European Commission

Business Innovation Observatory

Public Private Partnerships

Large-Scale Demonstrators & Small-Scale Testing Units

Case study 6

Enterprise and Industry

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1. Executive summary

Business innovations have the potential to tackle the societal challenges of today and become key contributors to the achievement of the European Union's 2020 objectives. Yet to realise the potential of their innovations, businesses require real-life settings in which their technologies can be assessed, and facilities in which their prototypes can be industrialised. The establishing of such settings and facilities is typically costly and risky, and may call for public support, often in the form of public private partnership (PPP). However, the uptake of PPPs is sub-optimal, and so more needs to be done to ensure that the public sector acts as a facilitator in the validation and industrialisation of private sector innovations.

Yet there are signs of improvement, as Europe is increasingly deploying large-scale demonstrators and small-scale testing units that adopt a PPP approach. These demonstrators and testing units meet the validation and industrialisation needs of businesses, and may lead to Europe realising a number of socio-economic benefits, including the tackling of societal challenges, job creation and economic growth.

Nevertheless, questions remain as to how Europe can create a business environment conducive to innovative solutions emerging from such demonstration and testing activities. Thus far, the public sector at the national and/or European-level has provided financial support to organisations launching large-scale demonstrators or small-scale testing units. In doing so, the public sector has reduced the cost and mitigated the risk borne by private entities and, in return, looks to reap the rewards of future socio-economic benefits.

To further analyse the public sector's approach to this trend, this case study assessed demonstrators and testing units within the PPP market, and sought the views of public and private entities engaged in the deployment of eight demonstrators and testing units. These eight settings are active in one of the following four cross-cutting themes: electrical Mobility (e-Mobility); Smart Grids; Smart Living; and Advanced Manufacturing. The innovative solutions of such themes are intrinsically uncertain, and so investment in them poses both a political and financial risk. However, the public and private sectors appreciate the need to stay globally competitive, and so, to some extent, have demonstrated willingness to onboard these risks with the aim of generating competitive advantages and becoming frontrunners in the global marketplace.

To increase the uptake of large scale demonstrators, projects financially supported by the public sector ought to have a clear framework for ensuring that innovative solutions validated in close-to-society environments are: economically viable; scalable; replicable; visible; and employ a clear leadership and governance structure. This may be achieved through the terms and conditions of the PPP, for instance by integrating tasks dedicated to achieving these critical success factors and calling for international partnership within the private sector. In addition, it is recommended that a feasibility study be conducted on whether innovative small and medium-sized enterprises (SMEs) have a larger and more consistent place in large-scale demonstration projects. Such a study should also analyse whether tender specifications for large-scale demonstrators are too stringent, and thereby exclude SMEs from the public procurement process.

In contrast, small-scale testing units are well-served by SMEs that are somewhat dependent on financial support from the public sector. This financial support typically covers the high upfront costs of constructing small-scale testing units but tapers off when small-scale testing units go operational. Therefore, it is recommended that the public sector assesses the long-term costs of small-scale testing units in order to assess the degree of financial support that should be provided once operations have begun. The justification for such long-term financial support by the public sector is rooted in innovative businesses' desire to industrialise their prototypes in environments that are independent, complete and have enough critical mass. Finally, the public sector should also identify the optimum location for testing units in Europe, quantify their long-term financing needs (i.e. beyond unit construction) and create appropriate networks and portals to inform innovative businesses as to their location and capacity.

2. The emergence of PPP cooperation for demonstrators and testing units

Large-scale demonstrators refer to the real-life settings in which innovative solutions can test their economic feasibility and their ability to resolve, at an industrial scale, the problems faced by society. Large-scale demonstrators differ from market-replicated technological feasibility testing in that they provide scope for innovative solutions to adapt to their real-life setting, thereby better satisfying society's needs through social innovation[1]. Finally, the large-scale nature of such demonstrations is not only rooted in the testing covering a large area but also lasting for a longer (typically multi-year) period of time.

In contrast **small-scale testing units** refer to facilities that: test innovative solutions; provide certification on innovative solutions; provide training on the implementation of innovation solutions; and provide market intelligence. These small-scale testing units also help industrialise innovative solutions that are typically at a prototype stage.

For the sake of this case study, small-scale testing units will be treated as a single structure in which testing activities may be performed, i.e. a pilot plant, or an innovation centre. In contrast, large-scale demonstrators are treated as spaces (beyond a single structure) in which innovative technologies are rolled-out for demonstration, e.g. across a village, city, region or country.

In spite of their structural distinctions, both settings are undergoing a trend of cooperation between public and private sectors. This **public private partnership (PPP) trend** has been supported by the European Union (EU), which has encouraged the uptake of PPPs for the delivery of infrastructure and services through its: Communication on promoting the development of PPPs2; the European Economic Recovery Plan[2]; and the launch of the Project Bonds Initiative[3].

Demonstrators and testing units' adopt the PPP approach by using long-term agreements of cooperation between at least one public authority and at least one private sector entity. These long-term agreements are typically in the form of contracts or established relationships that include:

- A financial commitment from both sectors;
- The deployment of the demonstrator or the testing unit by the private sector for a given period of time ;
- The commitment of the public sector to being a facilitator for demonstration and testing activities, whether in terms of political support or the provision of infrastructure by municipal authorities; and
- The sharing of the risk-reward potential derived from delivering the services or infrastructure.

Without such cooperation between the public and private sectors, the development of such settings would likely not have happened. Businesses would likely not have the opportunity to industrialise and validate their innovations, and the opportunity of the private sector to commercialise and profit from innovative solutions would probably have been lost. Similarly, the public sector would have likely lost the opportunity to nurture regional competitive advantages that would lead to economic growth and create jobs.

3. The trend's socio-economic relevance

To understand the socio-economic relevance of the PPP trend in large-scale demonstrators and small-scale testing units, this section explains their potential socio-economic benefits, and their need for public private partnership. In addition, the section explains the challenge of providing quantitative estimates on the market potential of the PPP market, let alone its two underlying segments, large-scale demonstrators and small-scale testing units. Consequently, this case study places greater emphasis on the experiences of the interviewed entities involved in the deployment of the eight demonstrators and testing units.

3.1. Bringing innovative solutions to market

The socio-economic benefits of large-scale demonstrators and small-scale testing units are found in their ability to validate and industrialise innovations that can contribute to the achievement of the EU's 2020 objectives. For instance, they have the potential to contribute to smart, sustainable and inclusive growth as well as to regional competitive advantages that lead to global market opportunities.

- **Smart growth**, by providing a setting in which innovative solutions draw on knowledge and intellectual capital-intensive activities;
- **Sustainable growth**, by providing an environment in which innovative solutions aim to tackle Europe's societal challenges, including the need for the development of sustainable communities and Europe's transformation to a low carbon economy; and
- **Inclusive growth**, by creating skilled jobs on a direct (i.e. jobs at demonstrator or testing units) or indirect (i.e. jobs created by innovative solutions assessed in the demonstrator or testing unit) basis.

Large-scale demonstrators and small-scale testing units achieve these socio-economic benefits by providing validation and industrialisation settings for which innovative solutions that disrupt market channels, revolutionise business processes and organisations, and enhance the customer experience. For instance, many innovations for e-Mobility need to be validated at a large-scale (beyond the confines of a laboratory) and over a long timeframe. Such innovations include energy storage systems, drive train technologies, vehicle system integration and grid integration. The validation and industrialisation of these innovations may ultimately lead to socio-economic benefits like: energy savings; the reduction of greenhouse gas emissions; the reduction of noxious gases; increasing range and speed; and the mitigation of cost and technology constraints on raw materials.

e-Mobility, Smart Grids, Smart Living and Advanced Manufacturing, represent the four themes covered by the eight demonstrators and testing units in this case study. A summary of these eight settings is provided in Table 1. All of these demonstrators and testing units apply a PPP approach. Further detail on the need for this PPP trend is provided in the following sub-section.

Table 1: Summary table of the eight selected demonstrators and testing units

Theme	Project name	Primary location	Activity
e-Mobility	TIE-IN	DE	A testing unit in which e-Mobility products and services can be tested and developed.
Smart Grids	GRID4EU – Demonstrator 1	DE	A demonstrator in which Smart Grid measurement devices and agents may be tested.
	EcoGrid EU	DK	A demonstrator in which real-time price response is expected to contribute to the improvement of balancing mechanisms for generation and load.
Smart Living	Amsterdam Smart City	NL	A demonstrator in which projects are given the opportunity to showcase that it is possible to save energy now and in the future
	North West Bicester	UK	A demonstrator that caters for the eco-development of a community that caters for sustainable lifestyles.
Advanced Manufacturing	The Neobuild Innovative Centre	LU	A testing unit in which construction technologies can be tested.
	The Bio Base Europe Pilot Plant	BE	A testing unit in which companies can develop and scale-up biobased products and processes.
	The Cleantech Facilitator	DK	A web portal from which entities can find facilities for testing or demonstrating their innovative solutions.

3.2. The need for public-private partnership

To optimise the socio-economic benefits of demonstrators and testing units, the opportunity to link public and private actors must be seized upon. If this can be achieved, it is likely that the public sector's financial resources would well-complement the private sector's technological expertise. Moreover, the private sector would be more willing and able to develop such demonstration and testing environments.

"If you start a project, you always try to do a first cross check to see the balance between risks and benefits."
– RWE

Thus, in spite of its inherent costs, the decision of the public and private sectors to cooperate in the deployment of the aforementioned demonstrators and testing units suggests that the benefits of the PPP approach exceed its costs. Of the PPP benefits listed in Table 2, of particular importance is the ability of the public sector to alleviate some of its fiscal pressures. In return, private entities look to benefit from sharing the cost and risk of developing demonstration and testing environments with the public sector.

Table 2: Benefits and costs of the PPP approach for demonstrators and testing units

Sector	Benefits	Costs
Both (public and private)	• Spending on delivering demonstrators and testing units may stimulate the economy; • Allocates risk to the sector best positioned to mitigate each particular risk; • Widespread innovation and improved quality standards through the introduction of competition to the procurement of public sector services.	• PPP procurement can be lengthy and costly; • Do not achieve absolute risk transfer.
Public	• Spread the cost of the public sector's financing of demonstrators and testing units over the lifecycle of the asset, thereby reducing the immediate pressures on public sector budgets; • Improve the delivery of projects both on a time and cost basis; • Allows the injection of private sector capital; • Encourages the public sector to focus on results from the start, i.e. focusing on value for money rather than short term capital expenditure; • Maximises the use of private sector skills.	• Private sector does not have sufficient expertise to warrant the PPP approach; • Unable to transfer life cycle cost risk; • Loss of management control by the public sector; • Private sector has a higher cost of financing; • Private sector view PPPs as unfavourable when compared to grant funding.
Private	• Increase the private sector's role in developing and implementing long-term strategies for demonstrators and testing units; • Private sector partnerships facilitates small companies' access to public procurement; • European companies can increase their capability of winning market share in government procurement in third country markets.	• Public sector must demonstrate long-term commitment and political will; • Public sector does not have sufficient expertise to warrant the PPP approach, as the public sector may lack the skills necessary to prepare, conclude and manage PPP contracts; • Public sector is unable to cope with the prospect of change amongst its private sector partners during the PPP's lifecycle; • Design of the PPP does not allow the private sector to generate a return commensurate to the risk undertaken.

Source: PwC Analysis, EC[4] , Davies and Eustice[5], DLA Piper[6], Grimsey and Lewis.

The assessment of costs and benefits was best exemplified by the Bio Base Europe Pilot Plant, which faced difficulties in raising the anticipated EUR 13 million required to construct and furnish the plant with the necessary equipment. These difficulties were largely attributed to private investors willing to contribute no more than EUR 2 million to the financing of the plant. This shortfall in private financing led to the partners involved in Bio Base Europe to pursue public sector funding for the raising of EUR 13 million for the construction and furnishing of the plant.

The public sector at the national and European-levels has also provided financial support to other broader demonstration and testing programmes. For instance, the European Economic Recovery Plan[7] launched the following three PPPs:

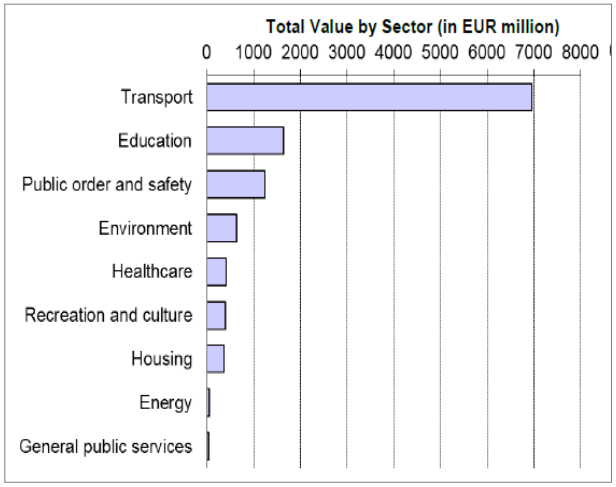
- Green Cars, which has drawn on a financial envelope of EUR 5 billion to trigger growth in the automotive sector, and more specifically, support the development of new, sustainable forms of road transport. The initiative is largely financed by loans made available by the EIB, as well as support from industry and the EC (under FP7).
- Energy-efficient buildings, which has drawn on a financial envelope of EUR 1 billion to stimulate growth in the construction sector. The initiative aims to achieve this by promoting green technologies and the development of energy efficient systems and materials in new and renovated buildings. The initiative is financed by industry and the EC (under FP7).
- Factories of the Future, which has drawn on a financial envelope of EUR 1.2 billion to boost the manufacturing industry in the field of new and sustainable technologies. The initiative is financed by industry and the EC (under FP7).

3.3. The segmentation of the PPP market

The focus of the initiatives pursued under the European Economic Recovery Plan bears strong resemblance to the four themes tackled by this case study. The theme of e-Mobility draws parallels with the Green Cars initiative, Smart Grids and Smart Living are linked to the Energy-efficient buildings initiative, and Advanced Manufacturing demonstrates close ties with the Factories of the Future initiative.

Yet in spite of this resemblance, these themes only represent a small segment of the entire PPP market, and are of varying significance. For instance, transport remains the preeminent sector in Europe's PPP market, followed by education in a distant second (see Figure 1).

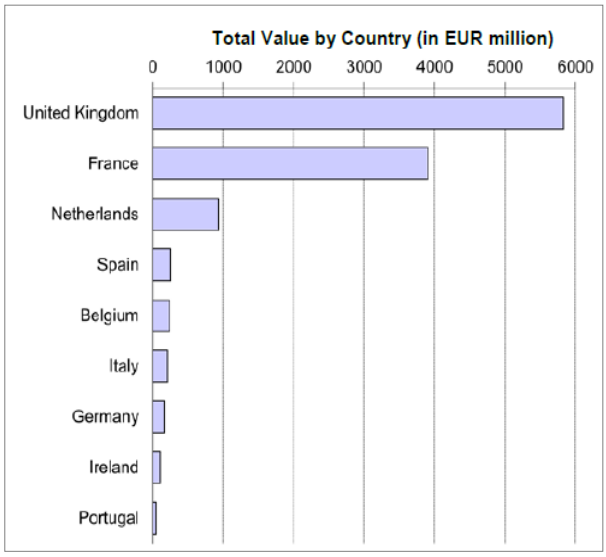
Figure 1: Sector breakdown of the PPP market by value (in 2012)



Source: European PPP Expertise Centre (EPEC)[8]

In terms of the PPP market's country segmentation, the UK has long been the primary user of PPP, accounting for approximately 52.7% of the total value of the continent's PPP market (Figure 2). This is largely attributed to the UK's early adoption of PPP initiatives via the country's Private Finance Initiative (launched in 1992). Other prominent Member States in the European PPP market include: Spain; Germany; Italy; France; the Netherlands; and Belgium.

Figure 2: Country breakdown of the PPP market by value (in 2012)



Source: European PPP Expertise Centre (EPEC)[8]

Nevertheless, it is important to note that the reliability and completeness of data regarding PPPs is poor. For instance, the European PPP Expertise Centre (EPEC) draws on a number of sources to review the PPP market but still states that "the data is inevitably incomplete"[8]. Similarly, Colverson and Perera[9] call for statistical caution when comparing PPPs, as the measurement of PPPs is subject to diverging approaches across jurisdictions.

Therefore, quantitatively assessing the PPP market, whether from a sector or country perspective, is a complex task. Moreover, such an assessment is further complicated by attempts to identify the size and geographies of cross-cutting activities within the PPP market, as is the case with large-scale demonstrators and small-scale testing units.

Due to these quantitative limitations in assessing the PPP market, this case study has taken a bottom-up approach in assessing the PPP trend for large-scale demonstrators and small-scale testing units across Europe. In doing so, emphasis has been placed on the experiences of the eight selected large-scale demonstrators and small-scale testing units taking a PPP approach (see Table 1, p.7).

3.4. Industrialising and validating innovations

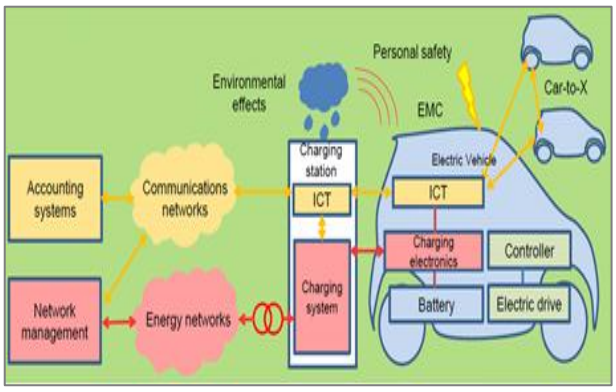
The eight selected demonstrators and testing units are deeply rooted in industrialising and validating innovations that tackle societal problems. These problems and prospective solutions are further detailed hereunder.

Problem 1 – The lack of an environment in which power system operators, manufacturers of charging stations, charging systems, billing systems, or equipment and communication facilities can test and develop their products and/or services.

PPP 1 – Public sector: EUR 6.5 million in funding from the European Regional Development Fund (ERDF). Private sector: Technische Universität Dortmund (TUD); AKUVIB GmbH; EMC Test NRW GmbH; LTi DRiVES GmbH; Rheinisch-Westfälisches Elektrizitätswerk (RWE); TechnologieZentrum-Dortmund GmbH; and TÜV Informationstechnik GmbH.

Innovative solution 1 – TIE-IN, which is located at TUD's centre of excellence, provides an environment in which such e-Mobility products and services can undergo testing activities. The project is led by TUD, in collaboration with five private sector partners. The project has public sector involvement in the form of EUR 6.5 million of funds received from the government of North Rhine Westphalia.

TIE-IN's conceptual design



Source: TUD[10]

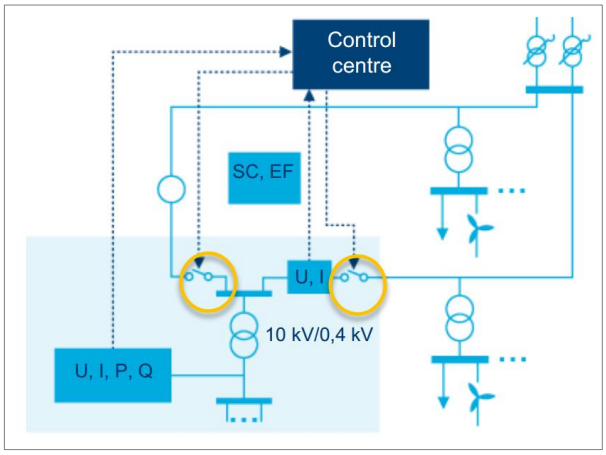
Problem 2 – Decentralised energy generation across Europe will require huge grid investments. This process of decentralisation will lead to the need for grid extensions, which would be costly if conducted in the traditional manner, and the increasing unpredictability of the power flow.

PPP 2 – Public sector: EC grant of EUR 25 million. Private sector: RWE; ABB; and TUD.

Innovative solution 2 – GRID4EU – Demonstrator 1, which is located in Reken, Germany, deploys demonstration activities conducted by three partners (RWE, ABB, and TUD) drawing on EUR 1.1 million of self-financing and EUR 1.5 million in EC financial support. These demonstration activities involve the installation of automated measuring devices that can control the grid for optimising distribution. In addition, agents are used to communicate among one another in order to determine when and where remote controllable switches ought to be used in order to adjust the grid's typology, thereby reducing grid loss.

"The driving factor [of Smart Grids] is the integration of renewables. In order to integrate renewables, we could reinforce the grid in a conventional way (with additional cables) but this is not the most cost effective solution. We need to find something more flexible." ***– RWE***

Measurement and switching concept of Demonstrator 1



Source: Verdier & Jerdernalik[11]

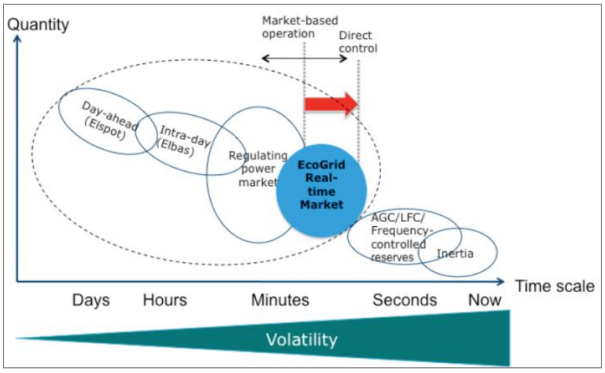
Problem 3 – Transmission System Operators (TSOs) in Europe are hindered by the lack of a market-based mechanism close to the operation phase.

PPP 3 – Public sector: Energinet.dk; TNO; DTU Elektro; Tallinn University of Technology; SINTEF; and a total budget of EUR 21 million from the EU's Seventh Framework Programme for Research and Technological Development (FP7). Public-Private sector: Elia Group; and Eandis. Private sector: ØSTKRAFT group; ECN; Austrian Institute of Technology; Landis+Gyr; IBM; Siemens; EDP; and Tecnalia.

Innovative solution 3 – EcoGrid EU is located in Bornholm, a Danish island in the Baltic Sea. Bornholm's distribution system is operated by the local distribution service operator (DSO), Østkraft. The demonstration activities being conducted in Bornholm involve 15 partners from across Europe, who draw on a budget of EUR 21 million, of which approximately half is financed by the EU. These demonstration activities seek to improve the balancing mechanisms for generation and load by introducing a 5 minute real-time price response. In order to do so, EcoGrid EU calls upon a combination of: price signal updates, which reflect imbalances in the power system; and a market-based platform and ICT infrastructure for extending the current electricity market to a shorter time horizon and to smaller assets.

"The issue that needs to be solved is the balance management of the energy generated and the energy load." ***– Elia Group***

The scope of a real time market



Source: EcoGrid EU[12]

Problem 4 – 80% of Europe's population lives and works in cities, where up to 80% of energy in Europe is consumed.

PPP 4 – Public sector: The City of Amsterdam; and European Regional Development Fund (ERDF). Public-Private sector: Amsterdam Economic Board Foundation. Private sector: KPN; and Liander.

Innovative solution 4 – Amsterdam Smart City is a large-scale demonstrator which covers five themes (living, working, mobility, public facilities and open data) across 3 areas of the Netherlands' largest city. The aim of the demonstrator is to showcase that it is possible to save energy now and in the future. In doing so, the PPP's partner (the City of Amsterdam, the Amsterdam Innovation Motor, KPN and Liander) provide equal financial support to the programme by contributing EUR 100k per annum. This money is used to cover the costs of Amsterdam Smart City in demonstrating its 32 underlying projects.

"There is a need for Smart Cities because of increasing urbanisation, which has led to the need for cities to become more liveable, both in economic and sustainable terms." ***– Amsterdam Economic Board***

The distribution of Smart City projects across Amsterdam

Source: Amsterdam Smart City[13]

Problem 5 – The need for Europe to examine the sustainability challenges it faces and develop action plans to live and work within a fair share of the Earth's resources.

PPP 5 – Public sector: Cherwell District Council. Private sector: Bioregional; A2Dominion; Farrell & Partners; Barton Willmore; and Hyder Consulting.

Innovative solution 5 – North West Bicester, which will be the UK's first demonstration of an eco-town. A2Dominion and BioRegional have created an action plan based on One Planet Living's ten principles. This action plan seeks to ensure that North West Bicester caters for sustainable lifestyles. The first phase of the masterplan is Exemplar, which will be the site of a new, eco-development of 5,000 homes. The private sector partners involved in the project are A2Dominion and BioRegional, who are complemented by a public sector partner, Cherwell District Council (and more specifically, its Eco Bicester programme).

An artist's impression of NW Bicester

Source: a2dominion and BioRegional[14]

Problem 6 – Europe's lack of testing facilities and pilot plants, notably in the construction sector.

PPP 6 – Public sector: Ministry of Economy and Foreign Trade. Public-Private sector: Public Research Centre Henri Tudor; University of Luxembourg; CRTI-B; Institut de Formation Sectoriel du Bâtiment; and Centre Scientifique et Technique du Bâtiment. Private sector: Conseil de Développement Economique de la Construction (CDEC); Belgian Building Research Institute (WTCB/CSTC); lemoniteur.fr; and batiactu Produithèque.

Innovative solution 6 – The Neobuild Innovative Centre is a small-scale testing unit located in Bettembourg, Luxembourg. The aim of the testing unit is to create a facility that captures the physical parameters of the environment in which tested construction technologies intend to be used, e.g. temperature and humidity. The Centre is a PPP as Neobuild has approximately 70 private sector members, and closely collaborates with the Ministry of Economy and Foreign Trade.

An artist's impression of the south west part of the Neobuild Innovative Centre

Source: Neobuild

Problem 7 – Europe's lack of testing facilities and pilot plants, notably in the bioeconomy sector.

PPP 7 – Public sector: European Regional Development Fund (Interreg IV programme); and the Flemish government. Private sector: Ghent Bio-Energy Valley.

Innovative solution 7 – The Bio Base Europe Pilot Plant is located in Ghent, Belgium. It is part of a broader Bio Base Europe programme that also encompasses a Training Centre in Terneuzen in the Netherlands. The aim of the Pilot Plant is to provide a large, independent and complete testing unit in which companies can develop and scale-up

"At university, the only thing that counts is publications. But who cares about a piece of paper? There needs to be a drive to industrialising results, and in order to bring your research to market, you need a pilot plant." ***– Ghent Bio-Energy Valley***

biobased products and processes. The Pilot Plant exemplifies public private partnership as the EUR 13 million cost of building the Pilot Plant has been roughly shared between the Flemish government and the ERDF's Interreg programme. Yet since the Pilot Plant's completion, the operating costs of the plant have largely been covered by revenues accumulated from the private sector (i.e. the private entities using the Pilot Plant or drawing on its in-house services).

Aerial view and process hall for Pretreatment and Biocatalysis of the Bio Base Europe Pilot Plant

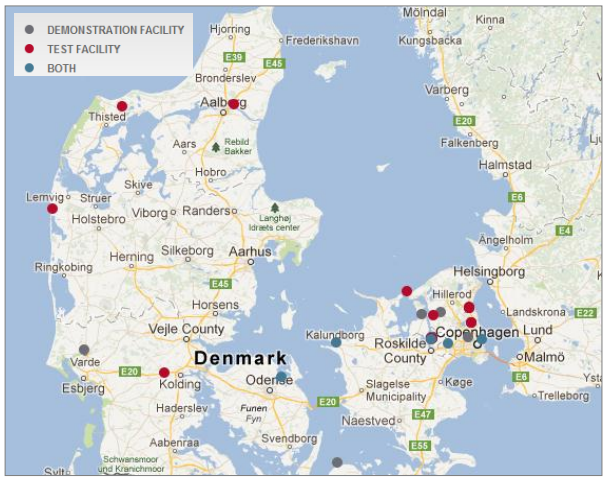
Source: Bio Base Europe

Problem 8 – Not all prospective users are aware of the location of relevant testing and demonstration facilities in Europe. Consequently, users of testing units often have to conduct their testing and demonstration activities at two or more testing units.

PPP 8 – Public sector: The Capital Region of Denmark; Region Zealand; and the European Regional Development Fund (ERDF). Public-private sector: Scion DTU; State of Green; and the Copenhagen Cleantech Cluster.

Innovative solution 8 – The Cleantech Facilitator is a web portal for demonstrators and testing units for clean technologies in Denmark. The aim of the portal is to help companies and organisations in find facilities for testing or demonstrating their technologies and concepts. The Cleantech Facilitator is a PPP as it is led by public-private sector participants (Scion DTU, the Copenhagen Cleantech Cluster, State of Green) and receives financial support from the public sector (Capital Region of Denmark, Region Zealand, and the ERDF.

Map view of the testing and demonstration facilities included in the Cleantech Facilitator



Source: The Cleantech Facilitator[15]

3.5. Partner perspectives related to the uptake of the trend

The success of the technologies trialled in these demonstrators and testing units is implicitly unknown from the outset. Yet information collected from the interviews suggests that partners engaged in demonstration and testing activities have an idea as to what results would lead to the increased uptake of the demonstrator and testing unit trend. In the case of large-scale demonstrators, increased uptake will largely depend on the success of demonstrated innovative solutions. These solutions will be judged on their ability to be:

"With regards to the whole cost-benefit analysis, it's sometimes difficult to assess that. We do not have reliable figures as we work in the topic area of assessing problems."
– RWE

- **Economically viable**, i.e. their ability to develop and survive as a relatively independent economic unit;
- **Scalable**, i.e. their ability to change scale in order to meet growing volumes of demand;
- **Replicable**, i.e. their ability to be duplicated at another location or time[16];
- **Visible**, i.e. their ability to be seen by various stake-holders; and
- **Implemented with a clear leadership and governance structure**, providing confidence in all stakeholders, ensuring them that responsibility is integrated into the partnership and its decision making processes.

The GRID4EU – Demonstrator 1 project and EcoGrid EU have effectively taken a task-based approach to achieving most of these success criteria, which are summarised in Table 3.

Table 3: The application of the success criteria by GRID4EU and EcoGrid EU

	GRID4EU – Demonstrator 1	EcoGrid EU
Economic viability	Economic viability is expected to be in the form of reinforcing the grid in a cost effective manner, i.e. the cost of the innovative solution for reinforcing grids is less than the cost of the traditional manner (installing additional cables). In addition, the grid operator may benefit from reduced grid losses. It is also expected that the end-user will benefit from reduced recovery times after grid failures.	Economic viability for the project is expected to be found in the reduced cost of balancing the grid. The benefit of reduced cost is expected to be passed onto the end-user in the form of reduced energy bills. In addition, economic viability could arise from reduced energy consumption by end-users.
Scalability and Replicability	GRID4EU has a work package on scalability that aims to conclude on scaling up rules and the possibility of replicating the demonstration results at EU-level.	Elia Group has been given the responsibility of the work package related to deployment and replication across Europe, which involves studying how the single marginal price related to system imbalance could be smoothly integrated into other European energy markets.
Visibility	One of the first four projects that received the European Electricity Grid Initiative (EEGI) label.	One of the first four projects that received the European Electricity Grid Initiative (EEGI) label.
Clear leadership and governance	Rémy Garaude Verdier of ERDF has been designated as the project coordinator. In addition, the partners involved in the project are reviewed by a professor from the University of Manchester.	Ove Grande of SINTEF has been designated as the project coordinator. In addition, the partners involved in the project will report to the Reference Group, which will act as a forum for feedback.

In contrast to large-scale demonstrators, the success criteria of small-scale testing units are independence, critical mass, and completeness. This was exemplified by the Bio Base Europe Pilot Plant, which is:

- **Independent**, in that none of the Pilot Plant's owners is a large corporation, which arguably strengthens the credibility of the Pilot Plant in keeping the secrets of the tested technologies confidential.
- **Critical mass**, as despite being considered a "small"-scale testing unit in the context of this study, the Pilot Plant has spacious production halls (1700 m^2 total surface area) that allow for the flexible set-up of process lines and the possible installation of new or rented equipment.
- **Complete**, in that the Pilot Plant has equipment for a variety of processes like biotechnology, green chemistry, and bio-refining. This often means that all the process steps of testing can be conducted in the Pilot Plant. As a result, product losses are reduced, and more reliable results are achieved.

These success criteria reflect the interests of the users of large-scale demonstrators and small-scale testing units. For instance, large-scale demonstrations are typically deployed by large companies at the forefront of innovation and operating over a wide geographical area. Consequently, these large companies are interested in making the innovative solution economically viable, scalable and replicable. In contrast, the users of small-scale testing units place greater emphasis on keeping hold of the intellectual property that underpins their innovation. In addition, the users of small-scale units would ideally have all the tools required for testing in a single location.

4. Drivers and obstacles

This section expands on the drivers and obstacles of large-scale demonstrators and small-scale testing units, including the need for: public sector funding; changing cultural mindsets; formulating effective demand-side policies; international partnerships; involving SMEs in PPPs; assessing the appropriateness of markets; and developing relevant skillsets.

4.1. The need for public sector funding

It was clear that the eight selected demonstrators and testing units would not have come to fruition had the public sector not offered financial support to the private sector. This need for public sector financial support is summarised in Figure 3, which highlights how, without PPPs, businesses would have suffered from a lack of demonstration or testing settings.

Figure 3: Quotes from interviews regarding the need for PPPs

"Without the grant, the project would not have happened. R&D projects are really high risk." **– ABB**
"In terms of Smart Grids, the technology is nearly mature, but the demonstration needed is costly and risky, therefore public funding is needed." **– Elia Group**
"Without public finding, the demonstrator would not have been set-up". **– TUD**
"Without a PPP structure, the project would not have taken place because of: (1) the current public funding issues; and (2) the need for a clear governance structure for such research projects. Society needs to know that public and private sectors are involved and are interacting in a trusted way." **– Adviser to energinet.dk**
"I tried to get private funds to set up the plant but it was not possible. Without public support, there would be no pilot plants. Even private companies find it difficult to make pilot plants profitable." **– Ghent Bio-Energy Valley**

Some interviewees also highlighted the administrative burden encountered in securing EU funding up front, and in reporting on the use of funding during and after project completion. In addition, some interviewees argued that Europe is well-equipped to channel funding to fundamental research but ill-equipped to finance the demonstrators and testing units that facilitate the industrialisation of Europe's research activities.

"There is a price for getting [EU] money, as the administrative burden is high. It seems that the administration is based on the hypothesis that money is not being used appropriately." ***– Scion DTU***

At a national- or regional-level, financial support is more easily secured if the field in which the demonstrator or testing unit operated is part of a broader national or regional agenda. For instance:

- The e-Mobility Competence Centre, Dortmund is tied to North Rhine Westphalia's "Master Plan for Electric Mobility". This master plan will draw on three competence centres in Dortmund (e-Mobility technology), Aachen (car technology) and Munster (battery technology) for the development of electric vehicles in the region;
- North West Bicester is deeply rooted in the UK government's launch of the "Eco-towns Prospectus 2007" together with a green housing paper. The aim of the Prospectus was to invite local authorities to make bids for funding for large-scale zero carbon eco-towns that promoted eco-friendly living as well as high quality design and architecture[17].

Interviewees also believed public sector financing was a prerequisite for the delivery of demonstrators and testing units, as the benefits of such infrastructures are not limited to the private sector. Moreover, private sector partners explained how they would be reluctant in bearing all the risk posed by rolling out large, multi-year projects like Smart Grids.

"The public and private sectors benefit from such projects [Smart Grids]. Corporations want to become the providers of energy products and services for the energy of the future. While the project is also relevant to European society, as improvements in the operation of grids will likely help mitigate rising energy prices." ***– AIT***

Finally, interviewees also expressed how few territories in Europe adequately manage the budget lines provided to demonstrators and testing units. This is particularly detrimental to the regional business environments of demonstrators and testing units that require funding over a multi-year timeframe.

4.2. Changing cultural mindsets

Instead of supporting the commercialisation of research, development and innovation, demonstrators and testing units start with the societal problem before identifying and validating the innovation solution. As a result, these settings are turning traditional innovation policy on its head1. Yet in doing so, private entities are challenged by resistance to

"Experience shows that France, Sweden, and Finland have a different way of working to the UK. The UK is reasonably quick to on-board new ideas in contrast to the other countries."
– BioRegional

change, particularly from the public sector. For instance, BioRegional highlighted how it has faced difficulties in convincing municipalities in France, Sweden and Finland to adopt a large-scale demonstration approach to sustainable living.

Furthermore, the lack of willingness to change by communities was also seen as a potential obstacle. In order to overcome this obstacle, EcoGrid EU's partners devised an accessible communication strategy to enable end-users to understand its demonstration project and its potential benefits. The partners also ensured that the demonstration did not promise more than it could deliver, and thereby avoided disillusioning customers if promised benefits did not occur[18]. This resulted in the population of Bornholm, Denmark, being extremely receptive in the rollout of the project, as exemplified by more than 1,500 participants signing up to the demonstration[19].

"The acceptance and success of such large scale demonstration projects depends on public awareness of environmental protection. The Danish population is an example of a well-informed population."
– Elia Group

4.3. Formulating effective demand-side policies

Europe has traditionally used macroeconomic policy to buoy market demand and avoid market distortion. Yet more recently, Member States have demonstrated a greater awareness of the interaction between supply and demand in the innovation process. Consequently, most EU Member States have adopted demand-side policies like public procurement, regulation and standards, in order to tackle societal challenges, and increase the productivity of public spending during times of fiscal austerity.

Nevertheless, according to Izsak and Griniece[20], 25% of EU Member States still do not have demand-side policies on their policy agendas. Thus, it is arguable that these Member States will not be as well-positioned to: react to market and system failures; respond to societal needs; and supplement the supply-side of the economy[21].

In terms of public procurement as a demand-side instrument for demonstrators and testing units, the UK appears to be leading the way with its Future Cities Demonstrator Programme. This Programme sought to identify an appropriate city in which new products could be demonstrated and integrated within city systems. On 25 January 2013, it was announced that Glasgow had won the bidding process for the Future Cities Demonstrator Programme, and would ultimately benefit from the £24 million prize. The Demonstrator will also be supported by the Future Cities Catapult, which will be located in London.

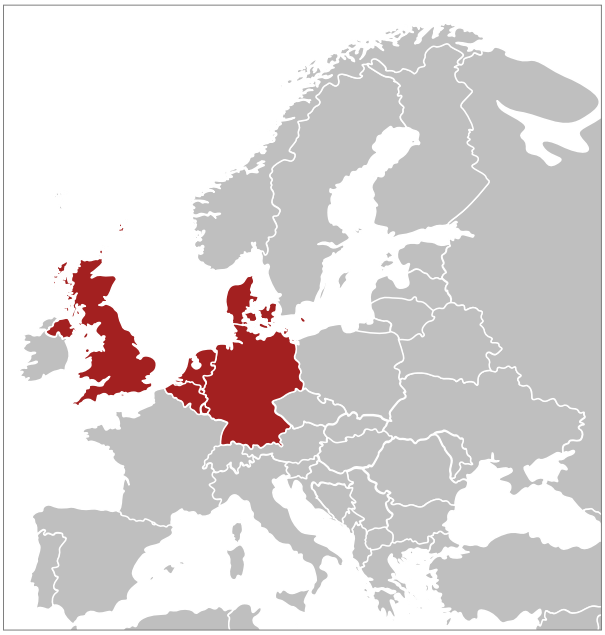
Yet the case of the Future Cities Demonstrator Programme seems an exception, as it is generally believed that policy measures place greater emphasis on supporting themes (see the North Rhine Westphalia's Master Plan for Electric Mobility or UK's Eco Towns Prospectus of 2007) than large-scale demonstrators or small-scale testing units. As a result, interviewees called for the public sector to put in place a public procurement framework for demonstrators and testing units that is: simple and relevant (shaped by the engagement of stakeholders through a public consultation process); facilitates funding from the public sector for an extended period of time; and aligns EU policy to Member State policy.

4.4. The need for international partnerships

As regional competitive advantages are more likely to be developed in Member States with high levels of innovation performance, it is a concern that the Innovation Union Scoreboard[22] recently observed a growing divide between EU Member States' innovation performances.

This widening gap is captured in the uneven distribution of our sample of demonstrators and testing units across Europe. Of the demonstration and testing settings selected, the following EU Member States are represented: Denmark (2); Netherlands (1); Belgium (1); Germany (2); Luxembourg (1); and the UK (1). Thus, all of the demonstrators and testing units covered by this case study are located in Northern and Western Europe (Figure 4).

Figure 4: Primary location of the selected large-scale demonstrators and small-scale testing units



In the case of EcoGrid EU, three of its partners accepted that the concentration of Smart Grid activities in Denmark was due to the Member State being at the forefront of wind energy developments. This is demonstrated by the fact that:

at certain periods of the year, the wind power generated by Denmark exceeds the nation's total demand for energy; and the nation produces the highest amount of wind power per 1,000 inhabitants[23]. Moreover, major players in wind energy, like Vestas and LM Wind Power, call Denmark home.

The existence of such large, wind power companies in Denmark is nourished further by the government's establishment of a support structure conducive to the emergence of SMEs. Examples of this include the establishment of Copenhagen's Cleantech Cluster, as well as the Cleantech Facilitator itself.

To attain the success criterion of replicability, large-scale demonstrators overcome the uneven distribution of innovation activities by engaging in international partnerships. For instance, EcoGrid EU has engaged both the Elia Group to understand the replicability of Denmark's Smart Grid solution in Belgium.

4.5. Involving SMEs in PPPs

Entities should not be included in partnerships only for the sake of building international consortia. However, in establishing international partnerships for large-scale demonstrators, it seems that large companies, universities and research institutions are favoured over SMEs. This lack of SME involvement is largely attributed to larger players offering a broader array of competencies, products and services, and having greater financial clout. Nevertheless, the lack of SME involvement in such partnerships may prove detrimental as SMEs with a track record of innovation are more likely to export successfully[24], and account for a disproportionately high share of new product innovation given their low research and development expenditures[25].

"[No SME involvement] is not a general trend [in Smart Grids]. We have other projects where we work a lot with SMEs. It is just that this partnership engages partners that we needed. Additional partners require an additional interface, which requires additional coordination." ***– RWE***

Therefore, the EU ought to further explore the willingness and ability of SMEs to be integrated into large-scale demonstrator partnerships. In addition, the EU should assess:

- SMEs' difficulties in participating in public procurement due to the stringent requirements of public tenders (e.g. in terms of turnover, experience and guarantees);
- The lack of a fully functional e-procurement portal, providing increased transparency and efficiency in the tendering process;
- The administrative burden and complexity of participating in public procurement;
- The extent to which large public tenders are divided into lots, thereby increasing the possibility of SME participation;
- The regulatory restrictions preventing second chance entrepreneurs from responding to public tenders; and
- The possibility of favouritism towards larger enterprises.

The findings of such an assessment would help Europe enhance SMEs' capacity to contribute to the development of innovative solutions that may help them better commercialise their own research. Furthermore, their engagement with the public sector will offer them an opportunity to build credentials for securing future public procurement, and managing it thereafter.

4.6. Assessing the appropriateness of markets

The ultimate goal of both large-scale demonstrators and small-scale testing units is to provide a setting in which potential innovative solutions can be validated, industrialised, and commercialised. However, large-scale demonstrators and small-scale testing units differ in terms of their stage in the innovation sequence.

For instance, large-scale demonstrators typically trial products that have already been tested and, hence, innovative solutions undergoing demonstration activities are close to market. This is reflected by Amsterdam Smart City, whose underlying projects target an array of societal groups. For instance, Health-Lab, one of the Smart City's projects, seeks to establish an environment that supports the creation and implementation of innovative care technologies for end-users.

In contrast, innovative solutions being examined in testing units are at a prototype stage, and so are more distant from the market. As a result, small-scale testing units target the entities trialling their prototypes, and so may be considered more inward looking than large-scale demonstrators. This is exemplified by the Cleantech Facilitator, a small-scale testing unit, which very much focuses on servicing the needs of the 200 or so enterprises located within the Scion DTU science park.

Therefore, the outward looking nature of large-scale demonstrators and the inward looking nature of small-scale testing units must be taken into consideration when identifying a suitable location for situating such settings. Furthermore, the public sector must have appropriate in-house expertise to assess the appropriateness of markets proposed for the establishment of demonstrators and testing units.

4.7. Developing relevant skill-sets

Whether it was TUD's involvement in the GRID4EU – Demonstrator 1 or TIE-IN, or DTU's involvement in EcoGrid EU or the Cleantech Facilitator, almost all large-scale demonstrators and small-scale testing units were located in close proximity to universities and/or research institutions.

"[O]ur recruitment strategy is largely opportunistic. I am the first to contact engineers recently laid off as a result of plant closures." ***– Ghent Bio Energy Valley***

Nevertheless, companies reiterated skill shortages in two disciplines, engineering and ICT. In the case of the former, companies stated that a shortfall of engineers could lead to demonstration and testing activities being relocated to countries with a greater supply of engineers, for example India China.

Bio Base Europe Pilot Plant also highlighted the difficulty it faces in finding personnel that are appropriately skilled and experienced, as such personnel are typically employed by the large industrial companies offering more attractive pay packages. In order to overcome this skills shortage, the Pilot Plant has, for the past three years, left an open post on a jobs website for the position of process engineer. On average, the Pilot Plant received one application per month in relation to the post. In contrast, a one-off communications officer position for the Pilot Plant received some 200 applications in the space of two weeks.

In the case of the ICT skills shortage, its continuation could inhibit the productivity and knowledge-intensity of innovative solutions emanating from demonstrators and testing units. This was exemplified by the GRID4EU demonstrator, which faces the issue of recruiting personnel with skills in cross-cutting fields. For instance, RWE highlighted how there is a growing need for employees to understand ICT, as the fields of electrical engineering and ICT are converging.

"We need engineers who understand both how electricity networks work but also how ICT can help and how this works, and how to combine these two skills." ***– RWE***

5. Policy recommendations

On the basis of the socio-economic relevance of the PPP trend in large-scale demonstrators and small-scale testing units, as well as the drivers and obstacles to their development, a number of policy gaps have been identified. These policy gaps have been allocated along six axes that are detailed hereunder.

First and foremost, there is a clear gap in financial expectations between the public and private sector. This gap is particularly pertinent for small-scale testing units that fear a shortfall of funding to cover costs upon going-live. Therefore, private sector entities suggested that there be funding schemes for financially supporting demonstrators and testing units post-construction.

In addition, the cost of pursuing public sector financing, particularly at the European-level, was deemed particularly high. Consequently, entities call for a simplification of the application and administrative framework. This issue is also linked with the public sector's questionable capability of managing budget lines for such multi-year projects.

In terms of regional industrial structures, there is an obvious need to locate demonstrators and testing units in regions that offer competitive advantages for the cross-cutting theme in question. As exemplified by EcoGrid EU, competitive advantages may come in the form of major companies being located in the region, or the clustering of competing and/or collaborating enterprises, as demonstrated by the Cleantech Facilitator.

To overcome the uneven distribution of innovation activities, demonstrators, and testing units, the EU should push for consortia to engage in international partnerships that ensure the replicability or transferability of innovative solutions to other Member States. In addition, the EU should explore if SMEs are truly underrepresented in the consortia responsible for rolling out large-scale demonstrators, and if so, the EU should consider taking the following actions:

- Allow SMEs to apply to public tenders as networks rather than as subcontractors to large companies;
- Ease access to public tenders by dividing big tenders into smaller lots;
- Increase transparency and reducing administrative burden by launching e-procurement portals;
- Provide dedicated support to SMEs in dealing with public tenders; and
- Provide unrestricted access to public tenders for second chance entrepreneurs.

Another factor that ought to shape the selected location of demonstrators and testing units is the target market. Therefore, it is recommended that the public sector develop criteria for assessing and prioritising locations in which such settings could be established. However, it must be noted that the criteria applied to demonstrators and testing units should differ, as testing-units look inwards in serving innovative

businesses, whereas demonstrators look outwards to society. Thus, potential assessment criteria for demonstrators may include the ambition and scope of the location to support the demonstrator's activities, and the ability of the demonstrator to provide a testing platform for innovative SMEs.

In terms of recommendations to catalyse cultural change, it is suggested that the public sector engages in public procurement activities for demonstrators and small-scale testing units. Such procurement activities will provide a test-bed in which the public sector will be able to tailor new demand-side policy to their needs. Should these policy measures prove successful, seeds of change may be sown in the public sector's mindset towards innovation policy. As such, it is also important that the public sector engages with the private sector in its marketing activities, so that communities are onboarded in demonstration activities. Finally, public sector involvement in the communication strategy is also needed to increase the accessibility of information on the project, and to ensure that demonstration or testing activities do not promise more than they can deliver.

With regards to the policy recommendations in the field of education, it is recommended that the EU further explores the cross-cutting nature of ICT with engineering, and analyses whether appropriate courses are available for leveraging on these in-demand skill-sets.

The final gap relates to policy agendas, which highlighted how the value of demonstrators and testing units is particularly pertinent in areas where regional economic growth agendas support cross-cutting themes. This was the case for North Rhine Westphalia's "Master Plan for Electric Mobility" or the UK's "Eco-towns Prospectus 2007". For similar future cases, feasibility studies as to the potential socio-economic benefit of demonstrators or testing units ought to be conducted. Should such studies result in favorable conclusions, legislators should also explore the possibility of creating a policy framework conducive to supporting the prospective demonstrator or testing unit.

Further to these policy gaps, it is also important to ensure policy transferability is achieved across Europe's array of regional business environments. In order to do so, it is important to acknowledge that policy transferability ought not to lead to the replication of similar demonstrators and testing-units across all other EU Member States. Instead, policy transferability refers to the identification of actions that can be taken in creating a European business environment conducive to large-scale demonstrators and small-scale testing units adopting a PPP approach.

As suggested by one of the partners of the Bio Base Europe Pilot Plant, before doing so, Europe must assess its landscape of large-scale demonstrators and small-scale testing units before financially engaging itself in such a business innovation trend. One suggestion would be to create a web portal, similar to that of the Cleantech Facilitator in Denmark. Such a web portal would enable Europe to complete its assessment of gaps in the demonstration and testing market before undertaking any policy making decisions. Furthermore, such a web portal would be well-positioned to:

"There is no need to create 10 new pilot plants across Europe with new funding provided by new EU programmes. Instead, Europe should fund existing pilot plants to enhance their critical mass." ***– Ghent Bio-Energy Valley***

- Identify where prospective demonstrators and testing units ought to be located in order to benefit from regional competitive advantages; and
- Upon completion, would assist businesses in identifying the location and capabilities of demonstrators and testing units across Europe.

Finally, should such a portal identify competitive advantages in Northern and Western Europe, then Europe must promote international partnerships to ensure the replicability and scalability of innovative solutions across Europe.

6. Appendix

6.1. Interviews

Large-scale demonstrator or small-scale testing unit	Partner	Interviewee	Position
TIE-IN	TUD (Competence Centre for Interoperable e-Mobility)	Dr. Fritz Rettberg	Project Manager
GRID4EU Demonstrator 1	RWE	Dr. Thomas Wiedemann	Demonstrator 1 leader
	ABB	Peter Noglik	Project Manager
EcoGrid EU	Adviser to energinet.dk	Maj Dang Trong	Consultant
	Elia Group	Stéphane Otjacques	R&D Manager
	AIT	Benoit Bletterie	Senior Engineer
Amsterdam Smart City	Amsterdam Economic Board	Saskia Müller	Programme Manager
Health-Lab (one of Amsterdam Smart City's projects)	iCrowds	Martijn Kriens	Partner
North West Bicester	BioRegional	Pooran Desai OBE	Co-founder
	Cherwell District Council	Jenny Barker	Team Leader
The Neobuild Innovative Centre	CDEC	Bruno Renders	Administrator
The Bio Base Europe Pilot Plant	Ghent Bio-Energy Valley	Dr. Wim Soetaert	Professor
The Cleantech Facilitator	Scion DTU	Torben Olsa Nielsen	Head of Business Development

6.2. Websites

TU Dortmund - Elektrotechnik und Informationstechnik - Institut für Energiesysteme, Energieeffizienz und Energiewirtschaft - Mess- und Automatisierungssysteme (Smart Applications & E-Mobility)	http://www.ie3.tu-dortmund.de/cms/de/Forschung/Schwerpunkte/Mess-_und_Automatisierungssysteme__Smart_Applications___E-Mobility_/index.html
GRID4EU	http://www.grid4eu.eu/
EcoGrid EU	http://www.eu-ecogrid.net/
Amsterdam Smart City	http://amsterdamsmartcity.com/
Amsterdam Smart City - Health-Lab	http://amsterdamsmartcity.com/projects/detail/label/Health-Lab
North West Bicester	http://nwbicester.co.uk/
Neobuild	http://www.neobuild.lu/
Bio Base Europe Pilot Plant	http://www.bbeu.org/about-pilot-plant
Cleantech Facilitator – Test and Demonstration in Denmark	http://www.cleantechfacilitator.com/

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