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1 Introduction

1.1 The ICE project

Supported by Interreg VA France (Channel) England, the Intelligent Community Energy (ICE) project aims to facilitate the design and the implementation of innovative smart energy solutions for isolated territories of the Channel area that face unique energy challenges.

Many islands have no connection to wider electricity distribution systems and are dependent on imported energy supplies, typically fossil fuel driven. The energy systems that isolated communities depend on tend to be less reliable, more expensive and produce more greenhouse gas (GHG) emissions than mainland grid systems.

In response to these problems, the ICE project considers the entire energy cycle, from production to consumption, and integrates new and established technologies in order to deliver innovative energy system solutions. These solutions will be implemented and tested at our unique pilot demonstration sites (Ushant island and the University of East Anglia's campus), to demonstrate their feasibility and to develop a general model for isolated smart energy systems elsewhere.

The ICE consortium brings together research and business support organisations in France and the United Kingdom; and commitment from SMEs will support the project rollout and promote European cooperation.

1.2 Purpose of this document

The project aims to achieve impact by promoting adoption of the ICE methodology by a growing range of isolated territories, building on the approaches and experience generated in the project. This requires two resources to be developed:

- A database of potential territories that could benefit from application of the ICE methodology;
- A value proposition that sets out the commercial and other advantages that territories could potentially enjoy by deploying the ICE methodology to meet their future energy requirements.

This document comprises the second of these, and results from work performed in Task 4.2. The database is being developed separately in Task 4.3.

A diverse audience is targeted by this document. First, it is necessary to consider the different types of isolated territory that could benefit from ICE. Remote off-grid islands and islands with a weak grid connection represent a significant user community for ICE. In addition, onshore communities that are isolated in an energy management sense are also relevant: university campuses and ports have been specifically studied.

Second, it is necessary to consider the different types of stakeholder who could be involved in the implementation of the ICE methodology on an isolated territory. The key decision-makers are of particular importance since without a positive commitment from these stakeholders the implementation will not proceed. Three categories of decision-maker have been identified:

- Public authorities at the geographic level of the territory concerned, or at a larger level (regional, national) if they have a significant control over the territory's energy resources;

- Network operators who will have responsibility for the energy system during its life, and who may also lead the design and construction of the community energy system;
- Investors who provide the finance to meet the capital spend requirements of the community energy system, who may be one of the above bodies or may be a third-party investor.

These audiences, especially public authorities, may be unfamiliar with community energy systems and may need convincing that such a system is appropriate to their needs. This document is therefore concise, to make the case for deployment of community energy networks and for use of the ICE methodology.

1.3 Content of this Document

A summary of the ICE methodology is first presented to provide some context for the value proposition. Further details of the methodology are, of course, available in other ICE deliverables.

The value proposition setting out the benefits offered by the ICE methodology is then presented, separately for each of the above types of decision-maker. In these sections, a use-case is described to show real-life examples where the methodology can be applied.

2 Task Methodology

There are two major components of the value proposition:

- Challenges or problems affecting particular stakeholders and/or the benefits that would be recognised by those stakeholders (in this case users of energy on isolated territories, or organisations responsible for meetings these users' needs)
- Ways in which the ICE methodology could offer solutions that meet the above challenges and offer the desired benefits.

Value propositions must be created to reflect the priorities for three critical types of organisation potentially involved in implementing community energy systems, listed above. For consistency, a value proposition template is used to capture and present the elements of the value proposition for each of these types of organisation.

2.1 Value Proposition Template

2.1.1 Challenges and benefits

The challenge section of the value proposition needs to capture the various problems that stakeholders would like to be addressed, including (where appropriate):

- Political challenges - policies that need to be met, such as carbon commitments
- Economic challenges – provide energy at reasonable cost
- Social challenges – protect consumers against unfair prices or unreliable provision
- Technological challenges – maximise resource efficiency and minimise emissions
- Legal challenges – avoiding conflicts with legal provisions on energy supply
- Environmental challenges – minimising exposure to visual impacts or emissions

Different types of organisation will have different challenges, but a common checklist will help to ensure comprehensive coverage. A PESTLE structure is proposed above.

2.1.2 Solutions offered by ICE methodology

Ways in which the ICE methodology could deliver the identified challenges and benefits are highlighted.

2.2 Populating the Template

The content of the templates for each of the three stakeholder types has been based on feedback from discussions with stakeholders by ICE project partners. This feedback has been consolidated into tables. The use-cases have been developed based on direct experience of project partners involved with planned or existing community energy systems.

3 The ICE Methodology

The project has developed and validated a standardised methodology for deploying energy management systems in 'isolated' communities, such as islands and communities like ports and campuses. This methodology accelerates investment in such systems by ensuring that benefits and risks are systematically considered from the perspective of all stakeholders. It is presented in detail in other project reports including the revised methodology report D4.1.1.

In this report, a value chain map has been defined to capture the scope of the ICE and is shown at high level below.

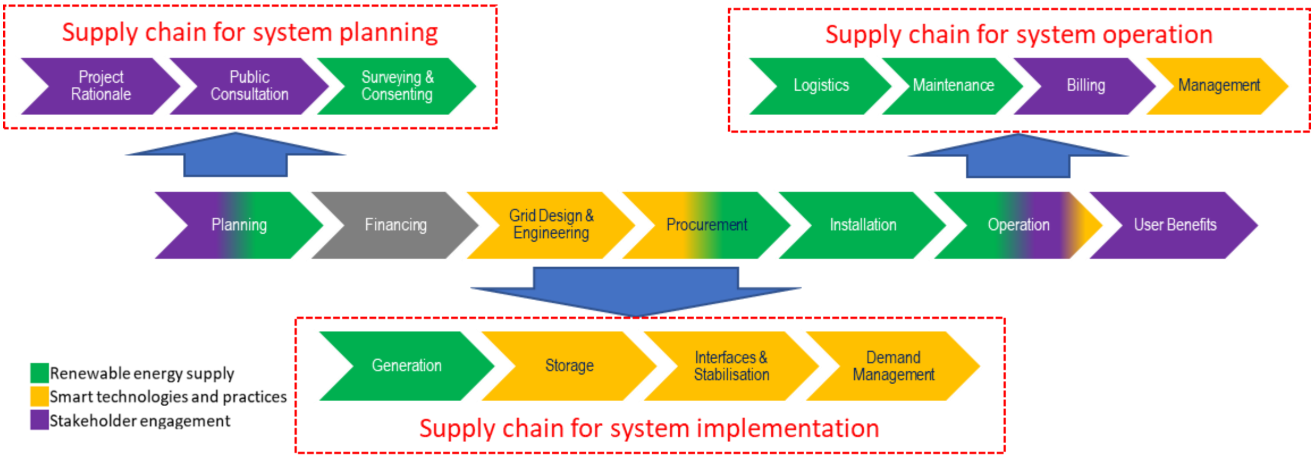

Figure 2 Value chain highlighting supplier opportunities as the project advances

The main strand of the value chain runs from the initial planning stages of the project, through project implementation, and leading to planned user benefits. Some of these value chain links are particularly well-suited to present opportunities relevant to specialist suppliers (some of which could be local firms) who would also benefit.

For these user and supplier benefits to be realised, lead actors need to be persuaded of the project's viability and at least one major investor needs to commit to the project. These players are the targets of this proposition document, namely:

- Public authorities (representing the community, the region in which it lies or the national government)
- Network operators who will own and operate the network that delivers energy to the community
- Investors who provide the finance to build the network (if different from the network operator).

4 Value Propositions for Regional/National Authorities

4.1 Context

A community energy system, or mini-grid, depends on a significant level of political support because it will have implications for domestic consumers and other energy users Performance of the mini-grid (the total system comprising generating assets, distribution infrastructure and metering) will determine whether carbon reduction targets are achieved, and policy pledges fulfilled.

On the other hand, a successful community energy system can mobilise significant private investment in security of supply and carbon reduction, often with local air quality benefits as well.

For public authorities (depending on their geographic scope) the deployment of a community energy system presents both opportunities and risks. It has an ability to influence both through its interaction with two stages in the value chain:

- System planning stage, where obligations on the network operator can be imposed as part of the consenting process;
- System operation stage, where community engagement can be strengthened through public communication and intervention.

The following factors present the most significant elements of the value proposition for public authorities, where optimisation using the ICE methodology can enable valuable benefits with limited risk.

4.2 Problems Overcome & Benefits Achieved

Political:	Outage of electricity supply presents a major political challenge. On an isolated territory, loss of power can bring down telecommunications and water supply as well. The ICE methodology allows the risk of outage to be built into the consenting process and then into the system specification. This can, in principle, allow a smart grid deployment to offer reduced risk of outage (through diversity of generating assets and/or energy storage) compared with the traditional diesel generator system.
Economic:	Unless the cost of power generation on an isolated territory is subsidised by the State, the high cost of diesel-based power is a major barrier to growth. Furthermore, most of this expenditure flows to suppliers outside the community and is lost to the local economy. A community energy system brings much of the value chain economic activity back into the community, including distributed power generation assets (solar, wind turbines, current turbines etc). Operating costs are also localised, bringing economic benefit back into the community served by the smart grid. The ICE methodology allows these value-chain benefits to be identified, and the resulting socio-economic advantages to be quantified. Engagement of local suppliers in the construction and operational phases can generate highly

	visible employment opportunities with a long-term benefit to the local economy.
Social:	Survey data (collected from inhabitants of the Ushant isolated territory) indicate a significant majority in favour of replacing fossil-fuelled generation with renewable generation. Solar and marine current devices were particularly favoured. Public bodies can benefit by championing moves towards renewables-based community energy systems. The prospect of local citizens having some ownership and influence on the community energy system, directly or via a local Council, was also positively received. Public consultation is central to the ICE methodology, to capture this positive social feedback.
Technological:	N/A
Legal:	Isolated territories are often subject to regulations enacted in national Governments even though the requirements of the territory may be radically different from the mainland. This can impose unhelpful constraints on energy generation and consumption, for example in tariff levels and discount rates. The ICE methodology includes consideration of energy system business models that are isolated from inappropriate national norms. This can devolve power over operation of the community energy system to the local authority.
Environmental:	Power generating assets can impose significant environmental impacts: air pollution, noise, loss of visual amenity. The ICE methodology includes consideration of these potential impacts in the planning and consenting phase, to ensure that new community energy projects do not encounter opposition. Replacement of traditional fossil-fuelled generation can also be very popular, on account of reduced emissions.

4.3 Use Case Example – Energy Management on Ushant

The island of Ushant has been progressing an energy transition for nearly 20 years, and many lessons have been learned along the way. The key motivations for action along this transition have been identified, as an example of how these investment projects gather momentum. Three broad phases can be identified.

<u>The trigger for action</u>

The journey on Ushant began almost 20 years ago. The trigger was a need by the network operator and electricity generator (EdF) to replace some generating capacity. Local citizens were aware of this, and wanted EdF to invest in renewable generating capacity rather than simply replace the traditional fossil-fuelled units[1]. Citizen pressure resulted in some interest from local politicians who wanted to respond positively to citizens' concerns.

An important feature of the trigger on Ushant is that citizen concerns were not economic, since the high cost of local generation was not reflected in local bills: the higher generating cost was subsidised by national government. Therefore the motivation of citizens was entirely environmental.

Resources to build on

The initial mobilisation of local citizens and politicians found a fertile ground in which to grow on account of two main factors.

First, a local renewable energy company, Sabella, was already active in the field of tidal energy conversion. As a local innovation champion, this company's commercial objectives aligned with local ambition. Together they were able to amplify the opportunity for deployment of renewable energy devices by highlighting the local content and the potential economic growth accompanying success of the company.

Second, the development of an energy and climate change strategy was beginning to emerge at national and regional levels. This resonated with the local situation and provided a top-down rationale for supporting expansion of renewable energy at local level. A significant energy monitoring campaign was launched to gather information about how energy was used and what potential existed to managed consumption better.

The MERIFIC project was initiated at roughly the same time, to explore the potential for improved energy management and resourcing in Brittany, and equally to quantify the value chain opportunity that could benefit industries across the region.

In parallel, a series of public meetings was held to promote public engagement, addressing two main factors:

- Reduction of energy consumption to address climate goals. This was the primary focus of EdF who recognised the role of energy saving in hitting carbon targets;
- Increasing renewable energy deployment. This was the primary focus of citizens.

Rapid growth in offshore renewables in other countries (Germany, UK) stimulated interest in the value chain opportunity that this new sector presented to the region, with its significant offshore resources and maritime industrial capacity. The political agenda was dominated by the bigger opportunity at regional and national levels.

Incentive for implementation

The combination of regional policy and local public support led to the decision to incorporate the Ushant investment plan in the cross-border ICE project. There was limited evidence to support an economic reason for this investment, but the decision was justified for other reasons, namely:

- The action was a concrete response to public concerns and aspirations for a green economy;

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[1] At that time, renewable energy devices could not be deployed near the shore which meant that tidal current turbines would bot be permitted. However, this law was amended in 2018 to allow deployment of such renewable energy technologies.

- The investment would help to nurture a local company to improve its prospects as an equipment supplier to the wider marine renewables market;
- The action would show how politicians were addressing the relative socio-economic disadvantage of island communities compared with the mainland.

The incentive for investment was therefore a complex mix of benefits which were social and political and with a mainly indirect economic benefit.

5 Value Proposition for Network Operators

5.1 Context

In an isolated territory, the network operator will typically manage the infrastructure that delivers power to domestic and commercial users, drawing on third-party generating assets. In some cases a single organisation will operate the generating assets and the distribution infrastructure. The network operator generates revenue from sales of power to its customers under a variety of tariff arrangements and power purchase agreements with larger consumers.

In grid-connected communities, the network operator (DNO = Distribution Network Operator) is increasingly integrating smart-grid functions to optimise how the system functions (as a DSO = Distribution System Operator). In isolated communities, a mini-grid operator is inherently optimising the system performance, sometimes interfacing with a DNO if the territory is grid-connected.

The business model for the network operator centres on bankable revenue streams from customers coupled with the ability to access local generating capacity most cost-effectively (eg using demand-side management to optimise the margin between prices paid to generators verses prices charged to consumers).

The following factors present the most significant elements of the value proposition for network operators, where optimisation using the ICE methodology can enable valuable benefits with limited risk.

5.2 Problems Overcome & Benefits Achieved

Political:	Energy networks serving domestic customers have a close interdependence with local governments, whose officers are elected by those same customers. Furthermore investment in infrastructure is subject to planning policies and comes under careful and sometimes contentious scrutiny. Public opposition to infrastructure deployment can prove difficult and costly to turn around. The ICE methodology places a strong emphasis on public engagement in order to avoid such problems at source, namely when the plans are embryonic. Early public participation can build a sense of shared ownership, supporting the project as it passes through the consenting process.
Economic:	There is an inherent tension between the need for the network operator to achieve an acceptable return on investment and the needs of the energy consumers they are serving. This tension needs to be neutralised and several options exist to do this: • Maximising the utility available to consumers so they can benefit in multiple ways from the community energy system, for example seeing a direct economic benefit from their acceptance of infrastructure such as wind turbines;

	- Offering suitable tariffs that allow consumers to participate in demand-side management and benefit financially from adjustments to their use of power; - Actively promoting local employment opportunities arising from the operations and maintenance of the energy system. The ICE methodology addresses the relevant stages of the deployment and operation of the energy system, to ensure that all opportunities to enhance the economic offer to customers are considered.
Social:	Apart from the public engagement in the planning phase, the most direct and important interaction between the network operator and society lies in the customer services and billing. A locally-branded customer interface, and accessible people to hold accountable for the quality of service, can create a constructive engagement with the public. The ICE methodology considers the overall public engagement process, including the consultations and the design of the operating model. This can provide a foundation for long-term public support for the network.
Technological:	The available technology base supporting smart grids is evolving rapidly and network operators need to assimilate these advances to optimise the performance of the network. Three critical technology areas within the overall system are addressed within the ICE methodology: - Assessment of power generation options and the scale of (renewable) resource available in the territory; - Energy storage options, taking account of round-trip efficiency, lifetime in terms of charging cycles, capital and operating costs; - Smart grid management systems capable of optimising system performance and of supporting demand management.
Legal:	N/A
Environmental:	It would be the intention of all community energy projects to bring some environmental gains, particularly in terms of local emissions. The ICE methodology allows these benefits to be analysed and quantified, to help strengthen the case for investment. However, environmental impact assessments are vital in the early planning stages of a community energy project, and are integral to the ICE methodology. This can ensure that any adverse impacts are recognised and addressed early in the project, avoiding risks of costly remediation and delay later on.

5.3 Use Case Example

There are many companies offering capabilities in design, construction and operation of micro-grids serving diverse community needs for energy. Micro grids are electricity networks which incorporate generation sources, as well as loads, that are normally connected to the main grid. Micro grids can also operate in “island mode” if they are disconnected from the main grid, either permanently or temporarily due to connection failure. A micro-grid can also be configured as a ‘smart grid’. Smart grids are electricity supply networks that use digital monitoring, communication and automation devices to detect and react to changes in usage.

The elements of a typical smart grid are shown below.

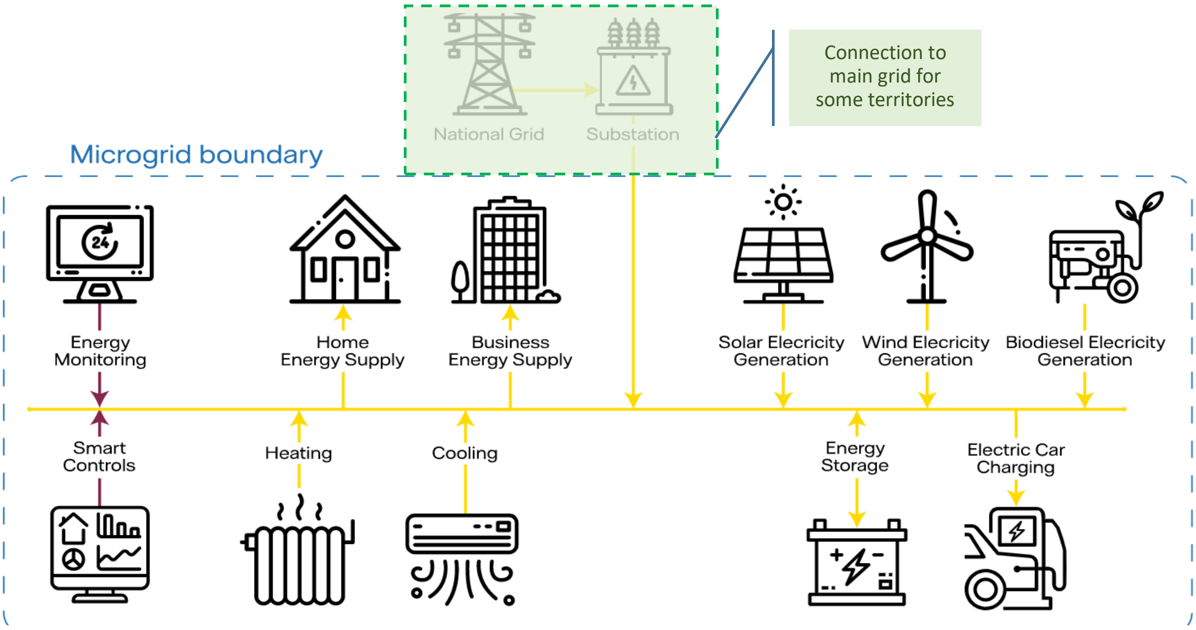

Figure 1 - Schematic of typical network operator scope (courtesy of Vattenfall)

Part of the network involves an energy storage system to work alongside the variable generation and local electricity demand. The task of the energy storage system is partly to accommodate lack of synchonicity between peak power generation and peak consumption and partly to bridge short-term faults, by means of frequency control.

In the event of a fault in any of the cables in the network there is a risk of an imbalance between generation and consumption, which could cause a total power outage. In order to reduce the risk of an imbalance an energy storage system that could supply a capacity output sufficient to deliver additional power at times of peak demand and to maintain stability for the time needed to remedy a fault.

The energy storage facility, in conjunction with variable generation and controllable electricity consumption (demand-side management) can enable an open marketplace for energy services supplied to consumers. This could introduce dynamic pricing and encourage energy generators and consumers to regulate their production and consumption to help stabilise the grid. The marketplace can also increase security of supply as flexible customers will become a dynamic extension of the energy store, by varying their supply and demand. Customers can reduce their costs by reviewing their usage and adapting to utilise the electricity grid when it is least under pressure.

6 Value Proposition for Investors

6.1 Context

For some community energy systems, the investment to finance the capital spend is provided by one of the other stakeholders, for example:

- A public authority leading the energy transition can access Government finance for a publically-owned network;
- A private or public-private company can self-finance projects to implement community energy systems as the network operator, and sometimes the network user.

For other communities, however, there is a need to raise finance separately and a robust case for investment is needed to do so. Although there are many different models for implementing and financing such systems, two widely-used examples can be highlighted:

- Schemes led by a Community Interest Company (CIC) or similar vehicle created by consumers themselves. This entity will contract with an implementation contractor to deliver and operate the system, and be accountable to the CIC and its members. The implementation contractor will typically have established relationships with providers of asset-backed finance to provide the capital against the revenue-generating capacity of the system;
- Schemes led by a specialist provider of smart grid systems who will tender to the end-user (local government, port etc) to build the network, and if necessary to provide the finance either directly or via a third-party investor.

In any event, it is essential to develop a robust investment proposition. The ICE methodology can minimise the implementation risk, and thereby minimise the cost of capital, in several ways as described in the table below.

6.2 Problems Overcome & Benefits Achieved

Political:	One of the most significant risks faced by an investor in a smart grid is the possibility of encountering consenting problems. This can seriously impact on project cost and completion time, with a major impact on return on investment. The ICE methodology can ensure that such risks are both understood and also remediated as far as possible. There is also a risk of policy changes (eg of tariff structure or support instruments) affecting the viability of the investment after it has been committed. This cannot be fully remediated, but the public authority engagement included in the ICE methodology can generate some political influence to counter this risk.
Economic:	Return on investment depends critically on the accurate forecasting of renewable energy productivity, customer receptiveness to different tariff structures and demand-side management, as well as the costs of through-life maintenance and repair. Some of these parameters are difficult to forecast with accuracy.

	The ICE methodology proposes several actions that could improve such forecasts. For example, access to diverse expertise in the system design stage can optimise the forecasting of device productivity, and public engagement and surveys can help to understand consumer responses to new tariff options.
Social:	By ensuring that the community energy system is built and operated using as much local supply-chain as possible, the project can be seen as fulfilling a socio-economic role. This can further de-risk the investment. The ICE methodology includes analysis of the supply chain opportunities raised by the project.
Technological:	Continued advances in technologies underpinning renewable energy devices and smart grids will lead to improved performance and cost reduction. It is important to ensure that the community energy system design is exploiting state-of-the-art technologies. Similarly, the cost-effectiveness of system maintenance can be enhanced by applying improved through-life management methods (eg for fault detection) as they become available. The ICE methodology incorporates best practices in system specification and procurement to ensure that the technological risk is minimised.
Legal:	Opening up the electricity supply market to new providers requires new policy development to define the legal framework for these operators, and much of this is relatively young. It is open to challenge and resulting legal risk to investors. Whilst this risk cannot be removed completely, the due diligence in planning highlighted in the ICE methodology can help to minimise this risk.
Environmental:	Although much of the environmental risk can be anticipated in terms offsetting targets for emissions reduction, for example, there remains a risk of unexpected environmental impacts. Examples include changing erosion or longshore drift of sediment as a result of current turbine deployment and excessive bird strike on wind turbines. Procurement of highly experienced experts to assist the planning and surveying elements of the ICE methodology can ensure that relevant experience from other similar deployments can be factored into the system specification.

6.3 Use Case Example

Some network operators are responsible for energy distribution over a geographic area with diverse customers but others are dedicated to managing energy distribution for a single customer such as a university campus or a port. Ports make an interesting use-case because they are facing rapidly changing energy demand, and because they are often required to raise their own finance to fund the build.

Most ports operate their own on-site energy system which is grid-connected, often via a dedicated sub-station. Portsmouth International Port is a good example: a middle-ranking major port with a diverse cargo and passenger throughput. It is also publicly-owned like the majority of continental ports.

The port is responsible for building, financing and operating its own energy system, subject to constraints imposed by the grid Distribution Network Operator that owns and operates the sub-station feeding the port. The capacity of this grid connection is very limited and the cost of any necessary grid-reinforcement would have to be factored into expansion of the port energy system.

The port sector is now facing the challenge of decarbonisation, and is anticipating a move towards electrification of vessels. This will impose severe pressure on port infrastructure and will require the port to build and operate an expanded port energy system in order to satisfy the energy requirements of visiting ships, port vessels and on-site infrastructure (eg refrigerated storage).

This investment will be phased, to cater initially for charging of port vessels (pilot craft, tugs etc) and some shore-powering of ships' hotel loads. Further ahead, all-electric vessel charging will impose significantly greater challenges. Scalability of the system will allow the port to justify each phase of investment against growth in customer demand.

The port is currently investing in some on-site power generation comprising:

- Solar panels on port roofs, currently with a capacity of 40kWp but expanding to around 500kWp;
- Wind turbines on quays and jetties with a likely capacity of a few MWp (subject to planning).

Figure 2 - new-generation hybrid cruise ship, Fridtjof Nansen, entering Portsmouth International Port

On-site energy storage will allow the port to maximise the use of this generating capacity, storing excess energy at times of low demand. It will also help to meet times of peak demand whilst remaining within the capacity of its grid connection, and to maximise its use of off-peak grid power.

A port-wide energy management system (including a battery management system) will allow the port to operate its network in a way that balances cost-effectiveness and security of supply to customers. Scalability is crucial, to allow the port to expand capacity as demand expands, and this is a key element of the system specification.

The work to install and test the initial battery (100kW) is starting imminently. A programme of monitoring is planned so operational data will become available for analysis, both to refine the system and to encourage investment by other ports.

7 Conclusions

Smart grid networks are being deployed to meet the energy requirement across a wide range of different territories and communities. They can accelerate the energy transition in isolated territories, bringing more renewable energy generation on line to replace conventional fossil-fuelled generators. Smart grids can also enhance security of supply by offering greater local network resilience, and in some cases they can allow cost savings for consumers.

The decision to invest in a new community energy system, using smart grid technologies, is a major one involving public authorities, investors and organisations with expertise in network construction and operation. The benefits of such a system depend on many factors and it is necessary to assess these in order to justify the investment needed. This document provides a baseline understanding of these potential benefits, and shows how the ICE methodology can help to justify a decision to invest.

The ICE methodology brings together knowledge and experience along the complete life cycle of a community energy system, from initial planning through to operation. By applying it, stakeholders can significantly de-risk the project by anticipating where the risks lie (political, economic, social, technological, legal and environmental) and how they can be remediated.

Maximising the use of local supplier companies for building and maintaining the network is one important way to enhance the cost-benefit achieved. It increases local ownership of the project and offers long-term business potential for firms and individuals involved in operating and maintaining the network over its life. The ICE methodology highlights the supply chain opportunities that community energy systems can bring.

Once a preliminary decision to proceed has been made, the ICE project can then bring additional resources to assist more detailed assessment. This includes case studies of territories and also a directory of labelised suppliers.