consideration by the Policy Council's Energy Policy Group.

14 Financial appraisal of options

14.1 As part of its preparation for new investment Guernsey Electricity has engaged consultants to examine the probable financial impacts of the various options. Inevitably the consultants have had to make a large number of assumptions about the capital and operating costs of the various different potential sources of energy, since their purpose has been to examine costs over a twenty five year time horizon.

14.2 In particular they have had to forecast future prices for heavy fuel, against a background of changing international legislation for the use of such fuel. Similarly they have had to forecast both forward electricity prices on the European markets and associated exchange rates, despite the supply uncertainties discussed earlier.

14.3 In considering the cable investments under discussion, it should be noted that under the present commercial arrangements, Guernsey has a guaranteed minimum capacity through Jersey of 16MW, although much larger capacities have regularly been imported in the past, when such capacity has been available because Jersey have not required it.

14.4 For the purposes of this report the appraisal results are presented in summarised form since it is hoped this will aid clarity. Figure 2 below illustrates the net present value of capital and operating costs of various options for providing electricity to the island over a twenty five year time period.

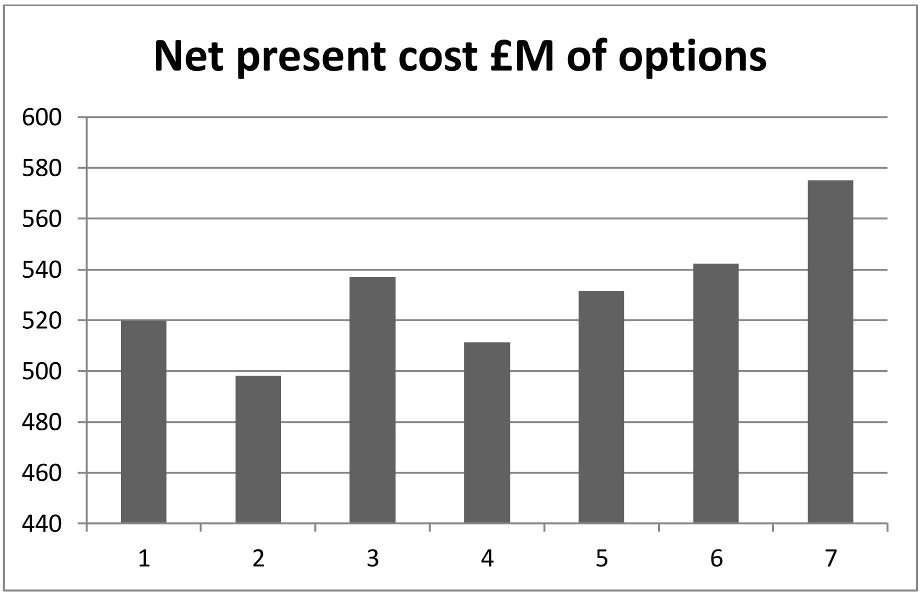


Fig. 2 Net present cost of various options for island supply

14.5 In this figure the options are as follows:

Option 1 – “Mixed” generation and importation with two 100MW cables installed direct to France, no further investment into connections via Jersey, local planting to “N-2” security standard

Option 2 – “Mixed” generation and importation with a single 100MW cable installed direct to France, no further investment into connections via Jersey, local planting to “N-2” standard

Option 3 – “All-local” option, no further investment in interconnectors, local planting to “N-2” standard

Option 4 – “Mixed” generation and importation with two 100MW cables installed direct to France and capacity through Jersey enhanced to a minimum of 60 MW, local planting to “N-2” standard

Option 5 – “Mixed” generation and importation with no direct cables to France but with capacity through Jersey enhanced to a minimum of 100MW, local planting to “N-2” standard.

Option 6 – “Mixed” generation and importation with a single 100MW direct cable to France, capacity through Jersey enhanced to a minimum of 100MW, local planting to “N-2” standard

Option 7 – The “all-import” option, with a major cable installation program designed to obviate the need for local generation. The program would entail two 100MW circuits direct to France and the enhancement of capacity through Jersey to a minimum level of 100MW.

14.6 From this modelling it will be noted that the cheapest solution is to install a single cable direct to France (Option 2), without any upgrade to the connections via Jersey. However, such a solution would ultimately result in the island having a major dependence on this one circuit just as it currently does on the single circuit to Jersey, a dependence which results in a lack of security.

14.7 The next cheapest solution (Option 4) is to upgrade the connections via Jersey to 60MW and install two 100MW circuits to France.

14.8 The “all-local” option (Option 3) is more expensive, mainly as a result of the forecast relatively high price of fuel oil.

14.9 The “all-import” option (Option 7) is the most expensive over a 25 year period due to the need to undertake a major programme of cable construction in a relatively short period, but might prove cheaper beyond the 25 year horizon as there would be no need for further local plant capital and operating costs.

14.10 The other options all illustrate potential differences in cost resulting from varying capital and operating costs, differing investment timings and differing abilities to import electricity.

14.11 The “all-import” option clearly leads to some medium term increases in cost.

14.12 The other options are actually quite close in cost terms, whilst the differences in costs displayed as net present values may look significant, the actual difference between the cheapest and most expensive of these options is approximately £44 million over a twenty five year period. Expressed as pounds per customer per annum this difference equates to **approximately £58 or 7.7%** of the annual electricity bill for a domestic customer using 5000 units of electricity annually.

15. The international situation

15.1 In the event that the islands choose to become wholly dependent on importation by cable and there is a shortage of supply in Europe generally or France more particularly, it is reasonable to suggest that the islands might receive rather less priority than other customers with a greater ability to influence their electricity supplier.

15.2 Historically, since the first importation of electricity into Jersey during the 1980s, the islands’ suppliers in France have proved to be extremely reliable and sensitive to the islands’ situation. It is very much to be hoped that this situation will continue, but in a changing world it may not be wise to consider historic performance as a wholly reliable guide to the future.

15.3 In considering what risk this brings to the island it is pertinent to examine the circumstances of the major European countries, and in particular France since France is not only the supplier for Guernsey and Jersey but also a significant player in the European power market.

15.4 The electricity network operator in France – Reseau de Transport d'Electricite (RTE) periodically publishes an adequacy report, the executive summary of the 2012 report is attached as Appendix 4.

15.5 In brief this report concludes that system adequacy is regarded as secure until 2015, but after that date retirements of older fossil fuelled plant resulting from European emission control measures, coupled with uncertainty on commissioning new plant results in less certainty that electricity demand can be met according to RTE's targets.

15.6 In the United Kingdom the Office of Gas and Electricity Markets – the industry regulator – periodically publishes its own system adequacy review. The autumn 2012 review contains the following wording in the executive summary:

We assess that the risks to electricity security of supply will increase in the next four years. In particular, we expect that electricity de-rated capacity margins will decrease significantly from the current historically high levels. In parallel, the risk of electricity customer disconnections will appreciably increase from near zero levels. This is primarily because of a significant reduction in electricity supplies from coal and oil plants which are due to close under European environmental legislation.

15.7 As an indicator of concern that insufficient generation will be available for the winters of 2014/15 and beyond, the system operator in the UK, National Grid, has recently published a consultation paper inviting industry views on the establishment of a "supplemental balancing reserve" – in effect asking the industry to make available additional generation – or load reduction facilities – in return for payment. This consultation has created interest in the UK in the potential for new diesel power stations to be constructed purely to create reserve capacity.

15.8 At the European level, a supra-national organisation - the European Network of Transmission System Operators for Electricity (entsoe) – broadly concludes that under most scenarios considered, system adequacy is likely to be assured for the whole period through to 2030, whilst acknowledging the difficulty of forecasting.

15.9 It will be appreciated that in the circumstances now prevailing in Europe where commercial operators engage in the market for profit and no organisation has fundamental responsibility for ensuring the reliability and security of supplies, making system adequacy forecasts is very difficult indeed, since the forecasters are attempting to take account of a large number of interconnected variables.

15.10 Drawing an overall conclusion from these forecasts is hardly straightforward, but it may be reasonable to recognise that Guernsey is a small community with little or no direct influence over the thinking of major players in the electricity markets. In such circumstances consideration needs to be given to the risks associated with dependency on the vagaries of the European electricity market with all its own uncertainties.

16 Emissions

16.1 In sections 9,10 and 11 above the various options for policy are considered. It is evident that one of these options, the “all-local” option, would progressively move the island back to a position where all electricity would be produced locally from fossil fuel, at least until local renewables could be deployed. Given that this would be replacing electricity currently imported and sourced from nuclear or hydroelectric sources, it is clear that this option would create a significant increase in atmospheric emissions which is inconsistent with the reduced emissions objective stated in the Energy Resource Plan.

16.2 On the other-hand the “all-import” option would offer the island the potential for further emissions reduction by further reducing the volumes of fossil fuel used locally.

16.3 The “mixed” option clearly lies somewhere between these two, but the precise quantity of annual emissions will depend on the balance of electricity imported and produced locally. The mixed option is consistent with the States objective of reducing atmospheric emissions provided that it is within the context of an enhanced interconnection system which allows use of local generation to be the exception rather than the rule. On the basis that in the area of 90% of local electricity requirements could be imported from low emission sources, or in the long term generated from local renewables, then Guernsey’s electricity would be associated with very low emissions by international standards.

16.4 Its present mandate and licence requirement requires GEL to source its electricity from the cheapest source. Given that the cheapest source is currently importation, then it so happens that the cheapest source is also that associated with the lowest emissions.

16.5 For this reason it is suggested that there is no present need for the States to consider and establish a changed mandate for GEL. This situation will be kept under review and should a situation occur where the objectives of the Energy Resource Plan are facing a long-term threat, a paper will be presented to the States setting out the issues and recommending an appropriate change in policy.

16.6 It should be recognised that within the context of a “mixed” generation and importation policy with improved interconnection arrangements, total annual emissions should reduce as required by the Energy Resource Plan. Instantaneous emissions, however, will still be high if local generation is in use.

17 The role of local renewables

17.1 Given that Guernsey has effectively no fossil fuel, then it is reasonable to note that the only major source of potential indigenous energy is the island's natural supply of sun, wind and tides. The States has previously recognised this and has given the Commerce and Employment Department charge of overseeing research into the various technologies to establish what part they might play in Guernsey's energy future. Commerce and Employment has established the Renewable Energy Team (RET) comprising States members, staff and interested volunteers to further research into the technologies and legislation.

17.2 Whilst all these technologies differ in the manner in which they capture energy, they all share the characteristic that the energy delivered is intermittent and of variable amount. A tidal power device cannot generate at slack water, a wind turbine does not produce electricity on a calm day and a solar system does not generate electricity after dark.

17.3 This intermittent nature of renewables dictates that they are best used in a power system that possesses many other sources of supply. Guernsey's exploitation of its renewable potential is made much more simple and effective if the island has strong interconnections to a larger power system.

17.4 Even a modest local renewable generation system might well produce greater power than could be absorbed in the island overnight.

17.5 The widespread adoption of renewable technologies is, therefore, wholly coherent with the island adopting a strategy which involves strengthening its connectivity to Europe, but incoherent with a strategy which sees the island with either weak or no connections to the outside world.

17.6 Use of renewables is also coherent with a strategy which requires the continuance of local generation in some form and could, in the right circumstances, see renewables being used, to some extent, instead of local fossil fuelled plant. Such a use of local renewables would contribute to the island's energy security.

17.7 This strategy would also be wholly in accordance with the stated objectives of the Energy Resource Plan.

17.8 A review of the potential role for local renewables appears in Appendix 3.

17.9 The essential conclusions of that review are:

- **The island possesses significant resources of a number of forms of renewable energy**
- **The technology for harnessing these resources at a scale suitable to provide a significant proportion of the island's electricity is not yet at an**

adequate state of development to allow the island to use these resources without creating unreasonable additional costs.

- **The likely time scale for deployment of large scale renewable devices is in the decade beginning 2020, when it is forecast that technical progress will have led to major cost reductions and improved installation capabilities.**
- **This time scale could provide much synergy with the present electricity importation contract which runs until 2023**
- **In the meantime further preparatory work is required to ensure that the island has the necessary legislative and technical background to allow effective deployment.**
- **For small scale developments, solar electricity and heat production can offer acceptable economic performance today, but the contribution to the island's total energy demand is likely to be modest.**

18 Financing the capital investment in infrastructure.

18.1 The nature of investment

18.1.1 Whilst this report is intended to create policy which will ultimately have an impact on the amount of capital investment required, the nature of the infrastructure projects which will be needed show common features which have a bearing on the total costs which must be met by islanders in some way.

18.1.2 The common features are:

- Capital investments tend to be large – a cable link to France is expected to cost between £60 and £80million, a new 17megawatt diesel generator will cost in the region of £13million. Although the calculation is simplistic, assuming the cable link costs £70million and it is written off over 25 years with annual island electricity demand of 400 million units, the additional cost per unit of electricity is 0.7pence.
- Capital investment on this scale does not occur every year, rather it occurs at intervals of something like 10 years, depending on the nature of the plant and equipment and on the island demand.

18.1.3 These common features have a significant impact on the costs of providing an electricity service and on how those costs are recovered.

18.2 Recovery of investment costs

18.2.1 Given that Guernsey Electricity remains an entity owned by islanders and which exists for the benefit of islanders then there are only three mechanisms available for investments in electricity infrastructure to be recovered:

- Electricity customers meet all the costs

- Taxpayers meet all the costs
- A combination of the two sources above.

18.2.2 To date, taxpayers have not been asked to make any contribution to the financing of electricity infrastructure and customers for electricity have met all the costs associated with the provision and operation of the necessary equipment.

18.2.3 This approach can be described as the "user-pays" principle and can be readily justified. Whilst all islanders use electricity, the customer base for it is not exactly the same as taxpayers because some individuals and corporates may be major users of electricity but make little contribution to tax revenues.

18.2.4 Whilst the argument in favour of retaining this approach may be clear and persuasive, it can be challenged when a period of major investment leads to rapid rises in charges for customers. The discomfort associated with rapid rises can sometimes be made worse by simultaneous changes in wholesale energy prices which have the effect of creating an even more severe increase in final selling prices.

18.2.5 Despite this challenge, the "user pays" principle is regarded as the fairest method of recovering costs.

19 The "N-2"security criterion and potential developments

19.1 In the event that the States requires the continuance of local generation, then it is appropriate to consider the characteristics of that generation and how much might be required.

The present criterion

19.2 In section 3 above the existing security criterion approved by the States in 2005 is set out. A mathematical explanation of the meaning of the criterion is given in Table 1 below, but in broad terms it provides that GEL is required to ensure that it has sufficient plant and import capability to meet the island maximum demand with its two largest sources of supply simultaneously unavailable. Although the criterion was formalised and adopted by the States in 2005, it had been in existence for many years previously as the internal policy of the former States Electricity Board.

19.3 In current circumstances where the island has only a single cable link and in the previous circumstances where the island was dependent on its local power station the criterion was widely accepted as sensible and was recommended by consultants acting for the Commerce and Employment Department in 2005.

19.4 It is important to recognise that the purpose of a security criterion is to provide some margin of control over the **probability** that the power system will be able to cope with forecast maximum demand. The existence of the "N-2" criterion does not guarantee that supply will be sufficient, as it might be that three or four major sources of electricity might be unavailable at the same time and that this time might coincide with a time of maximum demand. It will be appreciated, however, that the greater degree of redundancy that is built into the system design reduces the probability that the system will not be adequate, but also increases the cost since more capital plant must be installed.

19.5 It is generally accepted that a criterion based on removing items of plant is reasonable for small power systems like Guernsey's, more sophisticated mathematical techniques are used for large systems.

19.6 Table (1) below illustrates the operation of the criterion as presently understood between the States, Guernsey Electricity and its regulator.

Table (1)
THE "N-2" SECURITY CRITERION – PRESENT POSITION

SOURCE	COMMISSIONING DATE	RATING MW
GENERATOR 1C	1979	12.2
GENERATOR 2C	1980	12.2
GENERATOR 3C	1982	12.2
GENERATOR 4C	1987	13.8
GENERATOR 1D	1993	14.5
GENERATOR 2D	2013	17
GENERATOR GT2	1996	19.5
GENERATOR GT3	1997	19.5
GENERATOR GT4	2003	11
GUERNSEY/JERSEY LINK 1 (see note 1)	2000	16
TOTAL CAPACITY		147.9
TOTAL CAPACITY MINUS TWO LARGEST SOURCES (N-2)		108.9
MAXIMUM DEMAND		85
PLANT CAPACITY N-2 IN EXCESS OF DEMAND		23.9

Note 1. For the purposes of security calculations the capacity of the link to Jersey is taken as the minimum commercial entitlement, currently 16MW.

19.7 The capacity margin of 23.9MW is healthy, but prior to the recent commissioning of generator 2D, the capacity margin was only 6.9MW. This position coupled with the ages of the older generators and forecasts of rising demand drove the decision to install generator 2D, at a cost of circa £14 million.

19.8 Applying a 35 year useful life to the generation fleet, results in the reserve margin becoming minus 0.5MW by 2015 and minus 12.7MW by 2017.

19.9 These figures should not be construed as implying that GEL has decided to apply a 35 year useful life, they are simply intended to illustrate the declining position of the reserve margin with the passage of time, unless further investment is made.

19.10 Table (2) below illustrates the position in the event that GEL and Jersey Electricity reach agreement to increase the guaranteed capacity available through the existing single Guernsey/Jersey link to 40MW, following reinforcement of the links between Jersey and France.

Table (2)

THE "N-2" SECURITY CRITERION - WITH G/J LINK INCREASED TO 40MW

SOURCE	COMMISSIONING DATE	RATING MW
GENERATOR 1C	1979	12.2
GENERATOR 2C	1980	12.2
GENERATOR 3C	1982	12.2
GENERATOR 4C	1987	13.8
GENERATOR 1D	1993	14.5
GENERATOR 2D	2013	17
GENERATOR GT2	1996	19.5
GENERATOR GT3	1997	19.5
GENERATOR GT4	2003	11
GUERNSEY/JERSEY LINK 1 (see note 1)	2014	40
TOTAL CAPACITY		171.9
TOTAL CAPACITY MINUS TWO LARGEST SOURCES (N-2)		112.4
MAXIMUM DEMAND		85
PLANT CAPACITY N-2 IN EXCESS OF DEMAND		27.4

19.11 It will be noted that the installed capacity margin has increased from 23.9MW to 27.4MW, a very minor increase considering the scale of investment required to achieve it. The small increase is caused by the working of the criterion, which requires the two largest sources to be excluded and the largest source in this calculation is now the Guernsey/Jersey link.

19.12 With the present system, where the failure of the single connection between Guernsey and Jersey is both foreseeable and has happened, it is reasonable that the security criterion removes all the importation capacity from the calculation since that would be the effect of the cable failing.

19.13 Moving forward, however, in the event that more than one interconnection between Guernsey and the outside world is constructed, it is pertinent to consider the workings of the security criterion in these revised circumstances.

19.14 Table (3) below illustrates the working of the present criterion in the event that a decision is made to install a direct cable to France from Guernsey with a continuous power rating of 90MW.

Table (3)

THE "N-2" SECURITY CRITERION - WITH G/J LINK INCREASED TO 40MW & LINK TO FRANCE

SOURCE	COMMISSIONING DATE	RATING MW
GENERATOR 1C	1979	12.2
GENERATOR 2C	1980	12.2
GENERATOR 3C	1982	12.2
GENERATOR 4C	1987	13.8
GENERATOR 1D	1993	14.5
GENERATOR 2D	2013	17
GENERATOR GT2	1996	19.5
GENERATOR GT3	1997	19.5
GENERATOR GT4	2003	11
GUERNSEY/JERSEY LINK 1 (see note 1)	2014	40
GUERNSEY/FRANCE LINK	2019	90
TOTAL CAPACITY		261.9
TOTAL CAPACITY MINUS TWO LARGEST SOURCES (N-2)		131.9
MAXIMUM DEMAND		85
PLANT CAPACITY N-2 IN EXCESS OF DEMAND		46.9

19.15 It will be seen that despite very considerable investment in interconnections totalling 114MW of capacity, the N-2 criterion has only allowed the capacity margin to increase from the present 23.9MW to a revised level of 46.9MW. Given that the direct cable to France and the route through Jersey are physically and technically diverse so the probability of them both failing together is low, under this model the criterion would no longer be suitable to the revised circumstances where more than one interconnection and local generation exists.

20. Options for a revised security criterion

20.1 "All-local" strategy.

20.1.1 The purpose of a security criterion is to enable the States to direct the probability that there will sufficient electricity system capacity to maintain supply and thus what level of costs the community must bear.

20.1.2 The nature of the criterion will depend to a large extent on what policy the States adopts, be it "all-local, "all-import" or mixed.

20.1.3 In the event that the States decides to adopt the "all-local" strategy, then it is suggested that the present "N-2" criterion is perfectly adequate. It was originally devised in circumstances where the island was wholly dependent on local generation and has been proven over time.

20.1.4 If the States wished to adopt a slightly lower cost solution then they could opt for "N-1" security, which would reduce the required local planting. The capital cost saved by such a move would probably be in the order of £10million, amortised over 25 years or circa £400,000 per annum. GEL's total electricity sales volume is currently about 400 million units annually, so the additional cost represents about 0.1 pence per kWh on the cost of electricity, or about 0.6% on the present average electricity bill.

20.2 "All-import" strategy

20.2.1 In circumstances where the States has decided to progressively remove the need for local generation, then the security criterion will become all about the capacity of incoming cables.

20.2.2 Clearly a single cable without local backup would present an unacceptable probability of failure, given that the repair time for a submarine cable could be as long as six months.

20.2.3 In these circumstances, two cables becomes the minimum requirement, and it would appear reasonable that each cable should be capable of providing for the needs of the island on its own, so the minimum capacity of each cable would need to be at least the level of maximum demand forecast to occur before any new cable could be brought into service.

20.2.4 To provide credibility in security terms, such cables would need to be geographically and technically diverse.

20.2.5 Even in these circumstances it is questionable whether adequate security has been achieved. If one cable failed, then the island would be dependent on its "second string" until such time as the failed cable could be repaired – perhaps six months.

20.2.6 Realistically, therefore, in circumstances where the island has no local generation, three cables would seem to be the sensible complement, each rated to provide the islands forecast maximum demand.

20.2.7 It will be rapidly appreciated that the "N-2" criterion has emerged again for circumstances of "all-import".

20.2.8 For the reasons stated above the adoption of an "N-1" criterion in these circumstances can be seen to involve a high risk that supply could fail totally for an extended period of time.

20.3 "Mixed" strategy

20.3.1 Table 3 in 19.14 above illustrated the working of the present security criterion against a possible future system encompassing local generation, a 40MW cable to Jersey and a 90MW cable to France.

20.3.2 As was noted, the present criterion appears to be possibly unduly conservative in these circumstances because it is attempting to control both local generation and importation.

20.3.3 If the States resolves that it wishes to see a continuance of the mixed strategy, and adopts a security criterion which ensures that local generation is always available to meet forecast maximum demand, then it is questionable as to whether any criterion need also be applied to importation capacity.

20.3.4 It will, however, still be necessary to establish what security criterion should apply to local generation. As set out in 20.1 above, the two credible alternatives are "N-1" and "N-2", and it was noted in that section that the financial implications of maintaining the "N-2" criterion are relatively small in the overall financial package.

20.3.5 The arithmetic workings of these two options are set out in table (4) below, where the importation capacity has been excluded from the calculation.

20.3.6 It will be seen that the potential relaxation from an “N-2” criterion for local plant to the “N-1” criterion allows the reserve margin at present generation complements and levels of maximum demand to increase from 7.9MW to 27.4MW. In practice this change would have the effect of delaying the need for further investment in local plant either to meet increasing maximum demand or to replace ageing plant, giving somewhat lower total investment costs over time.

20.3.7 The savings are, however, modest and it is questionable as to whether the community would be well served by increasing the risks to its electricity supplies, particularly in circumstances where the island is seeking to promote itself as a location for sophisticated industries with a high dependency on electricity.

POTENTIAL SECURITY CRITERIA- WITH G/J LINK INCREASED TO 40MW & LINK TO FRANCE

Table 4

LOCAL PLANT

SOURCE	DATE	RATING MW
GENERATOR 1C	1979	12.2
GENERATOR 2C	1980	12.2
GENERATOR 3C	1982	12.2
GENERATOR 4C	1987	13.8
GENERATOR 1D	1993	14.5
GENERATOR 2D	2013	17
GENERATOR GT2	1996	19.5
GENERATOR GT3	1997	19.5
GENERATOR GT4	2003	11
TOTAL CAPACITY		131.9
TOTAL CAPACITY MINUS LARGEST SOURCE (N-1)		112.4
TOTAL CAPACITY MINUS 2 LARGEST SOURCES (N-2)		92.9
MAXIMUM DEMAND		85
PLANT CAPACITY N-1 IN EXCESS OF DEMAND		27.4
PLANT CAPACITY N-2 IN EXCESS OF DEMAND		7.9

INTERCONNECTORS

SOURCE	DATE	RATING MW
GUERNSEY/JERSEY LINK 1 (see note 1)	2014	40
GUERNSEY/FRANCE LINK	2019	90
		130

21. The nature of local plant

21.1 Planting options

21.1.1 In section 7 above the characteristics of present local plant were discussed against those features of economy, reliability/security and environmental performance which were considered as desirable.

21.1.2 It was noted that at present local plant was either diesel or gas-turbine, with gas turbine plant being less expensive than diesel to purchase but more expensive to operate.

21.1.3 It was further noted that included in the advantages of the mixed strategy was the ability to continue local electricity supplies without dependence on third party jurisdictions and with some ability to negotiate the price of imported electricity, against a background of having local plant with an ability to supply the island.

21.1.4 However, both of these advantages only accrue provided the island has plant which is capable of full time operation at reasonable cost.

21.1.5 In the event that the States resolves to continue with the "mixed" strategy, then it is apparent that States policy would not be complete without some suitable guidance on the type of local plant to be installed and, thus, its operating cost. Such guidance is important both in the context of seeking to maintain a credible on-island production base, but also in the context of guiding the regulatory authority as to what investment costs the States believes to be justified.

21.1.6 In the context of having invested in major importation assets, GEL could choose to meet the security criterion by fitting lower capital cost plant such as gas-turbines. Such a decision would meet the requirements of the security criterion but would not provide the island with a credible long term generating ability except at very substantially increased costs – which would have to be met by the community in some way. It would also significantly degrade environmental performance.

21.1.7 It should be noted that this issue only occurs with the mixed strategy. In the event that the States wishes to see an "all-import" strategy then the question of local plant simply does not occur. In the event that the States selects the "all-local" option, then the regulatory authority would rightly demand some low operating cost plant and GEL could not be commercially successful if it did not install such.

21.1.8 It will be appreciated that the types of plant presently available may change going forward and it is not the purpose of States policy to attempt to dictate to the industry what type of plant should be used, rather the concern is with the operating cost of that plant.

21.2 A local plant cost criterion

21.2.1 The average selling price of electricity can be calculated from GEL's annual accounts by dividing the company's revenue from electricity by its total volume of electricity sales. This figure will change with time to reflect GEL's overall operating costs.

21.2.2 Accordingly, if the States wishes to provide guidance on the operating costs of plant it seeks to have fitted locally it can do so by adopting a criterion which relates the operating cost of plant to be fitted with the average selling price of electricity.

21.2.3 Adoption of a criterion that a minimum of 80% of the island's maximum demand shall be met by plant having operating costs no more than 80% of the average selling price will provide guidance to GEL and the regulatory authority on the States requirements in this respect.

21.2.4 Table 5 below illustrates this criterion for the present plant complement.

21.2.5 In the table it should be noted that the principal source of data is GEL's annual report, but the calculation of the operating cost for plant installed would need to be agreed between the regulatory authority and GEL.

21.2.6 It will be appreciated that whatever type of plant may come along in the future, it can be examined for operating cost in this manner so the criterion should be capable of being used irrespective of plant type.

Table 5

PLANT OPERATING COST CRITERION			
SOURCE	INSTALL DATE	RATING MW	MEETS PRICE CRITERION
GENERATOR 1C Diesel	1979	12.2	Y
GENERATOR 2C Diesel	1980	12.2	Y
GENERATOR 3C Diesel	1982	12.2	Y
GENERATOR 4C Diesel	1987	13.8	Y
GENERATOR 1D Diesel	1993	14.5	Y
GENERATOR 2D Diesel	2013	17	Y
GENERATOR GT2 Gas-turbine	1996	19.5	N
GENERATOR GT3 Gas-turbine	1997	19.5	N
GENERATOR GT4 Gas-turbine	2003	11	N
TOTAL CAPACITY		131.9	MW
CAPACITY MEETING PRICE CRITERION		81.9	MW
MAXIMUM DEMAND		85.0	MW
SALES VALUE OF ELECTRICITY	£52,894,000		
SALES VOLUME OF ELECTRICITY	368,038,000	kWh	
AVERAGE PRICE OF ELECTRICITY SOLD	14.3719	p/kWh	
OPERATING COST OF DIESEL PLANT	9.8	p/kWh	approx
OPERATING COST OF GAS-TURBINE PLANT	32.0	p/kWh	approx
80% OF AVERAGE SELLING PRICE	11.4975	p/kWh	
PERCENTAGE OF MAXIMUM DEMAND MET BY PLANT LESS EXPENSIVE THAN PRICE CRITERIA		96.35	%

22. Conclusions and recommendations

22.1 The purpose of this report is to enable the States to consider and determine the answers to three key questions:

1. **Are States members willing to consider a future where all electricity is imported or do they wish to retain local generation?**
2. **If it is decided that local generation should be retained, how much is required and what type of generation is appropriate?**
3. **How should the infrastructure costs required for electricity supply be met?**

22.2 These conclusions and recommendations are structured to address these questions.

All-import or local generation

22.3 The report illustrates that whilst an "all-import" strategy is technically feasible, it could leave the island vulnerable since it would be at the end of a long supply chain from a European grid which is facing its own uncertainties. The possession of local generation in addition to cable supply spreads the risks to supply between those associated with importing electricity and those associated with importing fuel. Local generation also provides greater flexibility for the island to respond more quickly to changes in demand, such as those associated with the advent of new industries.

22.4 Despite these advantages of local generation, the option of returning to a situation where all or most electricity is generated by local fossil fuelled plant is not recommended, since such an option is likely to be associated with both higher costs and negative environmental impact.

22.5 Recommendation 1.

The States is recommended to continue its present policy of requiring there to be local generation, but with the expectation that there will also be enhancements to the islands connections to other jurisdictions which will allow local generation to take a secondary role to imports in the normal provision of electricity to the community.

The size and nature of local generation

22.6 The report examines the relative merits of the types of local fossil fuelled generation available to the island and also provides information on the potential role for local renewables.

22.7 It is noted that diesel engines enjoy the particular benefit of offering electricity production at costs which would not be crippling to the local economy in the event that they must be run for significant periods because importation is not available. This benefit, however, comes at a cost since the capital cost of continuing to install diesel plant is greater than that of gas-turbines. It is recognised that both of these types of plant are heavy contributors to exhaust emissions, but this is considered acceptable in the context of their usage being limited by the availability of imported electricity.

22.8 Whilst Guernsey is endowed with plentiful resources of renewable energy, the present cost of utilising these sources is deemed excessive as a result of the technical immaturity of the production equipment. It is expected that this situation will change over the next decade and that local renewables will be able to play a part in Guernsey's electricity mix in the 2020's. The adoption of local renewables is entirely coherent with a policy which wishes to retain local generation but also expects greater connectivity with other jurisdictions.

22.9 The report considers in detail the merits of various possible security criteria. It is noted that the present criterion, which seeks to control both importation and local generation plant would be inappropriate for a system enjoying multiple cable connections.

22.10 Recommendation 2

The States is recommended to adopt revised criteria which will not seek to control importation plant but will ensure that local plant is available to keep the lights on. With regard to the amount of local plant to be installed, it is recognised that it might be possible to reduce the security criterion to "N-1" and that such a decision would reduce the costs of local planting. The cost savings, however, are small at probably less than 1% of total costs. The States is therefore recommended to place its security criterion purely on local generation and to maintain the current "N-2" approach

22.11 Recommendation 3

The States is recommended to continue the present mandate for the Commerce and Employment Department to investigate and prepare for the use of renewable energy as part of the island's energy mix.

22.12 The report also discusses whether the "N-2"criterion for local plant is adequate on its own or whether the States should also put in place a criterion designed to ensure that local plant does not progressively have such high operating costs that, in reality, it cannot be used except in a dire emergency. A criterion is suggested which would relate the operating cost of plant to the average revenue from electricity sales, such that plant having an operating cost no more than 80% of the average selling price must be fitted to provide for at least 80% of the islands maximum demand. The adoption of such criteria will provide Guernsey Electricity with certainty as to the States requirements and a clear view of what planting will be required whilst allowing for the emergence of new technologies which might offer benefits including lower costs.

22.13 Recommendation 4

The States is recommended to adopt the 80/80 criterion to ensure that a base of low operating cost plant continues to be installed locally.

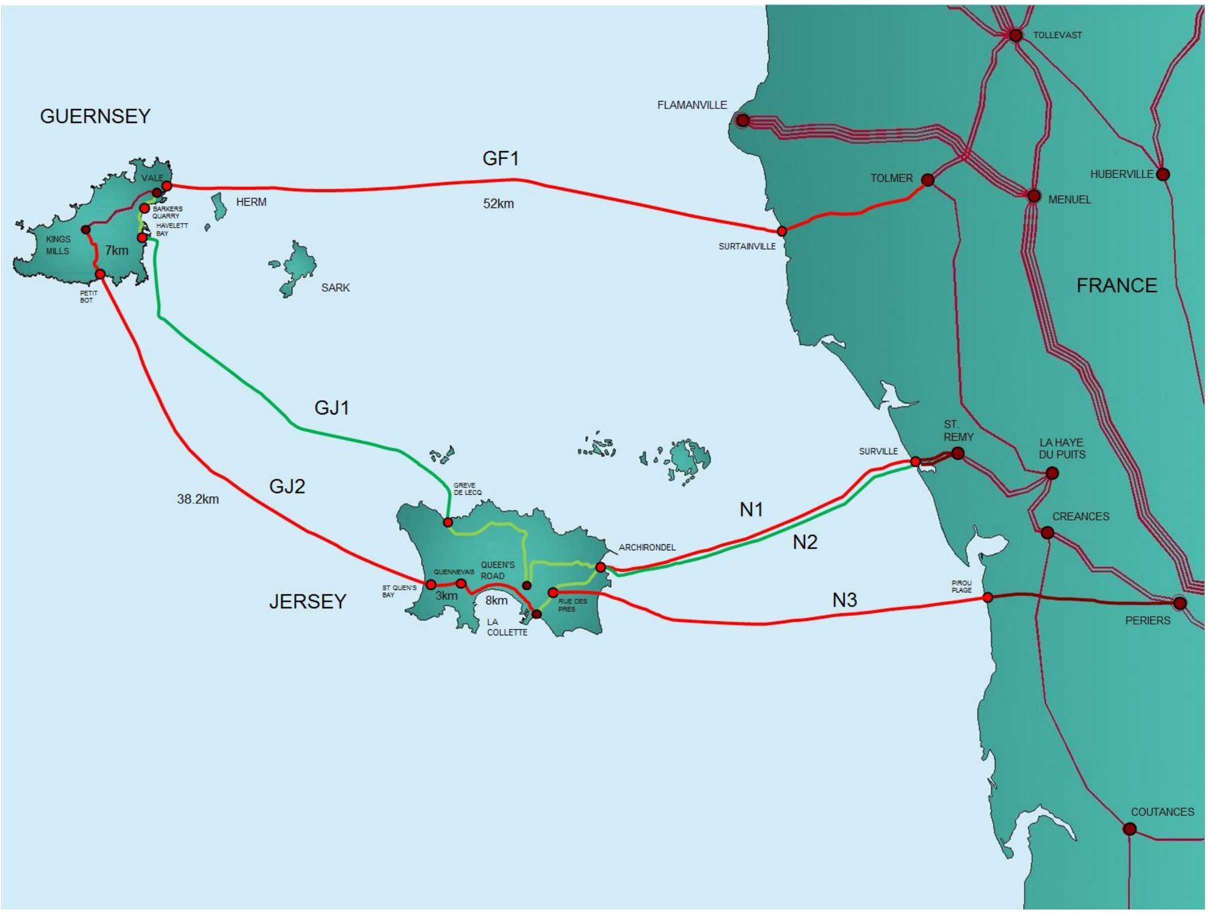
How should the island community pay for the necessary infrastructure?

22.14 The report discusses the three options for payment – from electricity users, from taxpayers or a combination of the two. The report notes that whilst there is much synergy between the two groups, taxpayers and electricity users, there are also significant differences since some corporate electricity users make only modest contributions to taxation.

22.15 Recommendation 5

The States is recommended to continue the existing practice of electricity infrastructure being funded entirely by electricity users.

Appendix 1



Routes of existing submarine cables and potential future connections.

Cables designated GJ1 and N2 are current connections. N3 is under construction and due to be commissioned in early 2015 GJ2, N1 and GF1are potential future cables. A second Guernsey to France connection could be laid on approximately the same route as GF1provided adequate physical security could be provided.

Appendix 2.

Performance measurement of Guernsey's present electricity supply.

Figure 1 below illustrates the cost of domestic electricity in the twenty eight European Union countries plus the Crown Dependencies of Jersey, Guernsey and the Isle of Man, and the islands of Bermuda, Barbados and St Lucia.

It will be noted that for domestic customers, as charted, the cost of electricity in Guernsey lies about mid table and very slightly below the "EU28" average number, whilst being slightly higher than Jersey and the Isle of Man. The price compares very favourably with the other islands charted, which do not enjoy the benefit of external connectivity.

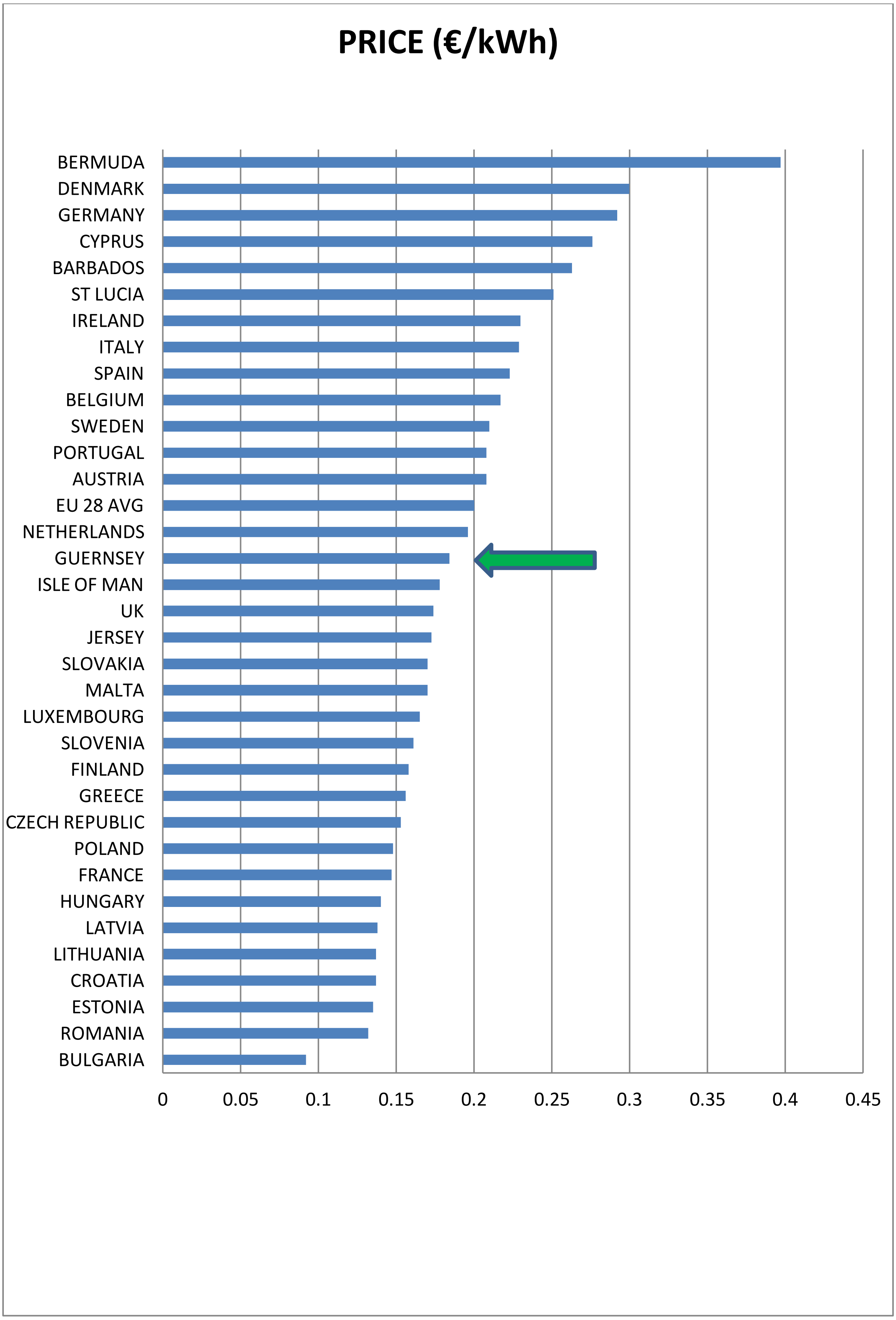


Fig 1 Cost of domestic electricity for 3500kWh per annum, first half 2013.

Source – EU countries, Eurostat, November 2013, data for Crown Dependencies assumes customers on time of day tariffs with assessed split of consumption between normal and low rates, other island data from supplier websites.

Figure 2 below illustrates a measure of the reliability of the electricity supply, relative to the performance in Jersey and the UK.

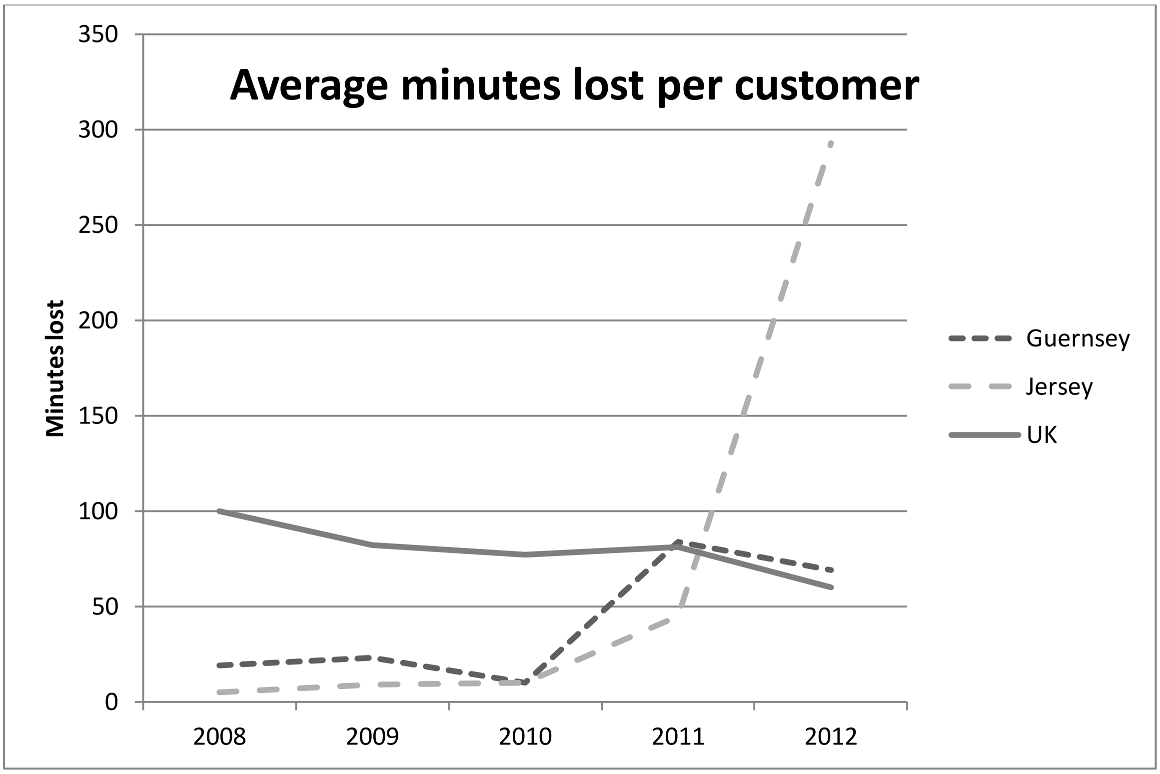


Fig.2 Average minutes of electricity supply lost per annum per customer.

Sources: Guernsey Electricity, Jersey Electricity, UK OFGEM published data

Supply in both Jersey and Guernsey normally has good reliability compared with the UK, but both islands have suffered reduced reliability following the interconnection problems experienced in 2012. Jersey had a particularly disappointing year in 2012 following the failure of the original Jersey/France submarine cable which led to that island having a heavy dependency on the single remaining circuit to France.

The reliability of electricity supply in Guernsey has improved significantly as a result of the interconnection to Jersey and Europe that was completed in the year 2000. Statistics for years prior to, and following, this connection are shown in Figure 3 below.

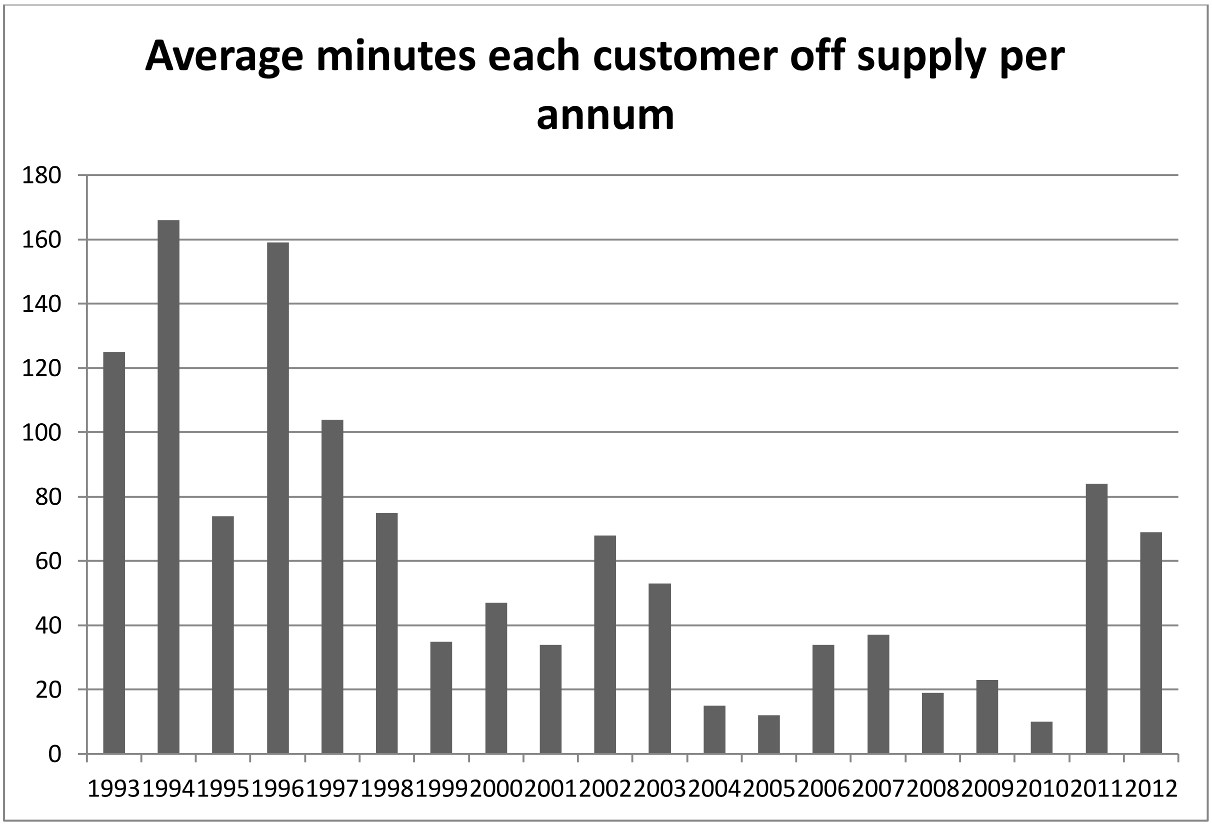


Fig 3. Average minutes each customer in Guernsey has been without an electricity supply for faults of all origins 1993-2012.

Source: Guernsey Electricity published data

The significant improvement created by the interconnection to Jersey and Europe will be noted.

From an environmental impact perspective, Guernsey Electricity's performance is critically dependant on its ability to import electricity. It has adopted an importation contract which requires its supplier to provide electricity sourced either from hydroelectric or nuclear sources, so that all electricity delivered to the island has very low associated atmospheric emissions.

Conversely, if local fossil fuelled generation is used then the atmospheric emissions associated with local electricity are high by international standards.

Appendix 3. Renewable energy.

1.0 Introduction

Renewable energy has been around in some form for centuries, ranging from the watermills used in the UK to the windmills of Scandinavia. Originally it was used for direct uses, such as to grind wheat to make bread, but now the phrase "renewable energy" is used to refer to the generation of electricity from resources that will not be destroyed by energy extraction.

The most often thought of is wind, an industry that, in modern form, has been around for over 30 years and solar energy. Tidal range (the rise and fall of the tides) is another technology that has been around for a number of decades. An example of this technology which will be familiar to many islanders is La Rance Barrage in Brittany, France.

Attempts to extract power from tidal stream (the speed of the flow of the tides) have been made since the mid 1990's and also from wave power in various forms.

Guernsey is fortunate that, to some extent, it has potential in all of these renewable resources. With a climate more akin to northern France than mainland UK, Guernsey experiences higher levels of sunshine (irradiance) than the UK. Guernsey also, due to its geographical position exposed to the Atlantic to the west, has a reasonable wind and wave resource. Through the Big Russel there is an extractable tidal resource, as well as tidal potential in other areas - for example to the west of the island.

Renewables have a high capital cost (CAPEX) relative to most traditional generation methods with offshore wind being in the region of £3million per megawatt installed, compared to approximately £800,000 for diesel generation. This is because while conventional power stations are built as an enclosed system, the way renewables need to be open to the resource means that there must be a number of, potentially large, individual structures. This raises the initial cost and reduces any savings that would be evident in the scaling of a traditional plant. In addition, large scale renewables tend to be installed in increasingly harsh environments (offshore wind/wave/tidal) and this also raises the CAPEX.

Renewables should benefit from lower operational costs (OPEX) over the future as while turbines, and other equipment, need maintaining, so do traditional power stations. However, renewables do not have a fuel cost requirement – the raw resource (wind, sunlight, tide or wave) is "free" - it is the generation equipment (CAPEX) which comes at a relatively higher cost. However, some of the savings on the resource/fuel aspect are offset by the often remote and increasingly harsh environments that the devices are being installed in.

Commerce and Employment has been mandated by the States to investigate and prepare the groundwork for local renewables. In carrying out this mandate Commerce and Employment has created the Renewable Energy Team (RET), a team comprising interested volunteers, political members of the C&E Board and staff. This appendix largely results from work carried out by RET.

This summary is not designed to be a full detailed status report of renewables but is designed to provide readers with a good overview of renewables and an idea of what part renewables may play in the island's energy future and what work still needs to take place.

2.0 Summary table of present and future cost ranges for renewables technologies.

In considering this table note that the current wholesale price of electricity in Europe is in the area of 5 to 6p/kWh, whilst production from diesel plant costs circa 9 to 10p/kWh depending on fuel price

Summary of estimated costs for the principal different renewable technologies

Renewable source/ technology	Potential Guernsey scale project	CAPEX – initial cost per MW of installed capacity (million £ per MW)	Current cost of power – per kWh	Predicted future cost – 2020 (unless stated) – per kWh
Onshore wind	225kW – Circa 0.2% of island electricity	1.1-1.7	8-12.5 p	8-12p
Offshore wind	30MW Circa 25% of island electricity	2.5 – 3.5	14-16p	10-14p
Tidal	100MW Circa 65% of island electricity	5+	Circa 30 to 40p	20-30p *see note 1*
Wave	Unknown – multiple MW	5+	Circa 30 to 40p	20-30p *see note 1*
Solar	500kW (airport) Circa 0.1% of island electricity	1.1 - 1.35	8-10p	7-10p

Note1. The price information in this table results from research carried out by RET and from international published sources. Price ranges for tidal and wave are very uncertain because there are no suitable installed device arrays to allow measurement and the technology has developed far more slowly than forecast. Other technologies are better proven but Guernsey conditions may produce different final costs.

3.0 Macro and micro renewables - definitions

Generally renewables are divided into macro (large or commercial scale) and micro (small scale or for home or small scale commercial buildings). Macro scale renewables tends to refer to large scale commercial projects, such as an offshore wind farm, a tidal array or a solar farm. Micro scale renewables tend to be located on, or in the grounds of, houses and places of business. In Guernsey it has been decided that macro is any development over 50 kW of installed capacity, and micro is any development of 50kW or less. Installed capacity is the maximum rated output that a system can provide, e.g. if a solar panel system is designed to be a 50kW system, it will never produce more than that, but at irradiance levels below a certain limit it will produce less.

For comparison purposes a typical micro system on a domestic property might be expected to have a maximum output in the region of 3kW, well below the 50kW limit.

In the context of overall policy for electricity, it appears unlikely that even the widespread adoption of micro renewable systems by islanders would make a significant difference to the overall strategic position, since the intermittent nature of renewable generation dictates that grid sourced electricity will still be used.

4.0 Overview of Technologies

4.1 Onshore Wind

Onshore wind is the most "mature" of the renewable technologies and can be found in many countries around the world at both macro and micro scales. With onshore wind, Guernsey does have a potential resource due to the islands location and local prevailing winds. Guernsey has decades of wind speed data from the airport, and has also been collecting data at Chouet headland for a little over two years in a more exposed part of the island for prevailing wind records more representative of conditions at sea.

However at a macro scale there are issues that would be difficult to overcome on an Island like Guernsey which is relatively small and relatively heavily populated. The primary limiting factor is that of noise in relation to property, and independent research has concluded that this (along with radar interference, communication links, grid infrastructure and rights of way) potentially limits the potential sites for macro deployment to the Chouet area, and various sites along the south coast cliffs. There may be potential for micro wind for individual property or business use, but this would require further investigation on a case by case basis. The visual impact of onshore wind is also a major factor to be considered but general research has proven inconclusive in favour or against and specific elements of a project and site will affect views.

It should be noted that wind power systems generate electricity during periods when the wind is blowing. They do not require high speed winds to generate, although wind speed affects generated power quantity up to the devices rated capacity (whereby generation is then constant in stronger winds below a cut off limit). There may be times when there is insufficient wind to drive the turbines.

4.2 Offshore Wind

Offshore wind has evolved out of the onshore wind industry and it is still in the cost reduction phase. Costs are relatively higher than onshore because of the increased harshness and remoteness of the locations, operating at sea will always carry higher costs than on land. Again Guernsey has a good resource due to the islands location, although it is limited by current technology. Three sites have been identified within Guernsey waters that could host a 30MW (Guernsey scale) wind farm that fall within the current restrictions of needing less than 30- 40 metre water depth, although because of Guernsey's hydrography they are all within a few miles of the land. The industry is engaged in work to extend the depth range to 50 metres, but costs are presently very high. There is also potential for larger scale development further to the north east of Guernsey, but this is in deeper water and outside of the island's current territorial limit of 3 nautical miles.

4.3 Floating Offshore Wind

Floating offshore wind is still in its relative infancy – the basic difference is whereas traditional offshore wind turbine structures have foundations on the sea bed, a floating turbine does not touch the seabed but is secured in place by anchoring or mooring systems. The concept is still being trialled and tested but may be a future technology that reduces the cost and increases the areas that offshore wind turbines can access - as locations with water depths of greater than 30-40 metres will be suitable for such developments. If the technology comes to fruition there is potential for large scale local developments towards the 12 nautical mile limit in the future which would make use of the prevailing winds to the west.

4.4 Tidal Stream

Tidal stream energy is still in the research and development stage, albeit with reasonably advanced full scale single turbine units in recent years. Guernsey does have a useful resource in the Big Russel, and potentially in other areas with future technological advances. The levelised cost of electricity from tidal is currently considerably higher than other renewable resources already mentioned, but the industry is looking to reduce costs so it becomes competitive with other renewable technologies. Tidal stream devices extract electricity from the flow of the tide, and currently developers are looking for flows in excess of 3 knots at peak spring tides.

It should be noted that tidal stream systems generate electricity during periods of tidal flow and do not require peak flows to generate, but the actual electricity generated is strongly correlated with the speed of the flows. There is no generation of electricity at slack tide and peak generation will occur at peak spring tides. This gives a pattern of four periods of generation and four periods of no generation per day. Unlike some other renewable technologies, this pattern and energy output at a given time are predictable.

4.5 Tidal Range

Tidal range extracts energy from the change in height of the sea from the movement of the tides. Guernsey is not well placed to take advantage of this as the geographical features of Guernsey do not really allow cost effective electricity generation. There are limited bays that could be used in Guernsey and these would require substantial concrete construction in order to generate, which would have a significant impact on the costs of generation and the local environment.

4.6 Wave

Wave power extracts energy from the wave motion, and so is related to general weather patterns and not related to the tidal cycle. It is reasonably correlated to the strength of winds, with offshore winds over the Atlantic generally creating the waves that reach Guernsey waters. There is currently not a universally consistent method for extracting wave energy, some devices float, some are sub surface, some extract from the surface rolling and some take advantage of the circular motion of the water within a wave. Guernsey does have a wave resource potential when the industry is more commercially mature, albeit that large scale measurement of the wave resource has not been undertaken.

It should be noted that wave devices extract energy from the circular motion of the sea due to wind acting upon it; therefore they will only generate power when there are waves. They do not require “big” seas necessarily, although the actual electrical output will be correlated to the wave amplitude and frequency.

4.7 Solar

Solar photovoltaic (PV) is the conversion of sunlight into electricity. This has generally been done in Europe at the micro scale, but some countries including Spain, Germany and the US have undertaken large scale farm projects to produce many megawatts of electricity. This is potentially economically viable in Guernsey as the island has acceptable levels of irradiance, as shown by the adoption across northern Europe.

It should be noted that PV systems generate electricity during daylight hours and do not require full sunlight to generate – although the actual electricity generated is correlated with the amount of daylight peaking at sunny times in the middle of the day in summer. There is no generation of electricity after dark.

Floating PV installed on Guernsey's water storage sites has been suggested recently. While there are efficiencies which can be created from the cooling effect on the panels from the water, Guernsey has a limited supply of open water pools. The main reservoir is not suitable due to its limited depth and the need for solar irradiation to form the first part of the water treatment process. Currently costs are too high to make use of solar for the grid, so only water pools with a demand for electricity in the immediate vicinity are likely to be economically feasible.

Solar thermal uses sunlight to generate heat which is then used to heat water in properties. Again this tends to be on the micro scale, used to reduce water heating costs. The technology for this is well developed and robust and an economic case for it can be made.

4.8 Other renewable technologies

Anaerobic digestion is the process by which micro-organisms break down organic material in the absence of oxygen. This results in the generation of biogas (methane and carbon dioxide, with other contaminant gases) produced by fermenting the organic material food source, usually farm or human waste (manure), slaughterhouse or food waste, or farm crops that have been grown specifically for digestion, such as forage maize. The methane is then used as a fuel for the generation of electricity with heat as a significant by-product. Both the electricity and the heat generated should be utilised.

The possibility of using AD to process either food or farm waste has been investigated in Guernsey but at the present time the small throughput and the quantity of electricity and heat that might be produced in a municipal plant suggests that it would not be an economically viable proposition, so an alternative recycling solution has been adopted for waste streams. This may be reviewed in the future if technology, recycling or farming practices change, but AD is unlikely to form a part of the Guernsey electricity strategy within the foreseeable future. In addition - an AD Plant receiving food waste (and other waste materials) would require a waste management licence as a waste disposal operation. Licences are administered by the Office of Environmental Health and Pollution Regulation. In considering an application for such a licence they would have to consider other waste facilities on the Island, and it would require the consent of the Waste Disposal Authority and States approval

The use of landfill gas to generate electricity is commonly used in the UK and elsewhere to reduce methane emissions and generate extra income. Previous studies in Guernsey have suggested that due to the flooding of the current landfill site it may not be economic to extract the gas for electricity. This is currently being reviewed.

5.0 Analysis of the technologies and their suitability for Guernsey

5.1 Onshore wind:

- Onshore wind is a commercially developed technology which is present in many countries around the world.
- However potential development in Guernsey is limited by a general lack of space on land – it is more likely as a series of micro projects than macro.
- The devices at macro scale are the commonly thought of three blade turbines of varying sizes and hub heights, depending on the power output of the device. At micro scale the devices are more varied, some come in the form of helix shaped vertical turbines, while others have a large number of small blades.
- Onshore wind is likely to increase the cost of electricity if done at a commercial scale, as it would be size limited. There is potential for a small macro device (250kW) to provide power to the grid at just under 10p/kWh and be profitable in future. For micro it would need to offset owners use in order to be worthwhile.
- The annual yield of a 225kW device would be around 870,000 kWh which is around 0.2% of Guernsey's electricity requirement.

5.2 Offshore wind:

- Offshore wind is a maturing technology which has been heavily adopted in northern Europe. It is currently the only large scale commercially available renewable technology that is readily expanding. It does not suffer from the same planning constraints as onshore wind, but does have higher costs.
- Guernsey has potential for offshore wind within the 3 nautical mile limit, to the west and the north of the island. Both would be visible from the coast, but could be scaled to meet local demand.
- The devices are similar in appearance to the onshore wind devices, but due to the increased energy production tend to be of a much larger construction. Hub heights are in excess of 100 metres- for comparison, the present power station chimneys are 55 metres in height.
- The likely cost of electricity from offshore wind is in the region of 15p/kWh currently, although this is predicted to fall in the coming years with the price forecast to be approaching 10p/kWh in the early 2020's.
- Guernsey has potential for a 30MW near shore wind farm that would provide around a quarter of Guernsey's electricity, of which virtually all would be used on island.

  There is also potential for a 100MW or greater wind farm to the north east of Guernsey and south west of the Schole bank which could generate in excess of Guernsey's electricity demand and so would require export.
- RET has undertaken a large amount of work looking at offshore wind and sites and economic appraisals. RET also understands the likely timeline for a

project from conception to completion is around 7 years. Any local development will require about two years detailed wind data from the site of the potential development.

5.3 Floating Offshore Wind:

- Floating offshore wind is in its relative infancy, but is seen as providing potential for the industry to expand the areas that can be exploited since it will permit uses of areas with greater than 50 metres water depth. There are currently test rigs in Scandinavia, and potentially devices will be deployed at “wavehub” in Cornwall in the near future.
- Should floating wind become commercial then there is potential off the west coast of Guernsey for large scale development, providing the territorial limit is extended to 12 nautical miles. This has not yet been quantified, but Guernsey has a good wind resource, so there would be potential for many hundreds of MW.
- The devices themselves would be similar to standard offshore wind turbines, but will probably be larger. The structure will be a floating moored platform (potentially utilising anchoring techniques from the oil and gas industry) rather than piled like current offshore wind.
- Currently cost would be relatively more expensive due to the experimental nature of floating wind; however it is hoped that in the future it will help reduce the cost of the wind industry.
- The potential production is likely to exceed the islands demand, so any project would probably be for export.

5.4 Tidal Stream:

- Tidal stream is still in the research and development phase, with a large number of developers present in the market with a number of different designs. There are test devices in the water in various countries all across the world, from Canada to the UK to China.
  The industry needs to consolidate on a potential design, a mooring system and a method of deployment in order to start to become commercial. Although there are a number of single devices in the water and some are generating power there are still no arrays anywhere in the world. The installation of arrays is an essential next step for the industry to prove the technology and solve other challenges before full scale deployment can take place.
- Guernsey has a reasonable resource in the Big Russel that would be extractable using current technology. There is also a potential resource to the west of the island, and Sark holds potential to the East. However, both of these latter areas would require advancement in technology.
- While there are numerous designs, the basic principle has been to take a wind turbine and place it underwater. The mooring systems are varied and the

installation methods are related to the mooring system. The industry appears to be moving towards easy access to the turbines, which may lead to floating or surface piercing devices becoming the most economical.

- In the UK tidal stream electricity is currently subsidised by receiving five Renewable Obligation Certificates (ROCs) (in excess of 25p/kWh) and when the UK market system changes to Contract for Difference (CfD) they will have a strike price of 30.5p/kWh. The wholesale price of electricity on the UK markets is currently in the order of 5p/kWh, illustrating that tidal is still a very expensive technology. The tidal industry is fully aware of the need to reduce costs and has identified a pathway to achieve this, but until arrays start to be deployed this is unlikely to happen quickly.
- France also offers financial support for tidal – at a lower rate than the UK per unit of power produced, but in addition there are capital grants which the UK does not offer.
- There are two potential avenues Guernsey is looking to explore, one is a next stage array – this is dependent on whether Guernsey would be attractive to a developer – and the second is waiting for commercial maturity for a large scale potentially 100MW scale array.
- The scale of the resource is difficult to estimate, being very dependent on the tidal regime and the efficiency of technologies. Research using data about the tidal streams taken from the Big Russel and knowledge of the current technologies indicates that there is potential to generate about a quarter to one third of Guernsey's current electricity demand within around half of the Big Russel – the half analysed had the best tidal conditions and the remaining half is unlikely to produce as much power.
- RET is staying fully appraised of the industry, has undertaken resource assessments and is undertaking work to fully understand the commercial attractiveness of development in Guernsey waters.
- Guernsey has a very promising tidal resource which is relatively close to shore in relatively sheltered conditions. Guernsey should be able to generate power from the tides when the cost reduces and the technology has made advances – these should happen in the future but are outside Guernsey's control.

5.5 Tidal Range:

- Tidal range is a well understood technology that has been around for many decades. The costs are high, but the lifetime of a project can be extended to a significant timeframe, La Rance has been operational since 1966. However there are potentially large environmental issues with tidal range and this, along with the huge capital cost, have stopped recent proposals such as those in the Severn estuary. This has brought much smaller tidal lagoons more into the focus as they should be relatively environmentally unimposing, although the capital costs will still be high.

- The devices are tidal turbines encased in a large concrete damn. Modern turbines operate in both directions whereas historically they only operated on the out flow, driving the turbines through a reduction in the head of water.
- Guernsey has little potential in tidal range, the tidal ranges are only sufficient to make it economical on spring tides. This combined with the natural geography of the island not having areas of deep water (such as river estuaries) or readily floodable areas make it have little local appeal.
- Cost would be high even with a 60 year project life.

5.6 Wave

- Current wave technology is slightly less well developed than tidal – there is no consistent idea on the best way to extract energy from the waves. There has been an "array" off the coast of Portugal, however this has not been followed up by further arrays, and there are no devices currently in Cornwall's "wavehub" site, set up to test small scale arrays.
- There are numerous different designs, most plan to be floating in some manner, but the Oyster device sits on the seabed. There are point absorbing devices which make use of the rise and fall caused by the waves; attenuating devices which use the bending motion of the waves on hydraulics; rotating devices that utilise the rotation of the waves and other methods as well. As such there is no real design that is common to all – but most appear to be surface piercing in some capacity.
- In the UK wave energy also has access to five renewable obligation certificates, so generators receive in excess of 25p/kWh and when the system changes to contracts for difference they will have a strike price of 30.5p/kWh. This indicates that the cost of wave, like tidal ,is currently much in excess of wholesale market prices, and so would cause an increase in electricity prices. The cost is predicted to come down, and the potential deployment for wave technologies is huge.
- Guernsey has a good wave potential off the west coast thanks to the exposure to the Atlantic Ocean. Potential is limited to the west coast as seabed friction reduces wave amplitude, and seabed depth decreases approaching the French coastline.
- Initial studies in Guernsey indicate that a small number of devices, 8-12, could provide approximately 1% of Guernsey's energy consumption. Further work is needed to full understand the potential for Guernsey, but it appears most likely that wave power would be used primarily for Guernsey consumption, not export.

5.7 Solar PV

- Solar PV is present in many countries across the world. It is more prevalent at commercial scale between the tropics, but countries such as the UK and Germany have commercial solar farms. Solar is also present at micro scale.
- Guernsey has a good potential for macro where the electricity produced can be used locally, replacing electricity purchased from the grid. This is also the case for micro. One challenge for solar is that solar panels require space (either on the ground or on roofs) and a farm of 1MW requires approximately 6-7 acres.
- With micro there are currently no subsidies locally so it would be used for offsetting electricity costs for the owner of the PV system. Businesses and properties that use electricity throughout the day would be well suited to this, while homes which are empty throughout the day with minimal electricity demand are less well suited.
- Electricity produced from solar would cost about 10p/kWh, rather higher than the wholesale market price but close to the cost of diesel generation at present fuel prices. However this is cheaper than the price a consumer pays for electricity at certain times of the day so it makes sense economically if the electricity is used on site.
- Solar is not easily scalable and due to the limited land availability on Guernsey it is unlikely there will ever be more than 10-15MW installed, representing around 2.5 -4% of Guernsey's electricity requirements.

5.8 Solar Thermal

- Solar thermal is a micro scale energy form, generally for heating domestic hot water. A solar thermal system can extract energy from sunlight with a greater efficiency than a solar PV system.
- Used in this way an economic case can be made, with typical payback periods in the order of 7 to 10 years.

5.9 Landfill gas

- Electricity from landfill gas is commonly used as a method to reduce emissions and generate energy, and therefore income, from the methane that is produced during the anaerobic breakdown of waste.
- Landfill gas escapes naturally from a landfill site while in operation, while closed cells tend to have pipes which allow the landfill gas to escape rather than build up to potentially dangerous levels. These pipes can be connected to a flare which is used to heat water and drive a steam turbine or directly to a gas fuelled diesel generator. One consideration is that there are other chemicals contained within landfill gas, and these vary from site to site based

on what waste is landfilled. In the landfill at Mont Cuet there was a deliberate flooding with sea water to put out an underground fire. This has changed the makeup of the landfill gas.

- There is currently work underway looking at whether the current landfill site would be suitable for electricity production going forward.
- Guernsey has historic landfill sites which are not suitable for electricity generation due to the age; the electricity production would not offer a suitable return over the remaining "life" of the methane production.

6.0 Timelines for most promising technologies (listed in order of quickest first)

From the research carried out by RET, the team has formed the following views on the likely timings of the various renewable technologies.

Solar power is the technology that can be deployed in the shortest time, with a project taking as little as 3-6 months to set up from initial investigations (although this can be much longer for more complicated sites)..

There is potential for land to be used for solar farms, at about 6-7acres required per MW installed.

Offshore wind is the only other commercial scale development that is likely to be possible to develop prior to 2020, however if this is to be the case a project would need to be agreed early in 2014, something that is not currently likely. There is definite potential for a near shore development of in the region of 30MW which would provide electricity for Guernsey. The cost of electricity produced would be higher than import prices, but it would provide a degree of security for this part of Guernsey's electricity supply that would not be affected by cost fluctuations.

The costs for offshore wind projects are presently in excess of current sources but they are continuing to decrease so it is appropriate to delay investigation until the early 2020's when costs are forecast be closer to 10p/kWh. In any event, outside development expertise and finance would be needed and a project would only take place if it was economically viable relative to other offshore wind projects. A "near shore" site may also prove controversial as the turbines would be more visible from the shore than a site further offshore. RET is performing analysis into understanding islanders' views on renewable energy generation including the aesthetics from all technologies including offshore wind.

There is also potential for a large scale deployment which would require export potential of 200-300MW although this has other challenges as it is in deeper water, is less accessible and is in an area which is used for other activities. Such a project may also need to be eligible for support mechanisms from outside Guernsey, since the majority of electricity produced would be exported.

Tidal stream power has not reached maturity as expected, and as such remains relatively expensive and still experimental. RET is working to understand if Guernsey would be a good site for first generation arrays, as the resource is good, but not as strong as other areas. If this is the case then, depending on how the industry progresses, there could be small scale development in our waters around 2020, however further work is being undertaken to assess this. An alternative option is to wait for commercialisation and this could lead to a project closer to around 2030 for the first arrays to be installed in Guernsey waters – when the cost becomes more competitive with conventional generation.

Wave power is potentially going to be slightly later than tidal and no development is expected before the 2020s, with any potential project dependent upon the advancement of the industry. More work is required to fully understand the wave resource and therefore to understand the potential power available.

7.0 Synergy with the present Guernsey Electricity import contract

It is understood that the present importation contract provides both low- carbon electricity from nuclear production and also a guaranteed quantity of certified renewable electricity from hydroelectric sources. It is further understood that this contract runs until the end of 2022. Based on RET's views on timescales, there appears to be some synergy between the timing of the end of this contract and the potential for local renewables to begin to provide supplies at reasonable cost.

8.0 Conclusions

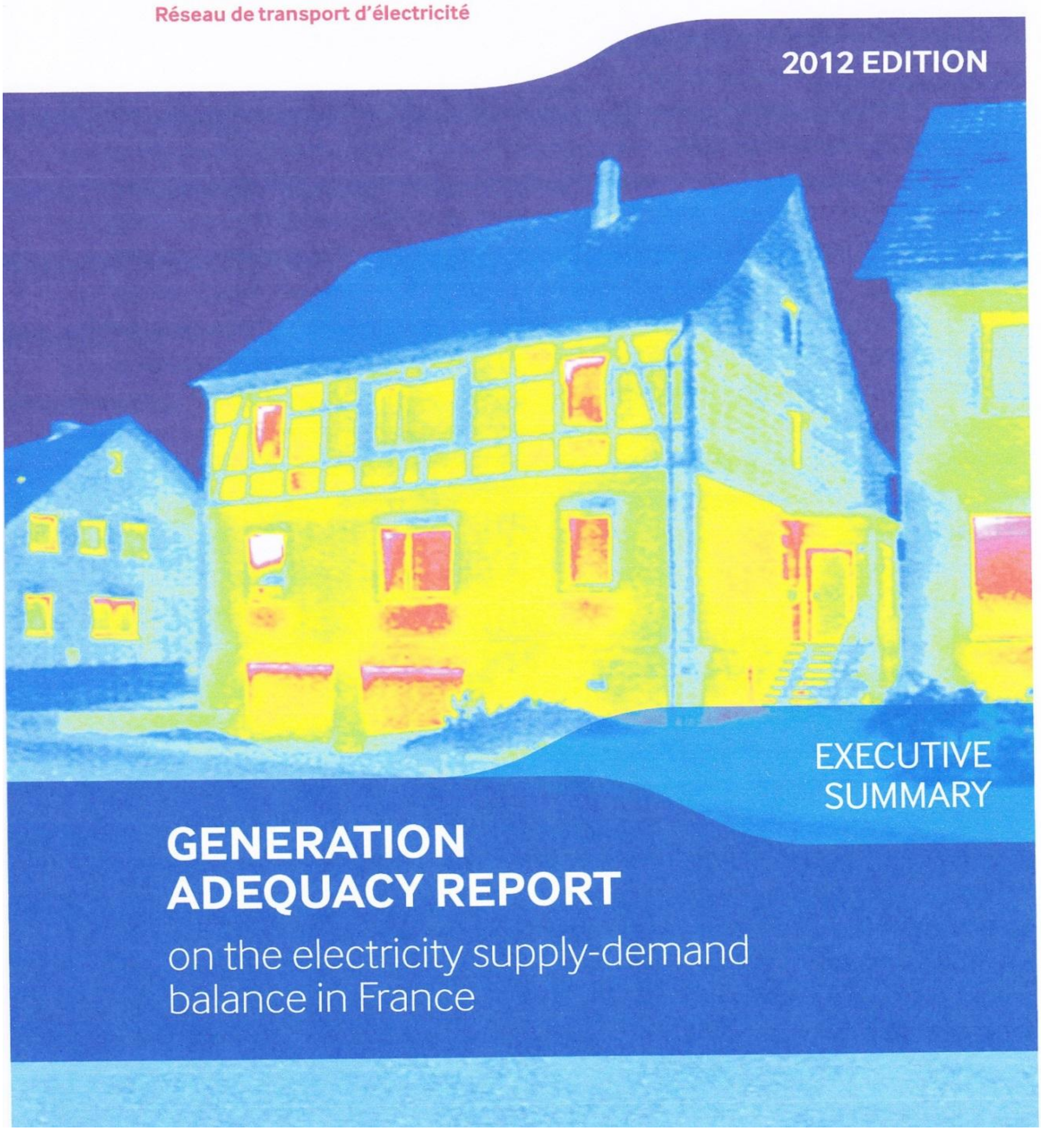
Renewables are an intermittent resource, increasingly predictable but ultimately uncontrollable. If future on island renewable generation was from a mixture of sources it is likely that there would be times when Guernsey could generate more than it would use on island. However, the different renewable sources also act as a balance against each other, with the likelihood of no wind, wave, tide or sunshine being lower than any individual resource.

With appropriate local political will, support and investment, at the appropriate time renewables should be able to play a real role in increasing energy security into the energy mix as locally sourced electricity. Due to their intermittency it is always going to be preferable to have a way to balance the load, whether through a robust cable strategy with another jurisdiction, or through energy storage, a technology which is not available currently.

Given that any deployment of local renewables may well have effects upon the costs of local electricity and potentially on other aspects of island life, it would be necessary to consider a fresh policy approach before large scale deployment could be undertaken. This issue will be kept under continuous review.

Small scale renewables are unlikely to play a major part in the island's electricity future, but are nevertheless desirable in the context of diversifying electricity sources and reducing global emissions. The revised planning system should ease the path for small scale solar.

Appendix 4 System adequacy report for France.



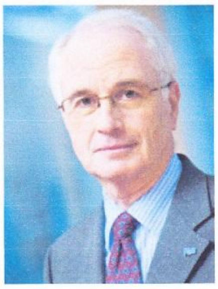
Rte
Réseau de transport d'électricité

2012 EDITION

EXECUTIVE SUMMARY

GENERATION ADEQUACY REPORT

on the electricity supply-demand balance in France



Chairman's message

As required by law, RTE periodically prepares and publishes a forecast of the balance between electricity supply and demand in France every two years. This document is submitted to the Minister responsible for energy to assist in the planning of multi-annual programmes for investing in electricity generation *(Programmation Pluriannuelle des Investissements de production* – PPI).

The purpose of the Generation Adequacy Report is twofold: provide a realistic picture of how the system will evolve over five years and analyse long-term supply-demand balance scenarios. RTE also uses these scenarios for studies conducted on the safety of the electricity system and on upgrades and development of the transmission network.

This year, in comparison to previous editions, a main feature of the analysis on a five-year timeframe is the drop in demand growth that has resulted from the economic crisis since 2011. Lower demand growth can, by nature, ease tensions in the supply-demand balance in Europe and France. However, the crisis has also caused a number of generation capacity projects to be postponed, and the retirement of some plants considered not profitable enough earlier than originally planned. Meanwhile, the exceptional cold spell of February 2012 drove peak demand above the symbolic 100 GW mark for the first time ever. This is proof that the French power system is very sensitive to temperature swings, and that an extreme climate event could create a shortfall situation in France.

Long-term forecasts underscore the potential impact of the main drivers available to adapt France's power mix: energy efficiency, the development of renewable energy sources and changes in the nuclear fleet. The options considered here are not intended to be exhaustive, but rather to provide sufficiently differentiated long-term views of the energy mix in order to analyse the potential consequences on the electricity system. The electricity transmission grid can be adapted in time to changes resulting from energy policy decisions, provided that these decisions leave sufficient room for advance planning.

Managing peak electricity demand must remain a top priority in planning energy efficiency measures, so that switches can be made between energy end-uses to electricity-based solutions while guaranteeing security of supply. In this respect, the development of demand flexibility mechanisms (load shedding, transferring consumption to low-demand periods, etc.) is one of the promising solutions upon which RTE is conducting experiments.

Wider penetration of renewable energy sources, which are intermittent by nature, would necessarily require making changes to how the safety of the system is managed (reserves, demand response and load shedding, etc.). A shift in the geographic breakdown of generation sites (renewable or nuclear) would also require structural changes to the electricity transmission grid. Current changes being effected in Germany are a striking example.

Contrary to popular belief, growth in local renewable energy sources does not result in a decrease in transmission network requirements, but rather makes grids more necessary than ever since they are the available and economically sensible solution for managing intermittent generation and sharing backup supply.

An increasingly large share of RTE's investments is being devoted to developing capacity for accommodating and facilitating the transmission of renewable energy on the grid. Along these lines, RTE is notably preparing plans for connecting renewable sources in cooperation with producers, local authorities and distributors.

The challenge for RTE is to keep pace with changes in the energy landscape. New wind and photovoltaic generation projects are up and running in just a few years on average, whereas the administrative procedures RTE must complete can take more than a decade. Therefore, approval processes for new network transmission infrastructure must be streamlined and shortened to match the time required to bring new generation infrastructure on line if RTE is to be able to keep up.

This Generation Adequacy Report thus contains RTE's analysis of the medium-term supply-demand balance as well as its technical contribution to the debate being held about the energy transition, addressing those issues that relate to the French electricity system in Europe.

Dominique Maillard

Summary

1. TRENDS IN POWER DEMAND OVER FIVE YEARS

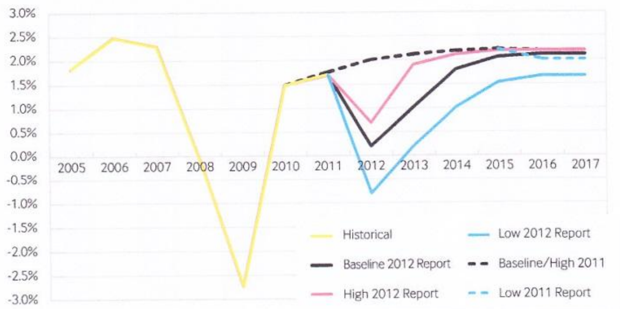
Medium-term analyses rest on four scenarios for demand trends, which are, in decreasing order of energy requirements, "High", "Baseline", "Stronger DSM" and "Low".

Economic crisis translating into lower domestic demand in the short term...

Economic growth slowed sharply in 2008 and then again in 2011, putting downward pressure on electricity demand, especially in the industrial sector.

This slowdown has raised a good deal of uncertainty about future growth forecasts. The decision made here was to base GDP growth estimates for the short and medium terms on a wide range of forecasts (economists' consensus opinions), working with the median and highest and lowest forecasts. The median growth assumptions applied in the "Baseline" scenario for 2012 and 2013, +0.2% and +1.0%, respectively, match those of the IMF (published in January 2012).

Average annual GDP growth by volume



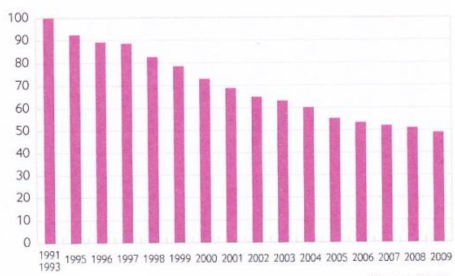
... slowing over the medium term, reflecting the implementation of the thermal regulation and energy efficiency measures...

The effects of energy efficiency measures can only be evaluated over time since they profoundly alter the structure of demand.

By way of illustration, energy labels, now required for a vast array of household devices (appliances, light bulbs, etc.), have substantially improved the performances of these devices.

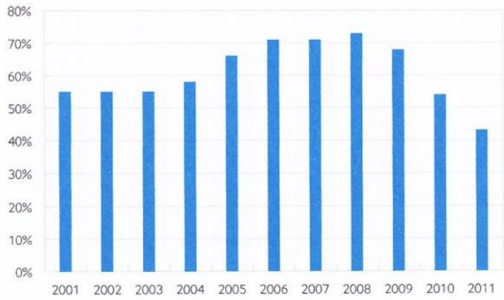
At the same time, there are plans to apply new, more stringent standards not only to household appliances but also to equipment used in industry.

Improvement in average efficiency for appliances thanks to energy labelling – Example of domestic refrigeration (demand by unit of volume, baseline 100 in 1991)



Source: CECED

Share of electric heating in new residential units



Source: BatiEtude

In terms of national regulations, two measures have had a noteworthy effect: the elimination of incandescent lights and the 2012 building energy regulation, scheduled to take effect later this year. Though not yet implemented, the latter has already substantially reduced the share of electric heating in new construction, as shown in the adjacent graph. In 2011, only some 40% of heating systems installed in new build were electric, an even lower share than in 2001. And the percentage should continue to decline in the years ahead.

The table below, showing results for the residential sector, illustrates how RTE's scenarios predict the effects demand-side management efforts will have on different sectors.

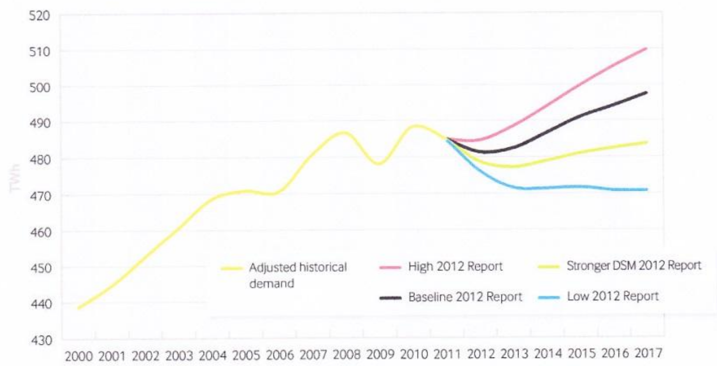
Quantification of the effects of energy efficiency in the residential sector, by scenario

	By 2017					
TWh	***Residential****	*o/w heating*	*o/w sanitary hot water*	*o/w lighting*	*o/w electric appliances (cold/washing)*	*o/w computers and TV*
Baseline	**-8.9**	-2.1	-2.4	-1.6	-3.3	-1.2
Stronger DSM	**-15.3**	-2.6	-3.6	-3.2	-4.2	-2.4

* Total energy efficiency effects are calculated factoring in faster development of some end-uses (controlled mechanical ventilation, distributed uses, etc.) that will reduce their overall impact on demand.

... leading to new demand forecasts for 2017...

Domestic demand forecasts for France (TWh)



Taking into account the current economic environment, the new energy demand forecast applied to the "Baseline" scenario for 2017 is 497 TWh.

The economic assumptions included in this scenario reflect the downturn in activity currently being caused by the global financial crisis. It drives a slowdown in the short term followed by a gradual and partial recovery starting in 2015, as global demand picks up, with economic growth rates more or less returning to the pre-crisis level.

These new forecasts also impact estimates of future peak loads, with the "one-in-ten" peak now set at around 102.3 GW for 2017.

Peak load forecasts under the "Baseline" scenario

GW	2014	2015	2016	2017
Peak at reference temperatures	85.3	86.0	86.5	87.0
"One-in-ten" peak	**100.2**	**101.1**	**101.7**	**102.3**

The demand peak recorded in February 2012 was higher than the "one-in-ten" peak forecast, the cold spell of that month having been an exceptional climate event the duration and intensity of which had not been seen in more than 20 years.

... with wide discrepancies remaining between demand trends in different regions...

An example of particularly dynamic regional demand – relative cumulative trend in demand in Brittany and France compared to 2003

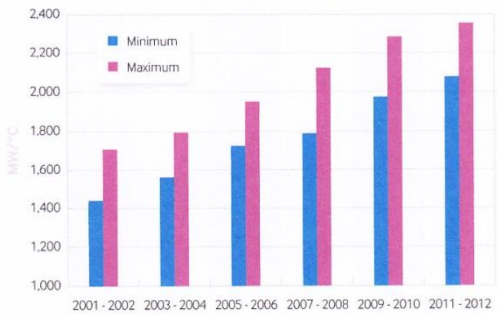
Energy demand is nonetheless evolving at very different rates from one region to the next, reflecting local economic growth dynamics and the power of attraction of the regions. Brittany and Provence-Alpes-Côtes d'Azur (PACA) are two examples of regions where demand is increasing fast and networks need to be strengthened considerably in order to ensure electricity supply.

As shown in the chart above, electricity demand growth in Brittany has been twice the national average since 2003.

... while temperature sensitivity across France makes caution crucial during cold spells.

While the building energy regulation has recently had an undeniable impact on growth in electric heating, and should help moderate the rise in temperature-sensitivity going forward, the fact remains that France has one of the most temperature-sensitive fleets in Europe.

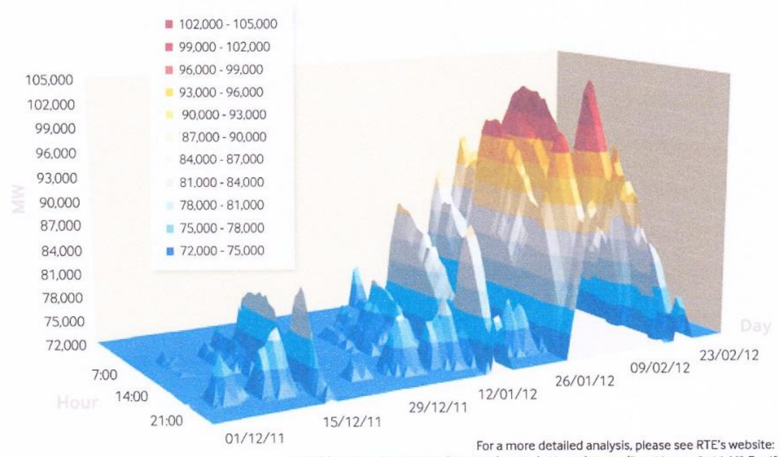
Trend in winter temperature gradient



Based on our newest estimates for the winter of 2011-2012, the gradient varied according to the time of day around an average value of 2,300 MW/°C at 7pm, when demand peaks on winter days. This winter gradient has been steadily rising since the early 2000s, as illustrated in the chart adjacent. It accounts for almost half of the European gradient.

This sensitivity of demand to temperatures is such that when weather is exceptionally cold, the demand peaks seen in France may pose a risk to the supply-demand balance and also lead to operational difficulties. During the cold spell of February 2012, demand in France peaked at 102.1 GW, and demand could only be met because the generation fleet showed a good availability rate and thanks to imports from neighbouring countries. The latter reached a record high of more than 9 GW, which was not far from the physical limitations of the interconnection network.

"Load mountain" in the winter of 2011-2012 – Demand in France



For a more detailed analysis, please see RTE's website: http://www.rte-france.com/uploads/media/pdf_zip/alaune/Rex_Vague_froid_V2.5.pdf

In a word, France must continue to be vigilant about situations of exceptional temperatures, knowing that peak demand might not necessarily be able to be met by a generation fleet designed to do no more than meet the adequacy criterion (loss of load expectation of three hours per year).

To remedy these situations, new demand-response measures must be encouraged, especially as the number of historical load-shedding tariff options is steadily declining. This is the purpose of the experiment RTE will be launching in the winter of 2012-2013 in Brittany, a region where generation only covers about 10% of demand, making the challenge of meeting peak demand particularly pressing.

2. TRENDS IN SUPPLY OVER THE MEDIUM TERM

Significant shifts ahead for the generation fleet with the decommissioning of fossil-fired units, the development of renewable energies and the closure of Fessenheim in 2017.

The biggest change affecting the generation fleet over the medium term will be the sharp contraction in fossil-fired generation capacity, with more than half of the coal- and oil-fired units and combined heat and power plants currently in service being taken off line by 2016.

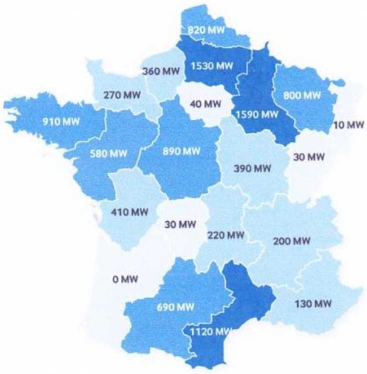
- In accordance with the EU directive on large combustion plants (LCP Directive), the 15 coal-fired units commissioned prior to 1975 will be retired in 2016, resulting in a 3.9 GW reduction in total capacity between 2012 and 2016
- Implementation of the Industrial Emissions Directive could result, by 2016, in six of the eight centralised oil-fired facilities being taken out of service, reducing installed capacity by 3.8 GW
- As for combined heat and power (CHP) units, feed-in tariffs are ceasing to apply to a large share of output as the contracts signed some 12 years ago expire. The 2012 Generation Adequacy Report once again assumes that capacity will be reduced by about 3 GW from the early-2012 level.

Four new combined-cycle gas turbines (CCGTs) are due to come on line by 2017, while the OCGT fleet will remain stable.

Centralised fossil-fired capacity - Installed capacity under Baseline scenario

The pace of development of renewable energies has slowed somewhat but remains robust. Approximately 1 GW of wind power had been added annually in France for several years, but in 2011 wind power growth was substantially lower, a trend that carried over to the first quarter of 2012. The expansion of the photovoltaic fleet had been extremely strong in 2011 and early in 2012 but is slowing sharply now due to adjustments made to support mechanisms early in 2011.

Estimated onshore wind power capacity in service in 2017 (Total = 11 GW)



For the 2012 Generation Adequacy Report, it is assumed that wind and photovoltaic capacity will expand by 800 and 500 MW a year, respectively, implying that growth in both industries will remain buoyant yet substantially lower than in the recent past. Connection of offshore wind farms is envisaged after 2017.

Lastly, as agreed with the government, it is assumed here that, with regard to the nuclear fleet, the two reactors at Fessenheim will be taken offline in 2017 (1.8 GW). The commissioning of the new Flamanville facility (1.6 GW), currently under construction, is taken into account, with commercial service scheduled to start in 2016.

Connecting renewable energy to the grid: an increasingly important driver of network development

Growth in renewable energy source capacity, especially photovoltaic and wind power, necessarily requires an adaptation of the transmission network, even when connection is to distribution networks. To this end, RTE is preparing regional renewable energy connection plans that will help the country meet its 23% RES target for 2020.

Following the publication of the first regional plans for the climate, air and energy late in June 2012, RTE is currently conducting studies on the first connection plans in liaison with local players (producers, local authorities and distributors). These plans will be used to better coordinate the development of the transmission network with that of renewable energies.

3. MEDIUM-TERM FORECASTS

Security of supply should be guaranteed through 2015, with the commissioning of several combined-cycle gas turbine plants offsetting the retirement of fossil-fired capacity over this timeframe.

Starting in 2016, security of supply will be tighter, taking into account the planned shutdown of coal- and oil-fired and CHP plants after the Industrial Emissions Directive goes into effect on 1 January 2016. At this horizon, the annual loss of load expectation rises to five hours, with the capacity shortfall reaching 1.2 GW. This is lower than the 2.7 GW shortfall identified in the 2011 Generation Adequacy Report. The decline is attributable chiefly to the drop in demand growth caused by the economic crisis.

In 2017, the annual loss of load expectation increases to 6.5 hours, as the scheduled shutdown of the two nuclear reactors at Fessenheim will not be offset in full by the commissioning of a CCGT plant and the expansion of the wind and photovoltaic power fleets. The capacity shortfall for that year is estimated at 2.1 GW.

Capacity shortfalls projected for 2016 and 2017 could be covered if projects that are already in an advanced stage, or new peak-load facilities, are brought on stream by that time, or if the decommissioning of some generation facilities is postponed.

It thus seems that supply and demand could be balanced at national level after a shutdown of the Fessenheim reactors in 2017, but only with support measures planned in

Summary of shortfall analyses for different demand and exchange scenarios

Capacity shortfall (GW)	2014	2015	2016	2017
Baseline scenario with exchanges	0	0	1.2	2.1
Baseline scenario "without exchanges"*	3.1	4.6	7.5	8.6
High scenario with exchanges	0	0	2.3	3.4
Stronger DSM scenario with exchanges	0	0	0	0
Low scenario with exchanges	0	0	0	0

* "Central scenario" mentioned in article 5 of Decree No. 2006-1170 of 20 September 2006

advance. Additional technical studies must also be carried out to assess the consequences decommissioning could have on the operations of the electricity system (distribution of flows, voltage stability, etc.), factoring in trends in electricity supply and demand close to Fessenheim, on both sides of the Franco-German border.

Estimates of additional capacity requirements at national level take into account the central role interconnection plays in security of supply, allowing generation capacity to be pooled across the continent. As such, the development of 2 GW of additional capacity by 2017, along the Spanish and Italian borders, would help reduce the shortfall risk.

If exchanges are excluded, the capacity shortfall would be significantly higher, reaching an estimated 7.5 GW in 2016 and 8.6 W in 2017. These results demonstrate the major contribution made by European interconnections to security of supply in France. The estimates are comparable to the ones included in previous editions of the Generation Adequacy Report.

The different variants used show the high degree to which the adequacy criterion is sensitive to the assumptions applied, in particular to trends in demand. Numerous uncertainties can influence this result going forward: the choices made by generators or policy decisions about retiring specific units or keeping them in service, the pace of development of renewable sources, the availability of the fossil-fired fleets, etc.

It should be noted that even if the loss of load expectation is kept under three hours, the risk of imbalance between supply and demand is not totally eliminated: the occurrence of very unfavourable contingencies, particularly an extremely intense cold spell such as that seen in February 2012, could result in even more significant power cuts, reflecting trends in temperature-sensitivity and peak demand.

4. PROSPECTIVE SCENARIOS FOR THE LONG TERM

Whereas for the medium-term horizon (five years) the structure of demand and supply can be more or less estimated based on decisions already taken, forecasts for the long term require the creation of prospective scenarios incorporating differentiated assumptions.

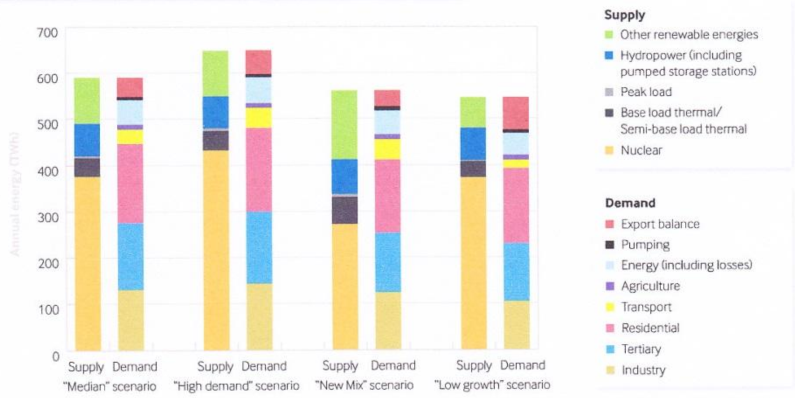
RTE has chosen to establish four prospective supply and demand scenarios that are consistent and balanced, yielding as many visions of what the electricity mix could be in 2030 and providing data for future analyses of the network's robustness:

- The "Median" scenario involves continuity with current trends, with a gradual reduction in installed nuclear capacity (down to 56 GW in 2030, per the "moderate" trajectory identified by the Parliamentary Office for the Evaluation of Scientific and Technological Options in its report, "The Future of Nuclear in France", published in

December 2011), moderate demand growth and the steady development of renewable sources

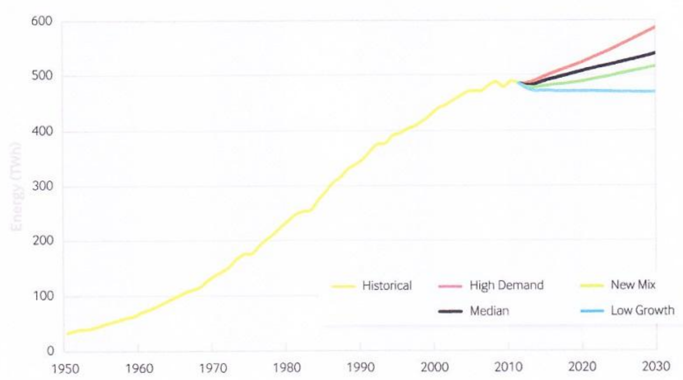
- The "High Demand" scenario, characterised by an acceleration of demand (notably from the development of electric vehicles), with nuclear continuing to account for a large share of electricity generation
- The "New Mix" scenario, detailed later on, considers a significant reduction in the nuclear generation fleet
- Lastly, the "Low Growth" scenario, under which economic growth remains sluggish.

Comparison of the different scenarios in the 2012 Generation Adequacy Report – Energy balance through to 2030



These scenarios lead to very different outcomes in 2030. Domestic power demand would reach 590 TWh that year if the "High Demand" scenario came to fruition, or 468 TWh if the "Low Growth" scenario proved accurate.

Forecasts of French domestic demand by 2030 based on the different scenarios



The trend in the "one-in-ten" peak converges toward that of energy demand thanks to ever-stricter thermal regulations for buildings. Even under the "High Demand" scenario, annual average growth in peak demand remains below the 3% of the 2000s, when it grew faster than energy.

Regarding trends in supply, renewable energy growth is robust under all scenarios, with the share of RES doubling or tripling from current levels. The share of nuclear generation varies under the different scenarios, ranging from about 50% under the "New Mix" scenario to almost 70% in the "High Demand" scenario.

"One-in-ten" peak load forecasts, in GW

Scenario	2014	2030	2014-2030 CAGR*, %
High Demand	100.7	119.2	1.1
Median	100.2	110.4	0.6
New Mix	98.8	105.7	0.4
Low Growth	97.5	97.7	0.0

* Compound annual growth rate

In keeping with the approach taken in the 2011 Generation Adequacy Report, the "New Mix" scenario explores several of the consequences of an assumption of significant nuclear capacity decommissioning in France, with the installed base contracting by 23 GW from the current level to 40 GW in 2030. This scenario incorporates a series of complementary assumptions that combine in a balanced electricity system, including:

- Maximal assumptions of demand-side management measures, pulling demand downwards, in spite of robust growth in end-uses like electric vehicles and heat pumps
- More sustained development of RES capacity, with capacities of 40 GW of wind power and 30 GW of photovoltaic power by 2030 and increases in biomass, biogas and marine power fleets. The share of renewable sources rises to 40% in this scenario
- The development of 2 GW of semi-base load generation and the construction of 10 GW of new peak-load capacity, either in the form of generation capacity or load-shedding, to ensure power balance at all times
- A strengthening of cross-border exchange capacity to 27 GW from 15 GW today, to efficiently manage intermittency by pooling the generation resources of different countries.

RTE has also investigated, in liaison with the government, the possibility of 40 GW of nuclear capacity in 2025, in the "New Mix" scenario.

Under all of these scenarios, the network will have to be expanded and upgraded to keep up with trends in demand and supply. This will be all the more important if a break with historical trends occurs.

If renewable energies are to be accommodated and new end-uses developed, including electric vehicles, then additional power transmission capacity will be more necessary than ever.

The electricity transmission network can adapt in time for the implementation of energy policy decisions as long as they are defined sufficiently in advance. Therefore, the elaboration of the schedule and trajectory of generation fleet trends, especially in terms of siting, are as important as the target defined.

Network development

New generation capacity is not necessarily located near demand centres, meaning the network has to be adapted to carry the energy produced. This is evident throughout Europe. By way of illustration, a study conducted in Germany by national energy agency DENA (Deutsche Energie-Agentur) shows that some 4,000 km of additional extra high-voltage (EHV) lines will have to be created as quickly as possible for renewable energies to be integrated. Overall, at European level, ENTSO-E's ten-year transmission network development plan calls for the creation or replacement of about 51,000 km EHV lines by 2020 to accommodate renewable energies.

It should be recalled that France's network was rolled out quickly in the 1980s to accommodate the nuclear development programme. Future changes in the energy landscape will also require an expansion of the transmission grid, though the challenges will be different due to intermittency.

RTE's ten-year development plan calls for €10 billion to be invested between now and 2020 in key transmission infrastructure. The integration of onshore wind power (19 GW target set in Grenelle environmental plan) and offshore wind (call for tenders for 3 GW) represent around €1bn each out to 2020.

One of the scenarios in this Generation Adequacy Report calls for the share of nuclear power in the energy mix to contract between now and 2030, making it necessary to double interconnection capacity in order to optimise the development of new generation capacity and load-shedding. Above and beyond the financial implications (cost evaluated at €350 million a year for interconnections), the biggest challenge would be the time required to build the interconnection capacity and new infrastructures. Obtaining permits for new lines can take up to ten years, notably because many administrative procedures are redundant and overlap one another; only 5,000 MW of interconnection capacity has been built in the past two decades.

In Germany, network construction times also pose a challenge to renewable energy projects, the government passed a law in 2011 that accelerates permitting procedures for grid expansion projects (Netzausbaubeschleunigungsgesetz– NABEG): the number of administrative layers has been reduced, allowing the relevant authorities to focus more on other priorities.

This law considerably simplifies authorisation procedures for new power lines. A single procedure will reportedly be introduced to reduce the time required for approval of overhead and underground 110 kV lines. The German government is seeking to reduce the total time required for permitting to four years in order to improve the implementation of energy policy decisions.

The European Commission is aware of the difficulties these lengthy administrative procedures create in many European countries and recommends, in its "Infrastructure Package", that they be reduced to three years.

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