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ICE REPORT 2.1.2

ICE GENERAL METHODOLOGY

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George Jr. Matthew, Oscar Fitch-Roy, Peter Connor, Bridget Woodman, Philipp Thies, Essam Hussain, Hisham Mahmood, Mohammad Abusara, Victor Kouloumpis, Xiaoyu Yan, Jon Hardwick, Helen C M Smith, Etienne Bailey, Patrick Devine-Wright, Phedeas Stephanides, Jérémie Bazin, Jonathan Williams, Konstantinos Chalvatzis

BRETAGNE DÉVELOPPEMENT INNOVATION
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About ICE

Supported by Interreg VA France (Channel) England, the Intelligent Community Energy (ICE) project, aims to design and implement innovative smart energy solutions for isolated territories in the Channel area. Islands and isolated communities 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 have more associated 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 researcher and business support organisations in France and the UK, and engagement with SMEs will support project rollout and promote European cooperation.

Executive Summary

This document describes a proposed methodological approach to the design and implementation of smart energy island systems. It is informed by a desk review of the available literature on smart energy islands (see T2.1.1 ICE deliverable report), current thinking in electricity system planning, and the particular challenges facing isolated systems (eg. Ushant). The approach consists of a series of sequential steps and iterations between steps that aim to guide communities through the process of creating a smart energy system. Unique to this approach is the emphasis of fostering local skills, businesses and industry in the delivery of the program with the aim of retaining these long-term benefits within the community.

The document lays out the specific considerations of the proposed generic methodology for the isolated system smart energy transition. The conceptual overview of the methodology is presented and the rationale behind this choice of framework is supported. The framework comprises a set of guidelines based on the understanding of the best practices in ongoing smart energy transition projects and the approaches to electricity system planning. Within the scope of the ICE methodological approach the role of the different key players in the implementation of the methodology and the rationale behind the choices made regarding technologies, policies and so on are detailed. These includes stakeholder engagement, assessing energy demand and supply outlook and issues around balancing. Options, system reliability, scenarios and the implementation, monitoring and revision of the energy transition aspects are then considered.

The ultimate goal of the document is to provide a blueprint for smart energy transitions in isolated and peripheral territories and to allow transferability of the methodology. The result here is that the specificities including business models related to issues featuring isolated territories are all covered by this generic approach. In turn, the document aims to empower policymakers and stakeholders with the outlook, circumstantial evidence, and innovation on how to develop smart energy transition strategies for isolated and peripheral territories.

Following an introduction to the aims and scope of the methodology and a schematic overview of the key elements, seven key processes are described:

- Section 0 emphasises the significance of stakeholder engagement to successful implementation and proposes some guidelines for community involvement
- Section 2.2 explores important considerations in the assessment of current energy demand patterns and their evolution through time
- Section 0 presents guidelines in the identification and assessment of available energy supply options
- Section 5 explores the issues and approaches to ensuring electricity system stability and reliability
- Section 0 provides guidance on how communities might synthesise various sources of information to create a range of credible future scenarios and identify a preferred plan
- Section 0 discusses implementation, in particular drawing attention to the crucial importance of ongoing monitoring and revision

- Section 0 outlines the key area for consideration to ensure local business involvement in smart energy island transition

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1. Introduction to the ICE methodology: objectives and approach

The proposed ICE methodology presented here informs and aids the design of the ICE business model for the energy transition of isolated territories, developed in tasks T2.2 and T2.3 of the ICE project. The business model will promote employment, support labour mobility and enhance competitiveness of SMEs in the channel area and in other island or peripheral communities. The methodological approach proposed here is a generic and transferrable set of guidelines, designed to be applicable in a wide range of isolated or islanded contexts.

The approach builds on and is a companion to the review of literature and known approaches to electricity system planning in general, and smart energy islands in particular reported in ICE deliverable T2.1.1. It covers issues such as general electricity demand, energy supply and capacity, energy efficiency potential, exploitable indigenous energy resources, social, environmental and legal constraints and the potential for smart technologies and practices.

The ICE methodology draws on the experiences and usage of methods such as Integrated Resource Planning (IRP). IRP is a well-known and established method of electricity system planning that has been used by electricity utilities around the world since the 1980s as a transparent and participatory planning process for their electricity systems (Tellus Institute, 1999). IRP can make planning more open and can help identify pathways along which an electricity system may achieve future goals. IRP has been shown to be applicable in smart energy transitions on islands, where a whole-systems approach is particularly valuable (Campbell and Bunker, 2017).

The core of the IRP process is a series of steps, which are:

(i) establish objectives;
(ii) survey energy use patterns and develop demand forecasts;
(iii) investigate electricity supply options;
(iv) investigate demand-side management and energy efficiency measures;
(v) prepare and evaluate supply plans and demand-side management plans;
(vi) integrate supply and demand-side plans into candidate integrated resource plans;
(vii) select the preferred plan;
(viii) implementation of the plan, monitor, evaluate, and iterate (plan revision and modification).

Similar to the IRP process is an approach based on a readily available framework within which communities can organize energy transitions. This approach utilises a so-called 'action-oriented playbook' (AOP) to serve as a guide for the successful initiation, planning, and completion of a transition to an energy system that primarily relies on local resources (ETI, 2017). The AOP approach is project-oriented and includes a constructive dialogue together with resources and lessons learned from smart energy transition efforts undertaken by other communities. AOP entails seven phases:

(i) committing to an energy transition;

(ii) setting the vision;
(iii) assessing opportunity pathways;
(iv) project preparation;
(v) project execution and quality control;
(vi) operations and maintenance;
(vii) process improvement

The phases of AOP represent practical steps towards the community's goals. The actions are grounded in empirical observations of a large number of island communities in pursuit of a smart energy system.

IRP and AOP are similar in some ways while distinct in others. Both are action-focussed, with local people and organisations the primary agents for change, unlike the concept of national energy roadmaps for islands which tends to focus on data acquisition and analysis (IRENA, 2017). However, IRP is a largely top-down, technocratic endeavour, in which change is expected to be initiated and shaped by an energy provider (usually a utility) to meet its interpretation of its users' needs, albeit with substantial stakeholder input. AOP, meanwhile, is a 'bottom-up' approach, anticipating that communities and their representatives work with utility managers as peers to affect change. The technical rigour of IRP and the consensual community-driven quality of AOP, rather than conflicting, present complementary lessons on the inception and guidance of system change. The ICE methodological approach, presented below, combines the planning aspects of IRP with the project focus of the AOP. It also expands the scope of both to incorporate the fostering of local businesses able to provide services in support of the transition, as shown in Figure 1, below.

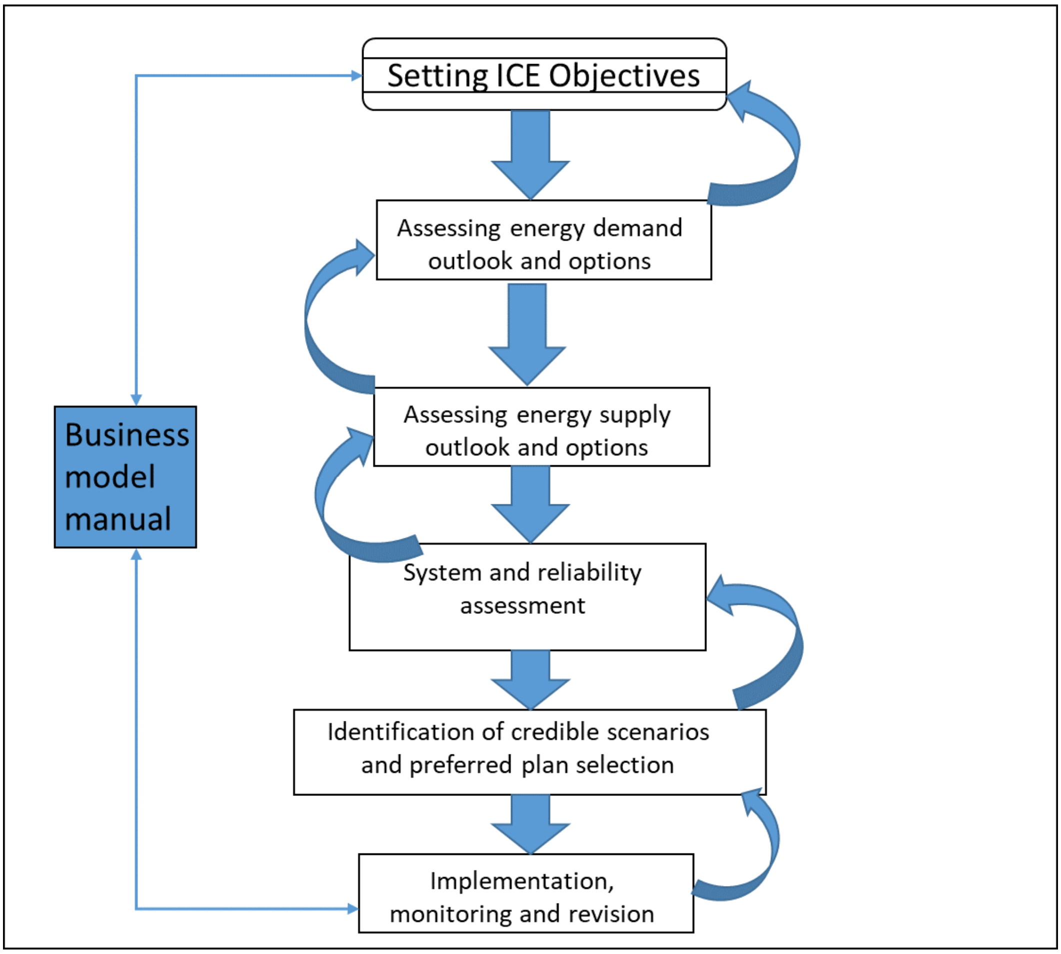

Figure 1.1 Schematic view of the ICE methodology approach

The proposed ICE methodological approach comprises seven interrelated steps. Six of these represent a hybrid, based on the most appropriate elements of the IRP and AOP approaches. The seventh element is a business model manual component, which will be adapted to the specificities of the isolated territories. The transferability and robustness of the ICE methodology for smart energy transition in isolated territories will be bounded within the scope of the set of guidelines for the smart transition and the business model manual. This will ensure that there is considerations of energy security, target reliabilities, the technological and policy selection, and the options for comparative environmental impacts.

The following sections detail the seven elements of the proposed ICE methodological approach.

2. Stakeholder engagement

This section provides an overview of the stakeholder engagement process and gives guidance on how this can be achieve within an isolated or peripheral system context. Sub-section 2.1 outlines the role of stakeholder engagement in the ICE methodology and sub-section 2.2 reviews the current state of art in the social science literature and sets out some best practices for engaging with communities.

2.1 The role of stakeholder engagement in the ICE methodology

Smart energy transition is a paradigm shift from one state to another, guided by the roles of the actors within the system. . The literature suggests that typical small island and peripheral community consumers and stakeholders have no power to influence fuel prices, as they are exogenous to the system (Eurelectric, 2012; Matthew, 2017). This is true even when the system is linked politically to a larger developed country (IEA, 2012; Vallvé, 2013; ERSE, 2014). The impetus for low-carbon and smart objectives, while remaining flexible, and reducing the dependency on expensive oil imports has created a strong economic incentive to change the existing system's status quo (Eurelectric, 2012).

The emergence of various and newer types of public policies can be seen as a guide to achieve the desired system. According to Chappin (2011), electricity policy can influence emerging challenges and behaviours within these systems since it forces changes to the technical components of the system. These changes can then influence the perceptions and preferences of the other social and economic actors within the system. The electricity policies have inherent challenges, which will appear over the transition of the system. These issues are compounded by the stakeholder's desire to achieve the required changes without greatly increasing economic costs that would risk an erosion of the sustainability and/or energy security of the future smart energy systems. Hence the need for stakeholder engagements.

The purpose of the necessary stakeholder engagement for the smart energy transition is to identify the major characteristics of the energy system to which the community will transition. The focus of this will be to establish the principles and shared visions such as fuel diversity and price stability that seeks to motivate stakeholders and lay the groundwork for the analysis and deployment of the smart energy transition (ETI, 2017). In order to establish these objectives of the smart energy transition the inputs from the stakeholders identified will shape a shared understanding that can satisfy the multiple community specific identifiable objectives, particularly for local resource use.

By nature, and due to the background of key stakeholders, objectives tend to conflict with each other to varying degrees. Examples can include:

- Conform to national, regional, and local development objectives.
- Maintain reliability of electricity supply.

- Minimize the short term or long term economic cost of delivering smart energy services
- Minimize the environmental impacts of electricity supply and use.
- Provide local economic benefits.

This leads to a need for objective analyses and examination of the key values and judgements of the stakeholders involved. Embracing this process as a first step is imperative to setting up the vision and goals of the smart energy transition. It takes to task, involving a broad cross-section of public and private stakeholders, some of whom are potential opponents in their views of the transition. This consideration is important to setting the vision for the smart energy transition. Moreover, it would create an opportunity for much needed civil discourse that it critical to the transition's long-term success (ETI, 2017). Additionally, some form of human capacity building and training of local residents are also essential elements for a long-term sustainability strategy and need to be incorporated in the selected energy transition projects (Hirsch *et al.*, 2015).

The existing national policy and planning influences the level of changes needed for the energy transition vision of the stakeholders. The wider stakeholder inputs are critical for the goal setting of this transition, and can be subject to modifications as initial assessments of these goals are completed. Explicit objectives of stakeholders will need to formulate in qualitative terms and tend to give criteria by which the achievement of the given objective can be measured (Tellus Institute, 1999). In addition, it is advisable to have quantitative and/or qualitative measures for the different planning objectives of the vision. For example, with a goal of minimizing environmental impacts, measurement of environmental impacts can entail a mix of quantitative measures such as estimates of air pollutant emissions and qualitative measures such as aesthetic impacts (Tellus Institute, 1999). The following table, Table 2.1, gives an overview of possible smart energy transition objectives.

Objective	Nature of the Objective
Reliable electric service	Serving consumers with minimal disruptions in electric service
Electrification	Providing electric service to those without convenient access to electricity is a common objective in developing countries
Minimize environmental impacts	Reducing the impacts of electricity generation (and energy use in general) is a goal that has received increasing attention in recent years. Environmental impacts on the global, regional, and local scales can be considered
Energy security	Reducing the vulnerability of electricity generation (and the energy sector in general) to disruptions in supply caused by events outside the country
Use of local resources	Using more local resources to provide electricity services — including both domestic fuels and domestically manufactured technologies — is of interest in many countries. This objective may overlap with energy security objectives
Diversify supply	Diversification may entail using several types of generation facilities, different types of fuels and resources, or using fuels from different suppliers
Increase efficiency	Increasing the efficiency of electricity generation, transmission, distribution and use may be an objective in and of itself
Minimize costs	Cost minimization is key impetus for pursuing IRP, and a key objective in planning. The costs to be minimized can be costs to the utility, costs to society as a whole (which may include environmental costs), costs to customers, capital costs, foreign exchange costs, or other costs
Provide social benefits	Providing the social benefits of electrification to more people (for example, refrigeration and light for rural health clinics and schools, or light, radio, and television for domestic use). Conversely, social harms, as from relocation of households impacted by power project development, are to be prevented or minimized
Provide local employment	Resource choices have different effects upon local employment. IRP objectives can include increasing local employment related to the electricity sector, and increasing employment in the economy at large
Acquire technology and expertise	A utility (or country) may wish to use certain types of supply project development in order to acquire expertise in building and using the technologies involved
Retain flexibility	Developing plans that are flexible enough to be modified when costs, political situations, economic outlook, or other conditions change

Table 2.1 Possible objectives for Integrated Resource Planning as given by Tellus, (1999) useful for smart energy transitions vision setting

With a list of smart energy transition objectives as given in Table 2.1, the main purpose of the stakeholder engagement can be satisfied. These aspirations of the local energy community can be garnered as the stakeholders identify key sectors of the smart energy economy, set clean energy goals in each sector and create multifaceted critical strategies to attain each sector goals (ETI, 2017). Additionally, they would strive to have a clear degree of formality to this process. In essence, with the possibility of a leadership team, some form of steering committee and working groups the task of stakeholder engagements can be facilitated.

The main aims of the stakeholder engagement will broadly embrace the concept of obtaining some level of sponsorship of the vision from public and private leadership. Use this public-private partnership to achieve aspirational goals and ensure it engages a broad cross-section of local stakeholders - even naysayers - to reach a consensus and secure community buy-in (ETI, 2017). Added to this, the engagement should seek to identify and involve local smart energy champions. These champions will be instrumental to highlight key challenges and successes for the smart energy transition process. However, the planning objectives of these leaders/key stakeholders should be considered as preliminary and include scope for further modifications as initial activities provide a better and much more clearer outlook of the goals, policies and objectives embraced. Moreover, the stakeholder engagement process can task working groups to identify and implement specific aspects of the smart energy transition objectives.

2.2 Stakeholder engagement and energy system change: engaging with local communities

Within social science literature, a number of guidelines and recommendations have emerged on the issue of effective public engagement within the context of low-carbon energy solutions deployment. These have typically been oriented around particular rationales for engagement, diverse types of engagement, as well as the specific timing of public engagement activities employed by technical actors in the low carbon energy arena.

At least three key rationales have been identified for undertaking public engagement. Firstly, an *instrumental* rationale, where engagement is conducted to increase the likelihood of achieving a predetermined goal, such as promoting greater social acceptance. Secondly, a *normative* rationale, where public engagement occurs because it is deemed that citizens' views should be sought before making decisions on their behalf. Thirdly, a *substantive* rationale, where engagement values lay knowledge and seeks to improve the quality of policy formulation and decision-making (Stirling, 2005; Wesselink *et al.*, 2011). Adoption of the instrumental rationale is seen to be associated with NIMBY (Not In My Back Yard) type assumptions of the public as ignorant and in need of information provision, with the result that lay knowledge is typically under-valued. The substantive rationale, in contrast, views lay public knowledge as valuable and as having much more to offer when it comes to decision-making around low-carbon energy projects. Literature points to the value of going beyond NIMBY-type assumptions of the public - and the instrumental rationales for engagement that can ensue - towards engagement that promotes deliberative approaches that value and promote the inclusion of lay knowledge (Devine-Wright, 2017).

Public engagement can encompass at least three distinct types of engagement activity, going from least to most optimal. These include: (1) Communication - one-way information flow between 'sponsor' (energy developer/government organisation) to the public, including leaflets, posters, newspaper adverts, and web-based materials. (2) Consultation - two-way information flow from between sponsor and the public, without dialogue (e.g. public exhibitions where the public can learn about proposals, phone lines, questionnaires). (3) Participation - the two-way exchange of information between sponsor and public with the possibility for transformed opinions on both sides, including deliberative workshops and citizens panels. With participation seen both to provide community participants with a greater degree of influence or control over the energy development process, and improvements in the quality of policy formulation or decision-making, it is often regarded as the optimal form of public engagement, compared with communication or consultation that can be viewed as tokenistic (Rowe and Frewer, 2000; Devine-Wright, 2017).

Research suggests that engagement activities that occur further upstream in the development process can offer affected communities a greater opportunity to shape decision-making concerning the low-carbon energy solutions. It has been suggested and as advocated in the ICE methodology, that public engagement which occurs earlier on in the development process is more likely to foster perceptions of procedural justice, greater feelings of trust between actors, and greater project acceptance (Cotton and Devine-Wright, 2012; Devine-Wright, 2013; Bailey, Devine-Wright and Batel, 2016).

Key recommendations within the ICE methodology context follows:

- The value of an upstream deliberative approach to public engagement (as both a research approach and a political decision-making process) for: (i) Highlighting the diversity of rationales for both support and opposition to a variety of renewable energy technology options. (ii) Affording communities greater freedom in defining the sustainability challenge at hand, and identifying locally desirable actions. (iii) Adopting co-production approaches, where (local) experts (e.g. policy-makers, technology and project developers) and publics are brought together to jointly define the problems and potential solutions at hand (Jasanoff, 2006; Whatmore and Landström, 2011; Burgess, 2014).
- The value of reconceptualising the local communities, not as reactive and latently hostile (Knapp and Ladenburg, 2015), but rather as a resource of local knowledge (Jasanoff, 2006; Wiersma, 2016), and a constructive, helpful audience for local energy development that can make a contribution to further understanding the negotiation around local smart energy solutions acceptance. Facilitation of communicating the smart energy transition visions to the public in general to generating grassroots support (ETI, 2017).
- An awareness that undertaking effective public engagement in island/isolated territories is challenging due to the diverse population types in such contexts, which include permanent residents, secondary homeowners, and seasonal tourists. Engagement strategies and activities should consider how best to cater for each of these population types, with the aim of achieving inclusive and holistic public engagement over the course of energy infrastructure siting.
- Undertaking further public engagement later in the decision-making process, and move beyond communication/consultation activities towards more participative, deliberative and inclusive forms of engagement (Rowe and Frewer, 2000; Bailey, Devine-Wright and Batel, 2016; Wiersma, 2016; Devine-Wright, 2017).

The stakeholder engagement itself, should allow for understanding the technical information about the local peripheral communities' energy profile, low-carbon technologies, policies, and barriers and opportunities based on initial assessments. It must engage dialogue as highlighted above that helps community stakeholders understand the smart energy transition opportunities and barriers from an appointed leadership team's perspective. With these initial interactions in place, the stakeholders can agree a shared understanding on a vision and establish broad goals for the smart energy transition.

3. Assessing energy demand outlook and identifying options

This section provides an overview of the assessment of current energy usage within an isolated or peripheral system context of the ICE methodology. Sub-section 3.1 outlines the data needed to make an appropriate assessment and common analytical techniques. Recognising that energy behaviours may change over time, in particular as individuals become more engaged in the energy system, sub-section 3.2, discusses some of the implications of the shift from *con*sumers to *pro*sumers.

3.1 Current energy consumption patterns

A key determinant of decisions about the future of an isolated or peripheral electricity system is an informed view of demand for electricity, the factors that drive changes in demand, and how these may evolve over time. The first stage in a demand assessment is the gathering of appropriate information. Data fall into several broad categories that are outlined below. We also introduce some of the considerations that must be taken into account when analysing such data.

3.1.1 Aggregate demand data

The most basic requirement of the assessment are data that represent the volume of electrical energy provided to consumers. This information is often recorded by the electricity utility and in some cases provided on an open-access basis. For example, electricity information about electricity production every hour since 2011 on Ouessant and surrounding islands is prepared and published by Électricité de France (EDF)[1]. This data can be used to establish variation patterns over daily, weekly and seasonal time scales. It can also provide an indication of trends in demand over time: is demand rising, falling? How fast? The greater the resolution and longer the time series, the more useful such a data set may be. Important characteristics that may be projected are total annual demand, average demand, and peak demand.

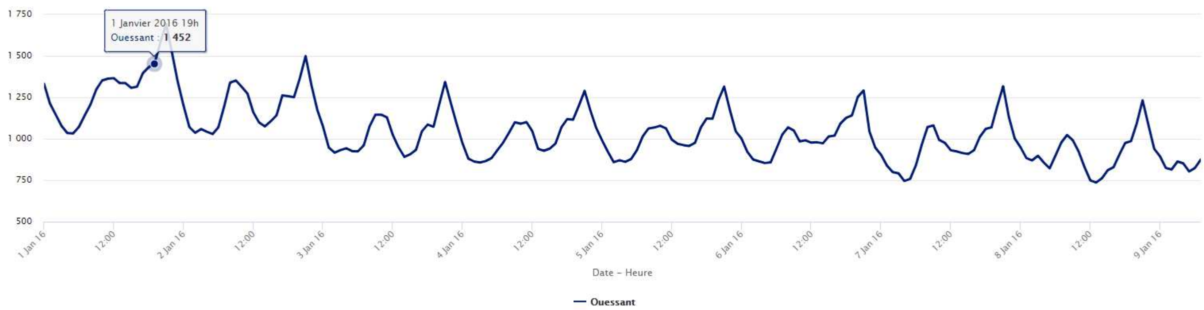

Figure 3.1 ***Example of total electricity production/consumption on Ouessant***

3.1.2 Historical demand by sector and geography

The detailed breakdown of historical demand into relevant consumer categories is often unavailable. However, extrapolation of analyses of household demand patterns, data reported from different classes of meter and other sources may inform a view on how demand within classes of consumer

[1] https://opendata-iles-ponant.edf.fr

may evolve. The categorisation of consumers depends to some extent on local factors (such as number of key industries, availability of data etc.) but in general, relevant consumer types include household, industry, commercial, and agricultural.

3.1.3 Energy usage patterns

A detailed picture of how energy is used in specific contexts, such as in the home, is valuable as an indication of important trends as well as identifying the scope for changes in these patterns. This granular and highly context-specific information my inform interventions that aim to either reduce energy consumption (by supporting more efficient appliances, for example), change usage patterns or promote smarter, more flexible consumption. However, such information is rarely readily available. Campaigns of energy monitoring, the use of smart meters, consumer surveys, and stakeholder engagement (see section 2) are all valid approaches to obtaining relevant useful information. However, the appropriate level of detail, design of data collection and scope of studies depend on factors including the objectives of the energy transition, the level of economic development, rates of electrification and appliance saturation, trends in adoption of energy consuming or energy reducing technologies.

3.1.4 Economic and demographic drivers of energy demand

A wide range of social factors influences demand for electricity. Cultural and behavioural factors are discussed in the next section, but economic and demographic changes can together drive changes to overall demand and the seasonal or diurnal demand profile. Island populations may fluctuate seasonally and small islands can see quite sharp demographic changes.

Collating and interpreting these data can be resource intensive but is often carried out by local, regional, or national government agencies. For example, in Ouessant, Association Les Îles du Ponant (AIP), a non-profit association of elected officials and community leaders in the populated islands of western France, focuses on development in island communities and carries out regular surveys and other studies of island demographics.

3.1.5 Analytical approaches to consider

There are several broad categories of approach that may be used to analyse electricity demand data. The most appropriate techniques depend on the technical capacity of the analysts, the availability of data and the overall goals of the energy transition.

Caution should be used when making projections (trend forecasting) about future energy usage and it should always be assumed that it is not possible to predict the future, especially since rapid and unpredictable changes in demographics, economics or technology can have very large impacts, especially in small, isolated systems. However, historic trends such as energy usage (average or peak) growth or reduction may be extrapolated to provide some useful indications of what may occur should those trends continue, at least in the short-term.

In some contexts, it may be appropriate to construct econometric models of energy consumption. Such forecasts seek to apply statistical techniques to establish firm mathematical relationships between variables (such as economic productivity, inflation, and household income or energy prices) and energy consumption. The type and range of data required to develop useful econometric models as well as the high-level of abstraction needed means that this type of analysis may be more appropriate in situations where a large population and more diverse economy improves the statistical validity of observed relationships. In addition, such models are based on the assumption that the relationships between dependent and independent variables observed in the past are valid in the future, an assumption that may be challenged by the dynamic nature of isolated or island communities, especially at a time when rapid energy transition is being sought through multiple interventions.

Finally, it may be appropriate to construct a bottom-up model of energy use from estimates of energy usage by consumers (a contextual understanding of usage for lighting, air conditioning etc.). Observations of energy behaviour may allow the construction of a detailed image of how energy decisions are made by, for example, households. As an example, the number of and type of heating appliances in a community, an observation of the typical usage patterns by members of the community and the energy requirements of the heating appliances can be used to estimate the daily or seasonal average or peak demand for electricity for heating. This approach requires highly detailed data about energy usage and a clear view of the types and numbers of energy consumer, which may be more appropriate in smaller, island settings.

3.1.6 Applying the analysis

Since we cannot predict the future and data will always be imperfect, making sense of energy demand in ways that allows decisions to be taken requires a pragmatic and problem-oriented approach that likely uses more than one of the techniques outlined above. A common approach applicable to the ICE methodology to inform decision-making is the creation of future scenarios, snap-shots of the future energy system that attempt to express a range of possible outcomes. However, since in the context of a long-term transition, almost *none* of the variables or relationships are exogenous to the transition, defining these scenarios based on intensive stakeholder engagement is crucial, a first step to this methodology. Scenarios may be aspirational (fixing a reasonable date for 100% electricity provision, for example) or salutary (what happens if the price of a commodity increases far more than anticipated, for example). Scenario construction and analysis is discussed further in section 6. To emphasis the dynamic nature of energy demand in the context of the low-carbon transition, the follow section outlines some of the considerations of energy demand change, specifically in light of a shift from passive energy consumption to more active energy *prosumption.*

3.2 The drivers and impacts of behaviour change

Given substantial energy security risks and the challenges of integrating and balancing fluctuating renewable energy supply with growing energy demand in remote systems (Eurelectric, 2017), active consumers play an increasingly important role in isolated energy systems. Four key ways that encourages the pattern in which the energy consumer is (re)envisioned as an essential component of effective management and energy transitions follows (PROMISE – IEE Island Project, 2013; Kielichowska *et al.*, 2017):

- Numerous energy efficiency action plans have been introduced with the primary goal of decreasing overall energy consumption in the medium/long-term. These entail education and awareness raising campaigns on energy saving techniques/ technologies, and/or a series of economic incentives for the adoption of energy efficiency measures at the consumption level.

- Various policies have focused on the roll-out of smart meters providing consumers with numeric information about their (dis)aggregated energy use (Friedrich-Ebert-Stiftung, 2016), in an attempt to equip them with the information they need to help reduce their overall energy consumption. And shift it away from periods of peak demand, and/or respond flexibly to periods of “over” supply (Buchanan, Russo and Anderson, 2015).

- In the short/medium-term, matching electricity supply and demand through load shifting is seen as an important component of grid operation stability and flexibility in the absence of energy storage. This entails the introduction of dynamic demand response (load management) systems that control end-user devices by rescheduling their operation in periods of large renewables availability and/or limited demand. These load management mechanisms vary from direct-load control and load limiters, to time-of-use pricing and demand bidding programs (Stathopoulos *et al.*, 2014; Zizzo *et al.*, 2017).

- Finally, a growing number of remote areas have explored prosumer-focused plans with the ultimate aims of reducing generation costs and supporting local energy systems. Against projects focusing on centralised demand-side management, these plans involve blurring the distinction between generators and end-users, with the latter increasingly capable of producing energy for self-consumption at either the individual or the collective level, prosumers.

These approaches share both deeply-seeded similarities and differences. On the one hand, there is considerable leverage with respect to the role envisaged for the users in the process of energy-related behaviour change. For instance, where centralised dynamic demand management encapsulates a ‘paternalistic culture’ whereby energy users require top-down management to change their energy-related behaviours, prosumer-focussed interventions entail radically new forms of inclusion of households in energy provision infrastructures and an increasingly active role for ‘energy citizens’ in the implementation and management of ambitious energy transitions (Strengers, 2013; Goulden *et al.*, 2014). On the other hand, across these dissimilar interventions there is a common, dominant set of assumptions around the drivers of behaviour change. These interventions unequivocally assume that individuals: have rational preferences among outcomes, always strive to maximise utility, and act independently based on full and relevant information (Fox, Foulds and Robison, 2017).

Relevant interventions and policies covered for applicability to the ICE methodology for the energy transition are to:

1. Provide and evaluate information to fill a presumed information deficit (Burgess, 2014) among the population and educate them to hold more (eco)rational attitudes and behaviours. This can include the adoption and usage of higher energy efficient technologies/appliances within their homes and for everyday commercial usage.

2. Assess appropriate price signals conveying meaning about energy use that enable utility-maximising individuals to avoid undesirable energy-related behaviours – as seen, for example, by the customary use of economic incentives and/or feed-in-tariffs to promote energy efficiency, domestic micro-generation and time-shifting of energy-intensive behaviours (Eurelectric, 2017).

3. Assess the possibility of prosumers to make rational, micro-management decisions through the transfer of energy utilities' values, expertise and technologies into homes – as seen, for instance, by strategic interventions to support the uptake of distributed generation (Strengers, 2013).

Moreover, whilst numerous feasibility studies of emerging smart grid interventions – such as centralised dynamic demand management – point to substantial benefits for energy production, there remains considerable disagreement on whether the public is willing to accept such technologies and change the temporality of their routines (Goulden *et al.*, 2014). Most importantly, social scientists acknowledge the immense complexities of changing consumption behaviours and, thus, challenge linear models of behaviour correction. Amongst others, scholars in the broader field of energy-related behaviours highlight a societal lock-in into unsustainable consumption patterns influenced by persisting routines, social norms, expectations, incentive structures, institutional barriers and restricted choice (Fox, Foulds and Robison, 2017). In spite of significant technological advancements and the growing affordability of renewables, a shift to prosumption appears equally challenging. Community energy projects have been particularly successful in delivering behaviour change because of their proactive focus on exploiting legislative opportunities to develop amenable contexts and mechanisms for prosumption (Middlemiss, 2008; Heiskanen *et al.*, 2010).

The questionable effectiveness of consumer-focussed interventions and the widespread success of prosumer initiatives reflect the interactions of specific behaviour change interventions with the context in which they are enacted. Energy transitions depend on adopting a whole-systems approach to behaviour change that accounts for physical, social, cultural, institutional and practice-based contexts that shape and constrain people's actions (Owens and Driffill, 2008). This holds particularly true for 'smart' interventions, which attempt to change the relation between consumers and producers and are, thus, dependent on significant changes in the infrastructures and networks of energy provision. Thus, the ICE methodology advocates for engaging energy citizens at an early stage to better understand whether and how they might embrace novel technologies and energy-related behaviours – load management, prosumer and energy efficiency. The next section looks at the existing and possible energy supply options available for the energy transition within the isolated system.

4. Assess energy supply outlook and options

This section gives an overview of current renewable energy supply within an isolated or peripheral system context. Sub-section 4.1 discusses the evaluation of the current energy supply system while sub-section 4.2 sets out an approach to the assessment of the potential sources of renewable generation and constraints on their exploitation.

4.1 Evaluating current energy supply

A comprehensive review of the current energy supply options with its related infrastructures, attributes and options is a good first step in gauging the supply options for the system. The available renewable energy technologies within the remote communities and the appropriate methodologies for assessing the available resources and identifying key constraints is useful within the ICE methodology. The availability of the current non-renewable and renewable technologies suitable for the isolated community and for undertaking a resource assessment for each technology can be verified from both globally available and vendor data. The following table, Table 4.1, gives an overview of a range of attributes to evaluate current and potential energy supply options.

Attribute	Information About the Attribute
Plant capacity	In what sizes is the supply option available from vendors (or via local construction)?
Maximum and optimal capacity factors	For what fraction of the year is the full capacity of a generation option likely to be available to generate electricity?
Fuel type	What quantities and qualities of fuel are required by a generation option?
Efficiency	What is the efficiency of the supply-side technology? For a generation technology, efficiency is the net amount of electricity produced per unit of fuel input. For T&D technologies, efficiency is expressed in terms of the percentage of power or energy lost during transmission or distribution.
Fuel costs	How much do the fuels used for power generation cost? How much are they expected to cost over the planning period time horizon?
Reliability	How reliable is the technology under consideration? What has been its operating history, either domestically or in other countries?
Capital and operating costs	How much does it cost to acquire, operate, and maintain the technology (in addition to fuel costs)?
Lifetime	How long will the supply-side technology be operable?
Decommissioning costs	What is the expected net value of the plant at the end of its useful life, including the costs of decommissioning? Decommissioning should be considered for all options, even dams that may last longer than other options.
Foreign exchange requirements	What fraction of the capital, operating, and maintenance costs of the power plant will be spent in-country, and what fraction must be spent on imported goods?
Environmental impacts	What quantities of air pollutants, liquid wastes, and solid wastes are produced by a generation option per unit of electricity produced? How much land is required for the option? Is cooling water is needed? For a hydroelectric facility, how much area will be submerged when a dam is complete, and how many households and farmers affected? What are the environmental impacts of plant construction and decommissioning?

Table 4.1 Possible attributes for evaluating and assessing the energy supply options as given by Tellus, (1999) useful for smart energy transitions

All peripheral communities are different with some similarities possible, hence, the various contextual availability and associated cost etc. of the different resources needed for electricity production. In light of attributes from Table 4.1 evaluations and assessments undertaken to quantify and/or to exclude the various resources, as a continuing supply option should be completed. Constraints from each category associated with each technology, resource/attribute assessment methodologies for each technology presented using best practice, and industry standard literature for quantifying energy generated is necessary.

Added consideration is that various sources of renewable energy have different issues regarding intermittency and predictability, and varying constraints affecting exploitation of the respective resource. The aim of this step is to enable ICE methodology stakeholders to compare the benefits and limitations of different technology types and to make decisions on which technologies they may wish to take forward.

4.2 Assessing renewable energy potential

Once the initial data on the current supply options is assessed, the current and potential supply options must be evaluated to gain insights into which of the supply option can be useful. The choice of supply option is intertwined into the stakeholder goals and objectives for the type of energy system pursued. For a smart energy transition as with the ICE methodology preference will be given to renewables and other smart energy solutions that can meet the demand of the system. In essence, the various technologies will be ranked and the inappropriate options based on cost, resource, technical and other issues will be excluded. According to Tellus Institute (1999) some of the economic screening analysis of the various supply options includes life-cycle cost (LCC), levelised cost of energy (LCOE) etc.

In addition, resource assessments carried out for the renewable generation technologies can provide a basis for their use as a supply option. This enables the quantification of the amount of energy available at a site or sites and to estimate the amount of electricity or heat that is be extracted. Included in the resource quantification can be the estimated power that could be exported to the local grid as a unit commitment with the demand. An assessment on the correlation of generation times with consumption is also needed. As highlighted in Table 4.1 consideration of the technical, environmental and social constraints to deploying the potential technologies should be included.

For example, in Oeussant the assessment of the supply options found that each renewable technology of wind, solar and tidal has the potential to provide electricity to the island's grid. The time of day in which generation would occur however is not aligned with the current demand profile and installation of the technologies on their own would result in the need to curtail generation or dump energy. Installing a combination of wind, solar and/or tidal generation would enable the island to reduce the amount of electricity generated from fossil fuels. In order to maximise the amount of low-carbon energy used and make full use of renewable generation (all these suggestions are within the scope of the ICE methodology):

- An energy storage solution should be installed
- Energy reduction measures should be increased
- Consumption behaviour should be altered so that times of use better correlate to times of generation.

5. System and reliability assessment

This section provides an overview of an approach to the analysis of the current system infrastructure and the reliability implications of an ICE methodology energy transition. Sub-section 5.1 outlines the data and analysis needed for an assessment of the current electrical system. Sub-section 5.2 discusses the options and implications for the integration of novel or smart technologies such as energy storage in isolated systems.

5.1 Review of current system infrastructure

The main purpose of the reliability study is to establish the reliability of the current energy system to then assess the impact different generation/storage/smart energy options may have on the system reliability in the future. Parameters that will be used for this analysis include:

- Reliabilities of energy security and availability
- Target reliability/availability
- Potential for optimised supply and generation mix.

There are two types of analysis that will be conducted in order to assess the reliability of the current island power network.

1. *Reliability study of the network:* This is done by translating the physical electrical distribution network into a conceptual Reliability Block Diagram (RBD). Some software to facilitate this process and the subsequent analysis readily exists, e.g. ReliaSoft. The primary objectives of the reliability analysis is to obtain a life distribution that describes the times-to-failure of a component, subassembly, assembly or system. This analysis is based on the time of successful operation or time-to-failure data of the item (component).
2. *Power Flow Analysis:* In order to understand the power flow in the network. This is derived through a power flow analysis, analysing the voltage levels for each load node. Software such as Matlab Simulink will be employed for the power flow analysis.

To carry out these assessments, the following primary data will be required:

A. Schematic diagram of the island power-system network and the network voltage.
B. The main components of the island network, such as power cables, transformers, circuit breakers and generator units.
C. Failure rate of the main components of the network or a record of the failure for each network components for 5 years or more.
D. The cables type, length and size.
E. The transformer parameters, terminals voltage, parameters and type.
F. The electrical generator parameters (power, type and impedance).
G. The load (active and reactive power) at each load connection node for a year at least in hourly time intervals.
H. The circuit breaker information, location and type

This data may not be available as primary data. However, there are some techniques/method which can be used to estimate/derive the necessary information.

Data for Reliability study of the network:

- If a schematic network diagram is available (typically from the energy supplier) showing the main distribution lines and connections, the main network elements can be identified.
- A site visit to the peripheral system can be arranged to confirm the main networks components and network power diagram elements. The ratings and specifications of the network components such as transformers, generators, and circuit breakers would allow to determine the governing parameters of the network.
- The length of the cable can be estimated by employing software such as Google Earth according to the network diagram and connections. Depending on the length, core materials and the size of the cable the equivalent inductance, resistance and the capacitor can be estimated.
- For the failure rate and reliability analysis, these data can be estimated. Published works/reports have many data about the failure rate of the power system components. Depending on the power and voltage specification, a comparison between the available data and the required data for the island power network can be used to get the required data.
- Another source for the reliability data is IEEE 493, Table 7-1, page 105 that has reliability data of industrial plants, for transformers, breakers and cables.
- For any missing data, literature and engineering handbook reference values could be used for similar voltage and power conditions.

Data for Power Flow Analysis

- For the active and reactive power of the load at each node, this can be obtained from the energy supplier or can be estimated, based on reference demand values. The estimated active and reactive power are based on the number of houses supplied from the same node. By accounting for the number of houses/buildings connected to the same node, the load power at each node can be estimated depending on the average house power use.
- If the total power load of the network is known, the power load at each node can be estimated based on the percentage of the total houses/building connect with this power node to the total number of houses/building of the peripheral system.

By mapping out the reliability of the current system, the ICE methodology allows the key stakeholders of the system to assess the possibility of future system failures as more smart energy solutions are added. In addition, it allows for more informed decisions for the inclusion of innovative technologies within the energy transition process.

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5.2 Options for smart system operation and innovative technologies

Once the reliability and power flow of the current system is established, this information will be used to model and assess the different generation and supply scenarios. This will incorporate the renewable energy generation and the correct physical locations, i.e. connect to the correct geographical network nodes. Both types of analysis, the reliability study of the network and the power flow analysis will be carried out for the range of generation/smart technology scenarios that will be identified in sections 4 and 6 respectively.

The evaluation will thus contribute a system reliability *and* a reliability of supply view to decide between competing generation options and technology solutions. This will also reflect the available options given the current network infrastructure and will highlight any electrical infrastructure / network upgrades, which may be required for a low-carbon generation and supply within the isolated community. The main challenge is originated by the intermittent nature and daily/seasonal disparity of renewable energy generation, in addition to the misalignment of generation and demand. Even though battery energy storage can, in theory, be used to align generation and demand, the battery energy capacity required to achieve the system's goal can be unrealistic. For example, in the island of Oeussant, with 1.8 MW PV and 2.0 MW Wind installations, the deployment of a 2 MWh battery storage system can only reduce the annual energy deficit from 2282 MWh to 1866 MWh. While there is still a surplus of 3672 MWh that must be curtailed annually leaving the deficit to be supplied by diesel generator(s). This issue points to solutions from demand response techniques to further align the demand with the renewable energy generation in light of achieving the smart energy transition. Additionally, an appropriate energy storage and management system needs to be developed for the ICE methodology approach.

Optimising the size of the battery while considering the size of the renewable energy sources and the load demand is considered to be the first step towards designing an effective intelligent energy system. The operation coordination of the energy system is divided into two levels, the power management level and the energy management. In peripheral systems such as Oeussant island system, the power management level is responsible for coordinating the operation of the energy sources and energy storage to regulate the network voltage and frequency while maintaining the power balance between generation and consumption. Autonomous curtailment of renewable generation can also be implemented at this level for fast response, and to reduce communication load and infrastructure, especially when most PV generation is produced by roof-top PV panels that are scattered all over the system.

At the energy management level, the Energy Management System (EMS) coordinates the operation of the energy sources and energy storage, and also manages the demand to maintain energy balance for the short term (hourly) and the long term (daily) horizon. Intelligent energy systems rely heavily on load and weather forecasts, as well as previous demand and weather data, to optimise the system operation for the next hour and 24-hour horizons, components of Sections 3 and 4 (demand and supply options) of the ICE methodology. Artificial intelligence and machine learning techniques can also be adopted to effectively exploit all the previous and forecasted data to develop an energy management system that is trained on previous data and continues to learn and adapt while the system currently operating.

For demand side management, heating loads are considered as the most attractive options due to their capability to store thermal energy, hence operating as virtual distributed energy storage. For residential heat loads, such as water heaters and heat pumps, local load management systems are more convenient as each load could have its own unique thermal/electric model and capacity. Also, it would be difficult for a central EMS to manage each household load separately as this requires the measurements of temperature and load at each house which would result in a huge amount of data exchange and heavier processing load on the EMS. In this case a local EMS's can be designed and deployed for better performance. One approach is to investigate the feasibility of Reinforcement Learning (type of Machine Learning) to adapt the local controller to its load characteristics, without requiring a specific detailed knowledge of the load thermal model. In this case, the central EMS is still responsible for coordinating the operation of these loads by, for example, by dispatching a 24 hours schedule of incentives and penalties to indirectly shift the heating load from high demand to low demand periods. By exploring the usage of EMS and ensuring the reliability of the system the ICE methodological approach provides a thorough outlook for the system as it transitions to smart energy solutions.

6. Identification of credible scenarios and preferred plan selection

This section provides an overview of approaches to the definition and interrogation of plausible scenarios for future smart energy transitions, created in-line with the aims of the transition. It sets out the objectives, principles of scenario analysis in sub-section 6.1 and discusses the key quantitative and qualitative data needed to define useful scenarios in sub-section 6.2. Sub-section 6.3 outlines the interrogation of scenarios and the criteria against which scenarios should be evaluated. In addition this section highlights the assessment of the various plans for both supply and demand side options and to get to the preferred plan for the transition.

6.1 Scenarios as an analytical tool

Uncertainty about the future is an inherent component of decision making in energy systems. There are an infinite number of different possible futures, each with different social, technical, economic and political characteristics. Which future we arrive at is decided by innumerable decisions and events along the way (Schwartz, 1997).

Strategic foresight is an approach used by government or business to enhance planning in the face of this uncertainty (Bezold, 2010). Scenario planning is a technique used within the foresight approach to frame and describe what plausible futures might come to be. It allows for medium to long term (10 – 50 years or longer) strategic analysis. The technique uses narratives/storylines to create scenarios which describe how the world might look at some stage in the future. A set of different scenarios is often developed to reflect the range of different possible futures that might take place. In order to be useful, each scenario must be plausible, internally consistent, based on rigorous analysis and engaging (Foresight 2009). These different futures are shaped by different actions, trends and events. The ICE methodology advocates the use of scenarios across the scope of the transition. The scenarios can be developed from the outlook of the demand and supply options and will give insights into the preferred plan/s that will signal the smart energy transition of peripheral communities.

Scenarios can be used for a number of purposes (Schwartz, 1997; Van Notten *et al.*, 2003; Foresight Horizon Scanning Centre, 2009)

- To test or examine different plans and policy options, with the aim of exploring which combinations are likely to work more or less well in which scenario(s).
- To provide the basis for developing new policies or actions
- To provide the basis of a strategic vision about an organisation’s evolving role or opportunity
- To act as a means of identifying signs of movement towards a particular kind of future.

Intrinsic to the smart energy transition is the need for long term planning which is particularly useful for energy because long asset lives of infrastructure mean that decisions made now will have implications for the shape of the system for decades to come. Scenario planning can therefore be a tool for the key stakeholders seeking to understand the future implications of decisions made now.

6.2 Creating plausible scenarios

There are numerous ways of generating scenarios, rather than a single prescribed approach (Godet, 2000; Van Notten *et al.*, 2003). Amer et al (2013) and Davis et al (2007) provide useful overviews of different scenario methods and their characteristics, and the application of quantitative modelling techniques once the initial qualitative scenario has been developed (Davis, Bankes and Egner, 2007; Amer, Daim and Jetter, 2013).

While there are several approaches, they do however, have factors in common, outlined in Figure 6.1. Importantly, this includes the scenarios development process involving multidisciplinary teams of people, often from a variety of backgrounds (government, academia, NGOs etc) as advocated within the stakeholder engagement process of the ICE methodology approach. Scenarios can be determined at the stakeholder engagement step however, it will be preliminary as the supply and demand options of the isolated system is not yet very clear. Identification of key trends and drivers (social, political, environmental, economic etc) which are either current at the time, or which could plausibly emerge over the timescale under consideration is necessary for the scenario development.

Figure 6.1 Scenario development process

The initial focus for the scenario can either be normative (eg how might we meet our GHG emissions targets in 2050), or open (eg what might the world look like in 2050, and what might that mean for GHG emissions). Non-normative scenarios would tend to be exploratory, geared towards creative thinking about trends and investigating how society might evolve in the face of those trends and events (Van Notten *et al.*, 2003).

Once the scenarios are defined within the scope of the supply and demand options, setting out a qualitative vision of what the future might look like, detailed quantitative work can take place to model what that might look like in practice using various software tools – HOMER, PLEXOS or (Matthew, 2017). These quantitative models are informed in most cases by the social, economic, political and environmental conditions described in the narrative scenario. Back casting can then be used to outline pathways from today’s world to the future described in the scenario, focussing, for example, on different policy decisions and the timeframes in which they are made if the direction of travel is towards one particular scenario's conditions.

6.3 Evaluating scenarios

As outlined above, there are numerous different approaches to developing scenarios, albeit with some characteristics in common. This section highlights the use of different scenario approaches and gives details of ways to select the preferred plan for the smart energy transition. In addition, the use of life-cycle assessment (LCA) is provided as an added benefit for ensuring that the energy transition is as carbon neutral and sustainable as it aims to achieve.

6.3.1 Scenario planning and preferred plan

One method of several different techniques for framing the final scenarios, is the Two Axes method which has been used in a number of energy-related exercises because of its usefulness for thinking about medium to long term (10 – 20+ years) policy making. The Two Axes approach sets out a high level vision of the future and is explicitly intended to be illustrative rather than predictive.

As an example, the UK's National Grid Company produces annual Future Energy Scenarios using the Two Axes methods (Figure 6.2) as a way of thinking about future electricity system development up to 2050 (National Grid, 2017). The axes are defined by two uncertainties about the future, which are identified as being fundamental. However, this does not exclude other uncertainties or drivers from the final scenario as they are built in to the narratives in each of the four quadrants. The two key drivers shaping the final four scenarios in the National Grid exercise are the degree to which there is commitment to decarbonising the electricity system, and the degree to which money is available for investment or spending.

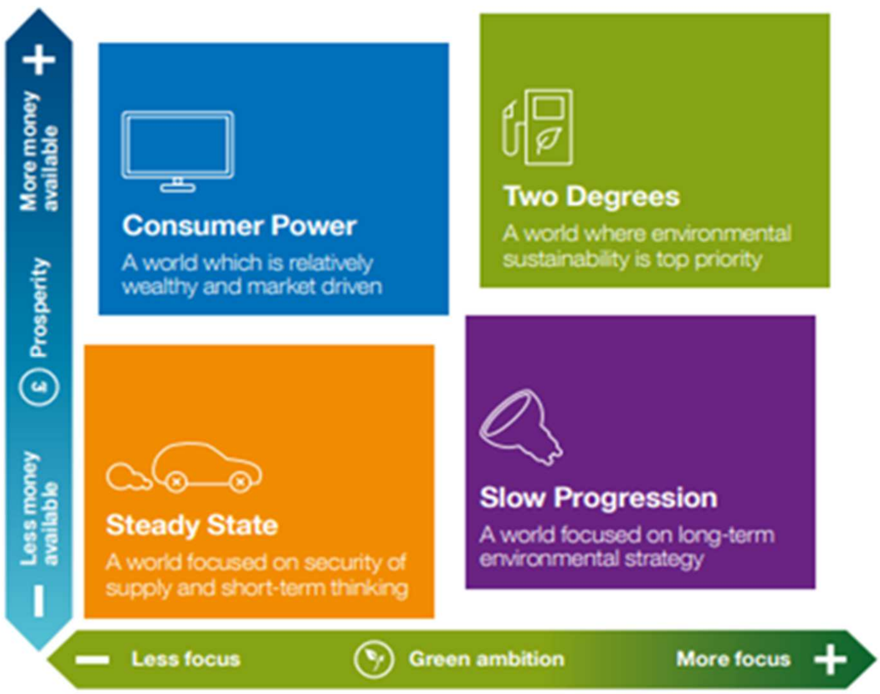

Figure 6.2 National Grid's Future Energy Scenarios (National Grid, 2017)

Each of the four quadrants describes a very different world, driven by the trends identified for the two axes and their resulting social economic and political impacts. The key characteristics of two of the narratives are outlined below, together with examples of the different quantitative modelling that can developed on the basis of the narrative. As can be seen, the two scenarios have very different outcomes for energy systems depending on the thinking about available finance and spending, despite the fact that both emphasise pro-environmental action. These quantitative outputs can be used to track outcome or shape business or policy action to encourage development along a particular route.

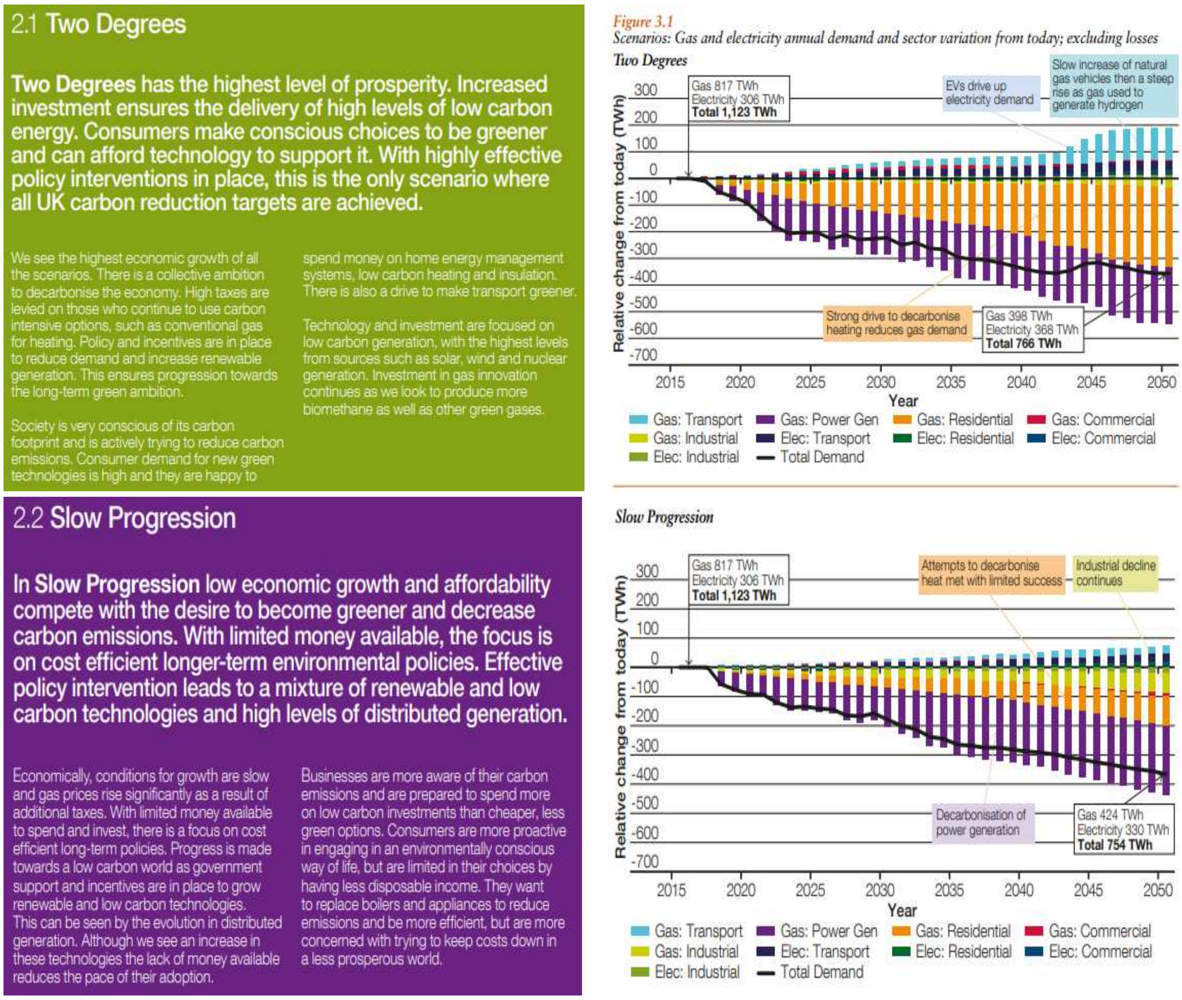

Figure 6.3 National Grid's Two Degrees and Slow Progression scenarios

Following an initial scenario planning and evaluation the preferred plan for the smart energy transition is pursued. This can be done as a deduction from the scenario evaluation exercise or it can be an additional culminating step of ensuring that the supply options and the demand options are in accord within the smart energy objectives of the system.

Further analysis using software tools can be incorporated to synchronise the demand/supply combinations. The preferred and alternative transition plan can be chosen as the best plan based on a harmonise ICE objective, supply and demand options that are energy system reliable and a system that can be sufficiently implemented – all within the scope of the various scenarios explored. One method that can be used to elaborate such a process is a Multi Criteria Analysis elimination of the candidate energy transition plans.

The following table, Table 6.1 gives a great overview of the many considerations to be taken in the choice of preferred and alternative plans. Note here that these criteria's are also useful when assessing the supply and demand options of the system and for exploring the scenarios of the smart energy transition of the system.

Financial Criteria
- Overall plan cost (including capital, fuel, and other costs, usually expressed in "present value" terms)
- Plan capital cost
- Plan fuel costs
- Plan foreign exchange cost
- Interest coverage ratio
- Return on equity
- Utility net income
- Internal generation of funds

Performance Criteria
- Customers served
- Loss of load probability
- Reserve margin
- Efficiency of energy use (on supply- and/or demand-side)

"Energy Security" Criteria
- Diversity of supply (fraction of each fuel used)
- Use of domestic resources
- Use of renewable resources

Environmental Criteria
- Amount of carbon dioxide produced over the life of the plan
- Amounts of other air pollutants (acid gases, particulate matter, hydrocarbons) produced over the life of the plan
- Amount of land used for energy facilities
- Liquid waste production
- Solid waste production (accounting for differences between hazardous and non-hazardous wastes)
- Plan impact on wildlife, biodiversity

Other Criteria
- Aesthetic issues (impact of plan on recreation, tourism)
- Employment impacts of plan
- Impacts of plan on other economic sectors (both positive and negative impacts)
- Political acceptability/feasibility of plan
- Social implications of plan (including impacts on local and indigenous populations)
- Cultural impacts of plans (impacts on culturally important resources)

Table 6.1 Possible attributes for evaluating and assessing the energy supply options as given by Tellus, (1999) useful for smart energy transitions

6.3.2 Life-cycle assessment

Scenarios can also be evaluated in more comprehensive details based on the three dimensions of energy security, energy equity and environmental sustainability. A life-cycle assessment (LCA) approach can be incorporated for exploration in the ICE methodological approach for the smart energy transition process. It will help the decision makers to define their preferable electricity mix and see how well these scenarios perform. The tool incorporates the results from three separate modelling processes that answer to each one of the three 'energy trilemma' questions.

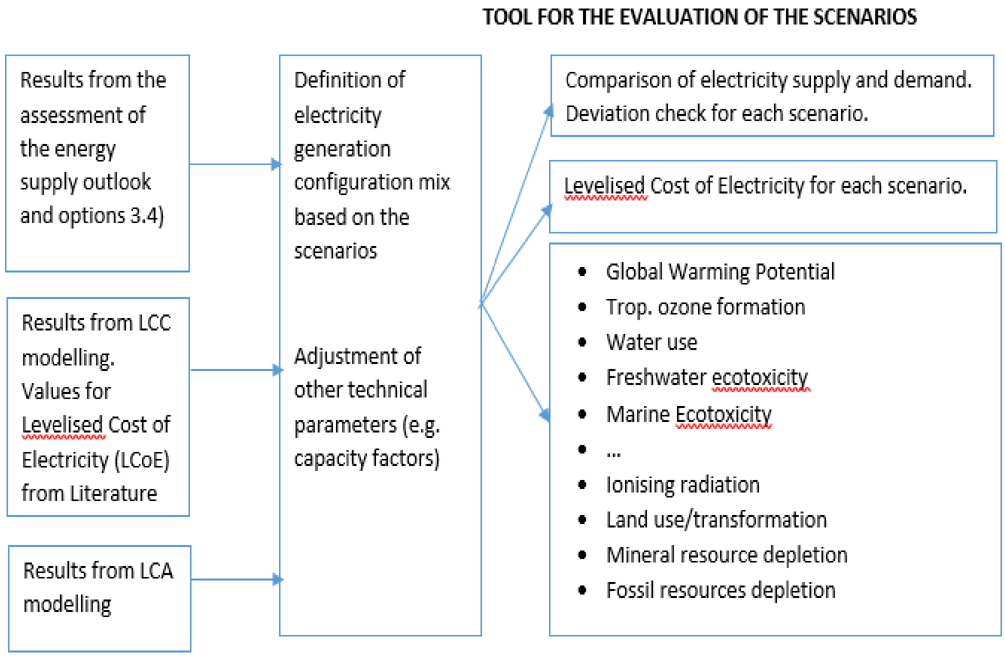

Figure 6.4 Suggested tool for the evaluation of the scenarios within LCA

Concerning the energy security aspect an analysis can be performed from the assessment of the energy supply outlook and options, as described in section4. Once the expected demand is estimated and the types of electricity generation plants and installations are identified (e.g. types of wind farms, photovoltaic installations etc), the resource capacity and other analyses can provide the expected technical specifications of these (e.g. their capacity factors) so that the expected electricity supply can be estimated. As a last step, the expected supply of each electricity mix defined under the relevant scenario is compared to the expected demand and based on that, the scenarios are evaluated on their ability to secure the adequate electricity provision based on annual electricity generation.

For the affordability aspect, this is examined by providing the ability to evaluate the scenarios purely on their cost. On that point, it is necessary to calculate the cost per electricity unit generated (e.g. €/MWh) for the whole lifetime of the electricity generation plants/infrastructure, that is taking into account the Life Cycle Costing (LCC). Therefore, the Levelised Cost of Electricity (LCoE) is used to take into account not only the capital costs of the investments but also the operation and maintenance costs as well as any fuel costs. In this way, hidden externalities and cost shifting issues can be revealed and a more representative economic evaluation is made. The output is a value that reflects the life cycle cost of each scenario expressed in €/MWh so that they can be compared based on their ability to deliver affordable electricity.

In relation to the environmental sustainability, in many cases this is perceived as making the electricity provision as low-carbon as possible. Nevertheless, in order to make sure that in our effort to do so we do not create other environmental problems, a wider suite of environmental impact categories are examined along with the Global Warming Potential (GWP), which is expressed in kg CO_2-equivalent and provides a good metric for the evaluation of which scenario is provides low carbon electricity. Special attention should also be made in order to avoid shifting the environmental burden to different places (e.g. where the solar panels are manufactured) and different phases of their lifetime.

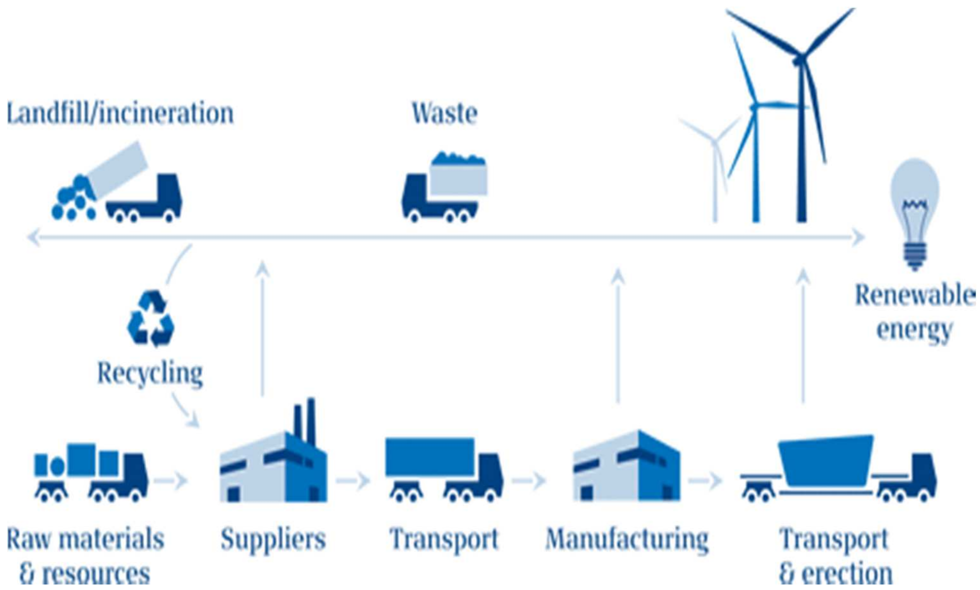

Figure 6.5 Wind turbine's general life cycle diagram. (www.vestas.com 2009)

The Life Cycle Assessment (LCA) methodology is used so that each electricity generation alternative can be examined during their whole lifetime; from the extraction of the raw materials, manufacturing, assembly, transportation, installation, operation, and disposal, which may include disassembly, recycling, incineration and landfilling of their various parts.

According to LCA, a goal and scope of the study of each electricity generation alternative is set and define the functional unit as 1 kWh of electricity that is supplied. Once the product model is constructed and data for the material and energy inputs is collected the Life Cycle Inventory (LCI) is created. With the help of sophisticated software and reliable commercial databases, the next step of the LCA methodology is performed and that is Life Cycle Impact Assessment. "Life cycle impact assessment (LCIA) translates emissions and resource extractions into a limited number of environmental impact scores by means of so-called characterisation factors" (RIVM, 2018) using the inputs defined in the LCI and the product model. The output of this modelling provides results for many potential environmental impacts for the generation of 1 kWh of electricity using each technology. These categories include not only the Global Warming Potential but also Marine Ecotoxicity, Human Toxicity etc. The results from the LCA modelling are used in the tool as parameters, which are combined with the expected electricity supply based on the chosen electricity mix envisaged in each scenario. The output is a set of values that reflects the life cycle environmental impacts of each scenario. Based on these outputs the scenarios can be compared within the context of the ICE methodological approach for the energy transition and useful conclusions can be derived about their environmental sustainability.

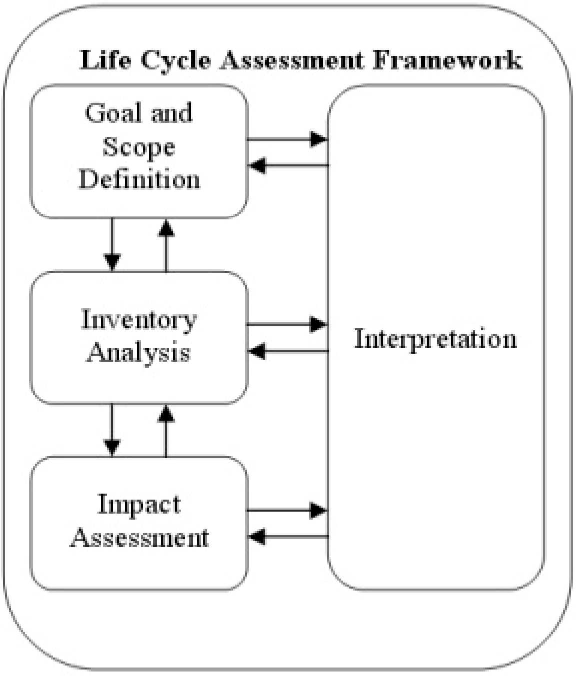

Figure 6.6 Life cycle assessment framework - The four phases of an LCA. (ISO 14040, 2016)

The analysis of the various scenarios considered for the energy transition leads to the choice of the best plan for implementation. Outputs from the various means of evaluating the affordability, energy security and the environmental impacts allows for the choice of the preferred plan by the key stakeholders to push the smart energy transition forward. The next section of the ICE methodological approach gives insights into bringing those plans into action.

7. Implementation, monitoring and revision

This section provides an overview of appropriate approaches to the implementation, inspection and, importantly, the re-evaluation of ongoing ICE transitions.

The adoption of the necessary steps within the ICE methodology leads to a decisional milestone of the preferred plan selection. However, the plan selection is far from the implementation planning and execution process. This implementation process of the smart energy transition follows and must be done in a timely and well-developed manner. In so doing, the transitional goals of the system can be leveraged against the actual performance criteria given (from the ICE methodology) for the smart energy transition. This would lead to an iterative process of revisiting the implementations and its outcomes into the choices of the ICE objectives as the conditions within the system can change, and new information becomes available.

In addition, a key part of the implementation, monitoring and revision of the smart energy transition is centred on taking advantage of the available human and financial resources. This can mean a combination of executing contracts and performance and reporting plans, coordinating project partners, procurement, continued public engagement and capacity building of key stakeholders. During these processes, stakeholders may gain information that differs from the original assumptions in the preferred implementation plans about the cost and availability of options. Hence, revisiting and revising of the plan is integral to the ICE methodology for smart energy transitions. To achieve a well-functioning monitoring and revision of the action plans there must be procedures for interim and full updates to the selected smart energy transition agenda. Well-documented outputs to include all models and reports used in the selection, implementation and operations of the various projects should be shared with all stakeholders.

According to Tellus Institute (1999) major planning cycles for electricity utilities and by extension key energy stakeholders can vary from two to five years with a view to plan for an updated process every 3-5 years. This approach is supported by the fact that the added resources (generation, energy efficiency, demand side management and other innovative technologies) to the energy system performances may change – better or worse than originally expected. Monitoring these entities within the energy transition implementation can provide critical inputs for subsequent iterations of the energy transition process. A basis for the judgement of the performance of the new/adapted resource would be to compare this performance with data from other similar implementations in other places to determine if the problem is local to this system or is common across this technology implementation. Of course, such information can be useful as inputs into the choice of preferred plan for the smart energy transition.

Other specifics within this phase of the ICE methodology encompasses the operation and maintenance requirements of the particular implemented technology. As shown similarly in ETI (2017), there is a need for a clear description of the necessary operating and expected performance metrics of normal usage of the technology/equipment and the closely related system entities. Added to this, there should be proper description of the critical personnel activities and responsibilities for technology maintenance and repairs and a means for sharing/handover of this information between staff. This should readily inform a means to facilitate equipment component replacement, planned offline requests, warranty claims, and documenting success and energy savings (ETI, 2017).

For implemented demand side management and energy efficiency and other innovative programs and plans, the key stakeholders with an appointed oversight entity should typically monitor the number and types of customers participating in the programs, the savings accrued, and the respective costs of implementing the different programs. Monitoring data would be used to facilitate the evaluation of the effectiveness of the demand side management and energy efficiency programs, with comparisons drawn from the original estimates as highlighted earlier. In addition, the assessment of the management, marketing, quality control procedures, and consumer and procurement responses should provide critical insights for the strategic roll out of the demand side management and energy efficiency program design. In doing so the key stakeholders will be informed about mid-stream corrections that may be feasible and desirable and for building on the lessons learnt to improve the smart energy transition. This assessment method can be termed as a process evaluation and must be thoroughly coordinated with impact evaluations. It can employ several methods such as in-depth surveys with program managers, site visits, survey techniques, focus groups, and documents review (Tellus Institute, 1999). It should be noted that by nature, assessing the performance of DSM programs is relatively more difficult than evaluation of the performance of other supply-side resources and programs within the energy transition. Observations cannot be directly made of the impact from load management in the same way as you can measure the relevant characteristics from a supply resource projects/implementation.

Since planning is a continuous process, the development of the smart energy transition planning is repeated periodically. Soon after the end of an implementation of a program or project within transition, it is critical to collect insights from team members and other stakeholders to inform the next steps for improvements to the next project for implementation. After the completion of a few projects, the local expertise (a project skills register can be developed) and the relevant information can help the community reassess their ICE objectives under new conditions and ensure that the forthcoming smart energy transition plan selections will capitalize on these findings. In essence, the learning from previously completed projects aids the development of and the execution within subsequently tabled projects. This will accelerate the progress toward achieving the smart energy transition.

The ICE methodological approach provides a structure and an opportunity for utility systems and key stakeholders to learn and to develop plans in a co-operative atmosphere as an initial blueprint for implementation and review in the face of changes in the system. Hence, the ICE methodology and the smart energy transition are not set in stone and can change over time when conditions do change, once done in a transparent and well-documented fashion. Flexibility for the implementation that may include policy updates within the regulatory framework of the system is important. When a development occurs that was not adequately foreseen or considered, it is important to revisit the plan, rather than rigidly abiding by it, or, in the alternative, bypassing it.

8. Fostering local enterprise – Business model manual

Fostering opportunities for local Small and Medium Enterprise (SME) is a core rationale for the ICE methodology illustrated as the linkage for the methodology, the business model manual of Figure 1.1. This section provides an overview of the opportunities that an ICE Methodology transition may present for local businesses. Section 8.1 outlines the key competences and local businesses required for an ICE transition; section 8.2 explores the issues and challenges of accessing appropriate finance for SMEs in this field and section 8.3 outlines the benefits, challenges and strategies for building capacity in local businesses that may be able to realise ICE transitions at home and further afield.

8.1 What companies are needed and how to find them

As with any major undertaking, the transition to a smart energy system within peripheral territories is likely to produce a wide range of commercial opportunities for the provision of goods and services. As we have outlined previously, the maximisation and exploitation of these opportunities by *local* firms and individuals is an important element of the ICE approach, which requires the identification and development of local capacity and skills.

It is also important to recognise that from location to location, the scale and nature of the opportunity for commercial involvement will vary widely. Firstly, the technologies and services required will vary with local conditions: which generation types are appropriate to local resources, which demand management approaches are technically and socially acceptable etc. seen in the previous sections – the preferred transition plan selection. In some places, the scope for commercial involvement in electricity generation or network management, for example, may be constrained by the structure of the electricity sector and the legal status of incumbent monopolies – issues to be highlighted with the stakeholder engagements of Section 2.

As well as the varying technical nature of the products and services required in a smart energy transition, local factors mean that 'who does what' is likely to vary widely between settings. For example, the precise range of services providers and their contracting arrangements depend on a wide range of contextual factors such as access to capital, risk perception, legal environment, experience of contractors etc. For this reason, it is inappropriate to specify here the scope of particular contract packages. Instead, we draw from the literature that underpins these guidelines to outline the types of products and services that are likely to be needed and present a framework that communities and other stakeholders can use and adapt to map against their specific requirements.

In general, a smart energy transition will present commercial opportunities spanning four broad domains of commercial opportunity:

- **Renewable energy supply -** In most (but not necessarily all) smart energy transitions in peripheral territories, an important goal is increasing the provision of energy from renewable sources.
- **Smart technologies and practices -** Better or 'smarter' management of electricity systems through the adoption of new technologies and practices is a crucial component of a smart energy isolated system.

- **Stakeholder engagement -** Establishing the goals of the energy system, establishing support for action and realising the benefits of action are all crucial parts of a successful transition.

- **Oversight and management -** Planning, guiding and measuring the success of the system transition as a whole.

Figure 8.1 below illustrates the domains of opportunity and the likely types of product and service that fall into each domain. As noted above, contracting arrangements may vary widely. For example, in some contexts, a single, well-resourced and experienced company may take on an engineer, procure, construct (EPC) contract for a renewable electricity generation project, while this service may not suit the capabilities available locally in other places. In each domain identification of the 'key service', the role without which other services are unlikely to be contracted such as project development, permits, skills team and capital is needed.

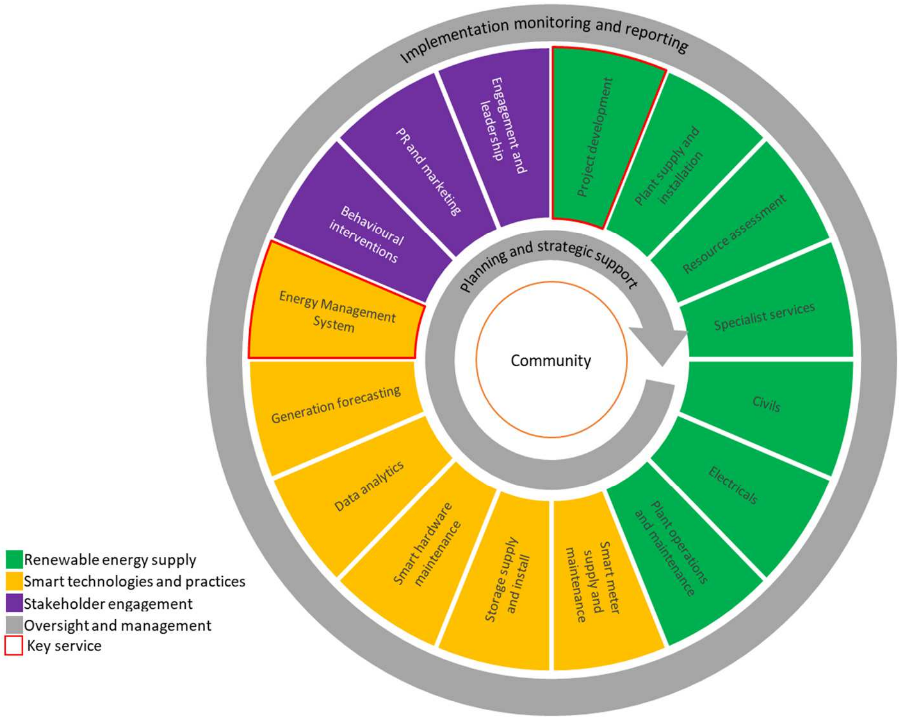

Figure 8.1 Domains of opportunity and the likely types of product and service for the transition

8.2 Access to capital

Access to finance has been identified as a major barrier to innovation by inhibiting business investment in bringing new products and services to market such as in the case of smart energy transitions. Limited access to finance particularly by SMEs is affecting all other sectors and is now addressed strategically at EU level under the COSME[2] programme and by the European Investment

[2] Competitiveness of Enterprises and SMEs, http://ec.europa.eu/enterprise/initiatives/cosme/index_en.htm

Bank. Most or all Member States also operate schemes to assist access to finance for SMEs, as part of their wider business support and funding approaches. These traditionally comprise:

- Grant funding – public funding which is essentially gifted to companies and other organisations in order to part-fund an innovation project. This is a risk-sharing approach, reflecting the fact that firms, especially SMEs, often lack the financial strength to take on 100% of the project risk; equally, the benefits of success will reach beyond the company taking the risk, so there is a justification in subsidising the project;

- Loan funding – commercial funding which companies can borrow to finance their investment plans, with an element of subsidy or risk under-writing with public funds to enable more attractive loan terms. Since the loans have to be repaid with interest at the end of the term, this type of funding is more attractive for low-risk projects;

- Equity funding – commercial funding provided to companies by external investors in return for a stake in ownership of the company. Although the equity does not have to be repaid (though the company may choose to repurchase the stake), this mechanism becomes very expensive for high-risk projects, particularly where investors have difficulty in quantifying the risk.

Many SMEs find that none of these funding sources is available to them on terms that are affordable for providing the needed services. Some new approaches that could help to address these gaps, with emphasis on approaches that could be enabled by cluster activities is emphasised here:

8.2.1 Grant Funding

A very wide range of grant funding programmes are potentially available to innovative firms, whether at EU, national or regional level.

8.2.1.1 European

H2020

The Horizon 2020 programme is the main European funding programme for collaborative RTD. The projects are co-financed by the EU and the participants. For research and development projects, the share of the EU contribution can be up to 100% of the total eligible costs. For innovation projects up to 70% of the costs, with the exception of non-profit legal entities which can also receive up to 100 % in these actions. In all cases indirect costs will be covered by a flat rate of 25% of the direct costs.

In addition, a dedicated SME programme is available for individual SMEs. Two categories of project can be supported: feasibility assessment (for which a lump sum grant of €50k is available), and innovation project (for which funding up to €2.5m is available, at an intervention rate of 70% of eligible costs). Further support for commercialisation is also available, but in the form of risk capital (instead of grant funding). Advice is available from the Enterprise Europe Network.

LIFE

The LIFE programme is the EU’s funding instrument for the environment and climate action. The general objective of LIFE is to contribute to the implementation, updating and development of EU environmental and climate policy and legislation by co-financing projects with European added value. As such, the scope of LIFE funding for innovation is limited. However, piloting of new clean technology to enable widespread deployment could be supported.

8.2.1.2 National & Regional

All member states offer grant support for innovation and collaborative RTD. Grants are allocated under a competitive process, addressing targets defined by the specific awarding body. All grant programmes have to comply with EU-wide State Aid regulations, which limits the level of intervention (depending on whether the project topic fits under one of the block exemptions).

Under the 2014-2020 programme period, a major element of regional funding is the European Structural and Investment Funds (ESIF) programme. These are administered by regional authorities alongside other sources of regional and national funding. Priorities, eligibility and access routes are therefore determined at regional level.

In non-European local jurisdiction there is the Green Climate Fund, other world bank financed local energy, and climate focused programs that can be accessed by the local communities for capital.

8.2.2 Loan Finance

Private Lending

The great majority of firms, across all sectors, raise all their external finance in the form of debt capital from commercial lenders such as banks. There are many reasons for this, including:

- Reluctance to dilute equity stakes of founders
- Complexity and management overhead of dealing with equity partners
- Potentially high cost of equity capital due to risk premium

Bank finance has become more difficult to access after the financial crisis due to banks' requirement to improve their liquidity ratios. In addition, company directors frequently have to risk their homes to provide a loan guarantee. Although there is a widely held belief that traditional bank lending is not the best way to support growth companies, there is presently a lack of accessible alternatives (see below).

Public/Private Lending

One possible answer to the lack of suitable commercial lending by banks is to leverage private capital with public funds. This can be achieved by using the public funds to underwrite most of the risk. These are generally operated at national or regional level. Assuming an average default rate, a relatively small amount of public underwriting can leverage a large (eg 50x) amount of investment.

A major source of public funding are development and investment banks such as the European Investment Bank (EIB) which provides long term financing to the EU. It is the largest multi-national investing bank in the world i.e. £70 billion of lending which is 2.5 times more than the World Bank. The individual Member State concerned, as well as the EC must sign off every project securing funding; this ensures that the project meets EU objective economic criteria and supports overarching EU policy goals.

The EIB invests in very large projects, including programmes, which can be jointly funded with national or regional programmes. This is how EIB money can assist SMEs, across a range of projects including general R&D, maritime clean energy, resource efficiencies etc. There is opportunity to combine grant monies with EU budget and work in partnership with EC e.g. JEREMIE (Joint European Resources for Micro to Medium Enterprises) which has provided individual loans to businesses of an average amount of £300,000.

8.2.3 Equity Finance

There is an over-reliance on debt finance, particularly in the SME market, but the level of over-reliance is highly variable between different Member States. For example[3], just 3% of small and medium-sized businesses use equity finance in the UK, below the EU average of 7% and much less significant than in countries like Denmark and Sweden, where equity investment accounts for 46% and 31% of SME financing respectively.

Venture Capital - Venture capital firms invest in early stage, high-risk but high-potential firms. Venture Capital investment is most typically suited for early stage companies that are experiencing high-growth or have potential for high-growth. For this reason, VC investment is unlikely to suit start-ups who have not yet established revenue. Typically after a 3-7 year investment, the venture capitalist will exit the company by selling their shares, either back to the business or to another investor.

Private equity - Private equity firms provide medium to long-term finance in return for an equity stake in unquoted companies, with high-growth potential. The investors return is dependent on the growth and profitability of the business. As a result, most private equity investors will seek to work with firms as a partner to grow the business. For example, a private equity provider like Broadlake manages a fund of €100m and looks to invest between €2-10m in long term capital and strategic support to established and growing companies. They have invested in 45 SMEs in the past 20 years. Such funding can be useful for local smart energy stakeholder/SMEs within the energy transition.

Public equity - In public equity, unlike private equity, the business becomes publically listed with shares able to be brought and traded by the public. The main public equity market in the UK and Europe for growing businesses is the Alternative Investment Market (AIM), which is operated by the London Stock Exchange. AIM offers smaller growing companies a public market with access to both retail and leading institutional investors within a regulatory environment designed specifically to meet their needs. There are no rules requiring companies to be a certain size or have an established trading record. However, a Nominated Advisor (Nomad) would expect that a viable AIM candidate would have strong growth prospects and a management team that compares favourably with its

[3] European Commission: Enterprise and Industry, SMEs Access to Finance survey 2011, December 2011

peer group. Since its launch in 1995, over 3,000 companies from across the globe have chosen to join AIM – collectively raising around €100bn.

Angel Investing - Business Angels are most commonly high-net worth individuals who invest in early stage or high growth businesses, either directly or through organised networks and syndicates. Business Angels usually have substantive knowledge and experience of growing businesses and can act as a mentor for the business, providing advice and guidance. Angel investment is suitable for seed or early stage companies looking for their first or second stage of external funding to grow rapidly, applicable for the smart energy transition and related capital financing.

Retail bond market - Bonds are essentially an IOU debt instrument. The purchaser receives a set return each year (coupon) for a set number of years, at the end of which the bond can be redeemed. Retail bonds are brought by individual investors, including individual savers, via an intermediary who manages the issue. The minimum amount invested can start at relatively small levels – usually under €1,000. Investors in retail bonds can buy or sell a bond at any time and check its price on the Stock Exchange – just like a share. In the UK the retail bond market is smaller than other developed countries. The MOT in Italy, created in 1994, is the most successful, liquid and heavily traded retail bond market in Europe, with over 800 bonds listed, raising €700bn since its establishment.

Self-issued retail bonds - It is possible for businesses to self-issue a retail bond which is a finance option used predominately by medium-sized businesses looking for long-term growth capital. In Germany, there have been around 200 self-issued bonds, with investors usually from the companies, its customer base or people local to the business. In the last year (March 2012-March 2013) the total issuance volume by German and Austrian companies was €1.9bn, with the average issue size around €35m. In the UK, the market for self-issued bonds is less developed, although there have been several high profile bonds raised in recent years, including the renewable energy generating company Ecotricity.

Corporate Venturing - Corporate venturing is a formal, direct investment relationship, usually between a larger and a smaller company. The larger firm provides direct support to smaller businesses usually in three ways, although some partnerships combine these types of investment:

- By making a financial investment in return for an equity stake in the business
- By offering debt finance to fund growth activities for an agreed return
- By offering non-financial support for an agreed return, such as providing access to established marketing or distribution channels.

Large businesses engage in corporate venturing for a number of reasons. It may be undertaken as a simple financial investment or as an opportunity to become an alternative provider of finance in the market. A firm might engage in corporate venturing for the strategic value it can provide e.g. supporting its supply chain, gaining market insight or ensuring knowledge transfer. Corporate venturing is most attractive to growing businesses that would value a partnership approach to their next investment. Whether in providing knowledge or routes to market, the partnership in a corporate venturing arrangement will be diverse, as it is tailored to the needs of both parties.

Peer-to-peer & crowd funding - Peer-to-peer and crowd-funding platforms enable individuals and businesses to lend to small and medium-sized firms for a specific project. The peer-to-peer and crowd-funding market is experiencing significant growth, particularly in the UK and US, and in 2012 $2.7bn was raised globally from crowdfunding and peer-to-peer lending. Peer-to-peer lending is suitable for businesses, which have been trading for at least two years. However, this may vary depending on which platform is used. Crowd funding differs insofar as investors generally receive a return 'in-kind' rather than an interest payment.

Given the wide range of possible financing options available to companies, it may seem surprising that there are any difficulties with availability of finance. Anecdotal feedback from companies and Governments indicates that there are problems that need to be addressed for financing the smart energy transition and these are recognised within the financial institutions. Therefore, it is key to ensure that all key stakeholders and local SMEs and businesses are able to receive the necessary support for pursuing the seed capital and funding needed to ensure they are poised to charter the smart energy transition. The ICE methodological approach to the smart energy transition will ensure that local businesses are prepared for the smart energy transition – developed in ICE deliverables T2.2 and T2.3

8.3 Building capacity in local businesses

Building of local individual skill is necessary but so is the building of the local business capacity. This section offers a brief description on how the innovation ecosystems at EU and national levels, for example, in France and in the UK, functions with a specific focus on the smart grids and/or marine renewable energy sectors.

8.3.1 Support to innovation

Innovation can be seen as a driver to the support of smart energy transitions. The way innovation is supported in the EU, and particularly how businesses are supported is key to enhancing the local businesses.

European level

Innovation is vital to European competitiveness in the global economy. The EU is implementing policies and programmes that support the development of innovation to increase investment in research and development, and to better convert research into improved goods, services, or processes for the market.

Varieties of tools do exist to support this EU strategy such as Enterprise Europe Network (EEN) or the European Business Network (EBN). ICE project partners such as Technopole Brest Iroise and Technopole Quimper Cornouaille on the French side are part of this EBN network. Their core activity is to support innovative ideas and transform them into a business. These innovative ideas can be tied to the smart energy transition for finding new ways to deliver the transition.

EBN is a network of around [150 quality-certified EU|BICs] (business and innovation centres) and [70 other organisations] that support the development and growth of innovative entrepreneurs, start-ups and SMEs. EBN is also a [community of professionals] whose day-to-day work helps these businesses to grow in the most effective, efficient and sustainable way. The growth of these local business should be support and they will then be able to assist effectively with the local smart energy transition.

National and local levels

The following propose a brief overview on how the system might work in a local/national level within the EU framework.

The innovation system mainly depends on the national government which propose different level of support that are operated by business support organisations such as Technopoles in France:

- **Incentives** to create innovative businesses
- **Tax support** for the development of young businesses
- **A legal framewo**rk to ease the integration of young people in the industry world, and to develop synergies between public and private research

8.3.2 ICE Offer to businesses

The ICE project partners with the framework of the ICE methodological approach are offering a support mechanism to businesses when it comes to working together from both sides of the Atlantic, with all the constraints it generates, notably with IP issues.

The objective is to offer the possibility to businesses to test some of their solutions on an energy-isolated region, in the ICE project case, on the Oeussant island, to be able in a second step to propose their solutions worldwide, to regions facing the same energy issues, within consortia gathering complementary expertise.

Business support organisation involved in the ICE project will work on:

- **The offer definition**: what are the businesses looking for? What can one do to support them?
- **Selection of businesses**: on which criteria the companies will be selected?
- **IP issues** to tackle any issue that might reduce or even annihilate businesses collaboration across France and the UK.

The overall objective is to make, for example, France and the United-Kingdom businesses, the leaders of the smart-grids solutions at EU and world levels. This is embodied within the identification and selection of local companies to be supported for access to financing and capital development – all labelled as ICE certified companies (an offer to favour collaborations) that can aid the smart energy transition of the specified peripheral regions.

8.4 The Manual

By identifying the key competences and local businesses required for the smart energy transition within the early stages of the ICE methodological approach, the issues and challenges of accessing appropriate finance for SMEs within the local environment can be mitigated with the business model manual. This business/SMEs targeted local and regional collation of ICE certified companies aims to aid the smart energy transition because of their adapted position in having access to get financial support for innovative activities related to their role for the energy transition. The strategies for collaborative funding within the SMEs for targeting a range of investment sources including the traditional banking sector but most importantly focusing on innovative funding schemes like peer-to-peer lending, crowdfunding, collective structures, funding angels and institutional funders is key to the business model manual of the ICE methodological approach. Apart from optimising and strengthening the cases for various funding streams, support is given for the business organisations involved in the smart energy transition to build capacity and networks for increasing their access to funds that are necessary for their growth.

9. Summary

This document describes a proposed methodological approach to the design and implementation of smart energy island systems. The approach consists of a series of sequential steps and iterations between steps that aim to guide communities through the process of creating a smart energy system. Unique to this approach is the emphasis of fostering local skills, businesses and industry with access to finance in the delivery of the program with the aim of retaining these long-term benefits within the community.

The report lays out the specific considerations of the proposed generic methodology for the isolated system smart energy transition. The framework is given as a set of guidelines based on the understanding of the best practices in ongoing smart energy transition projects and the approaches to electricity system planning. Within the scope of the ICE methodological approach the role of the different key players in the implementation of the methodology and the rationale behind the choices made regarding technologies, policies and so on are detailed. These includes stakeholder engagement, assessing energy demand and supply outlook and issues around balancing. Options, system reliability, scenarios and preferred plan selection, and the implementation, monitoring and revision of the energy transition aspects are then considered.

Following an introduction to the aims and scope of the methodology and a schematic overview of the key elements, seven key processes are described within this deliverable:

- Section 0 emphasises the significance of stakeholder engagement to successful implementation and proposes some guidelines for community involvement
- Section 3 explores important considerations in the assessment of current energy demand patterns and their evolution through time
- Section 0 presents guidelines in the identification and assessment of available energy supply options
- Section 5 explores the issues and approaches to ensuring electricity system stability and reliability
- Section 0 provides guidance on how communities might synthesise various sources of information to create a range of credible future scenarios and identify a preferred plan
- Section 0 discusses implementation, in particular drawing attention to the crucial importance of ongoing monitoring and revision
- Section 0 outlines the key area for consideration to ensure local business involvement in smart energy island transition. Providing networks for access to finance and capacity building of local businesses/SMEs.

The ultimate goal of the ICE methodological approach is to provide a blueprint for smart energy transitions in isolated and peripheral territories and to allow transferability of the methodology. The result here is that the specificities including business models and financing related to issues featuring isolated territories are all covered by this generic approach. In turn, the document aims to empower policymakers and stakeholders with the outlook, circumstantial evidence, and innovation on how to develop smart energy transition strategies for isolated and peripheral territories.

Transferability of the methodology is a key aspect of the business model. Hence, testing of the methodology is a next step and this will be pursued within task T2.4 of the ICE project as a means of validating the model. The island of Ouessant and the University of East Anglia campus as the demonstrators will be used as real cases to test the transfer capacity of the methodology. Additionally, the project will seek the use of four other isolated territories to study and validate the potential of transferability of the business model. For example, from the business manual aspect presented for the case studies - this should ensure that companies can access finance and capital streams in particular with a role from both French and English clusters to influence priorities for regional and national funding and in parallel assisting the formation of collaborative groupings to improve successful bids for funding.

The challenge here is to ensure that the specificities related to issues featuring isolated territories are all covered by a generic approach. The steps within the ICE methodological approach, Figure 1.1 (Sections 2-8) will be used to optimise and refine the generic parameters that need to be taken into account to transfer the business model from one isolated territory to another.

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