DEMONSTRATING LEARNING IN ACTION IN A WATER AND ENERGY SMART SPECIALISATION CLUSTER

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ABSTRACT

The Energy and Water sectors crave innovation. The sectors also exhibit clusters of firms which interact in developing innovations. We explore how demonstrating learning in a cluster facilitates innovation. The paper is built around an intervention at a demonstration site in Blackstairs Group Water Scheme (Wexford, Ireland) planning to implement a pump-as-turbine, a disruptive micro-hydropower technology, to recover energy from its water network. Group Water Schemes are small private community organisations focused on delivering water solutions to their rural communities We reflect on the relationships among cluster engagement, collaborative prototyping and learning mechanisms in order to understand how learning through demonstration in a smart specialisation cluster can contribute to the promotion of continuous innovation in energy and water in rural Ireland and beyond.

Keywords*: action learning, collaborative prototyping, demonstration sites, innovation, water and energy sectors*

Session track*: Design of incentives to encourage industry-university continuous innovation and collaboration*

1. BACKGROUND

Despite water crises being on top of global risk report list of the World Economic Forum annual, the water sector remains highly fragmented and lies behind other sectors when it comes to innovation (Wehn & Montalvo, 2017). Currently, governments are aware and seek ways to speed up innovation. A current approach is to design organisational clusters, rather than funding organisations solely focused on developing technology (Garrett-Jones, 2004; Grotenbreg & van Buuren, 2018). Organisations which develop solutions isolated from market and real-world needs are at risk of producing research that stops at a bench-scale. On the other hand, organisations which seek inter-sectoral collaboration can produce technology which is closer to the end-user needs. This can also speed up uptake of technology.

The question we ask is: how can learning through demonstration in a smart specialisation cluster contribute to the promotion of continuous innovation in energy and water in rural

Ireland and beyond? The design of a demonstration site within a collaborative, inter-sectoral and smart specialisation cluster can facilitate learning and innovation. Lessons learnt may inform later implementation of national or regional strategies. Therefore, demonstration of specific initiatives is fundamental to deployment elsewhere.

1.1 Underlying concepts

The research question prompts a number of underlying concepts. Those are explored in in the sub-sections below.

1.1.1 Smart specialisation clusters

Smart specialisation clusters are strong collaborative networks of multi-sectorial partners. They include stakeholders from industries, companies, NGOs, government, policy-makers, universities and other organisations. Clusters have one main goal: to learn and grow together towards achieving the shared aim of sustainability (social, economic and ecological). Smart specialisation promotes efficient uptake of public funding in research and innovation (European Commission, 2011; Navarro & Uihlein, 2016). One aspect of smart specialisation strategies is territorial cooperation in a shared area.

1.1.2 Demonstrating a technology

Demonstration is a methodology and a critical intervention that can speed uptake of technology platform by early-adopters. A demonstration site (demo site) is a physical space in which a "demonstrator" shows and tells about a new technology. The design, installation and running of a demo site offer an opportunity to share the technical, commercial and social value of a new technology. Designers and end-users can learn, interact and share knowledge during innovation. By engaging multiple stakeholders during the innovation process, a balance between usability and functionality and, therefore, better design can be achieved (Bart & Pujari, 2007; Bogers & Horst, 2014).

The lack of demo sites to show-case new technology is an acknowledged gap in the water sector (Bikfalvi, Marques, Pérez-Cabaní, Bosch, & Rodriguez-Roda). A demo site has the potential to bring new research into action quickly by showing savings, advantages and obstacles to be overcome. The advantage of deploying a new technology at a demonstration site is that an environment of interaction between designers and end-users is created.

1.1.3 Collaborative Prototyping and Action Learning

There is a parallel between a demo site and a prototype. Prototypes are "approximations of the final product along one or more dimensions of interest". Prototypes can serve four purposes: learning, communication, integration and milestones (Ulrich, 2003). Prototypes can be developed through collaborative prototyping. By involving multiple stakeholders during the innovation process, and allowing cycles of trial and error, possible, "learning in action" is enabled and better design achieved (Von Hippel, Katz 2002; Bogers & Horst, 2014).

Collaboration in collaborative prototyping may involve learning in action. Action Learning (AL) has a track-record of facilitating innovation in organisations (Pedler & Brook, 2017). AL approaches are rooted philosophically in theories of learning from experience, as practiced collaboratively with others through action-oriented inquiry (Coughlan & Coghlan, 2011). The prime value that guides the AL approach is a focus on learning for the sake of more effective helpful problem solving. Revans (1998) formulated AL by individuals around the formula, L=P+Q where L stands for learning, P stands for programmed knowledge and, Q stands for questioning insight. Vince (2004) added 'organising insight' to Revans' learning formula so that it read L=P+Q+O (O standing for organising insight). Thus, individuals' experience of AL included not only questioning insight for the individual, but also organising insights. Coughlan and Coghlan (2009) extended the formula into the inter-organisational setting with a further adaptation to L=P+Q+O+IO where IO stands for insight in an inter-organisational context (Coughlan & Coghlan, 2009). Articulating this formula in words, the learning is built on exposing programmed knowledge to questioning, combined with organisational and inter-organisational insights created in action (Coughlan & Coghlan, 2011).

1.1.4 Learning Mechanisms

Learning mechanisms typically refer to planned organisational structures and processes that encourage dynamic learning, particularly to enhance organisational capabilities (Coughlan & Coghlan, 2011). The mechanisms can apply at individual, group, organisational or inter-organisational levels and can initiate, facilitate, monitor and reward learning. Shani and Docherty (2003) argue that organisation design is critical to building learning mechanisms in order to develop and to sustain learning capabilities. Shani and Docherty (2008) present three types of learning mechanism: cognitive, structural and procedural. Stebbins and Valenzuela (2009) argue that these learning mechanisms are needed to create the sustainable organisation.

1.1.5 Emerging framework

The smart specialisation cluster engages in collaborative prototyping, learns and finds application in a demo site where learning through demonstration can contribute to the promotion of continuous innovation in energy and water in the cluster. Figure 1 illustrates a framework to map the relationships of interest.

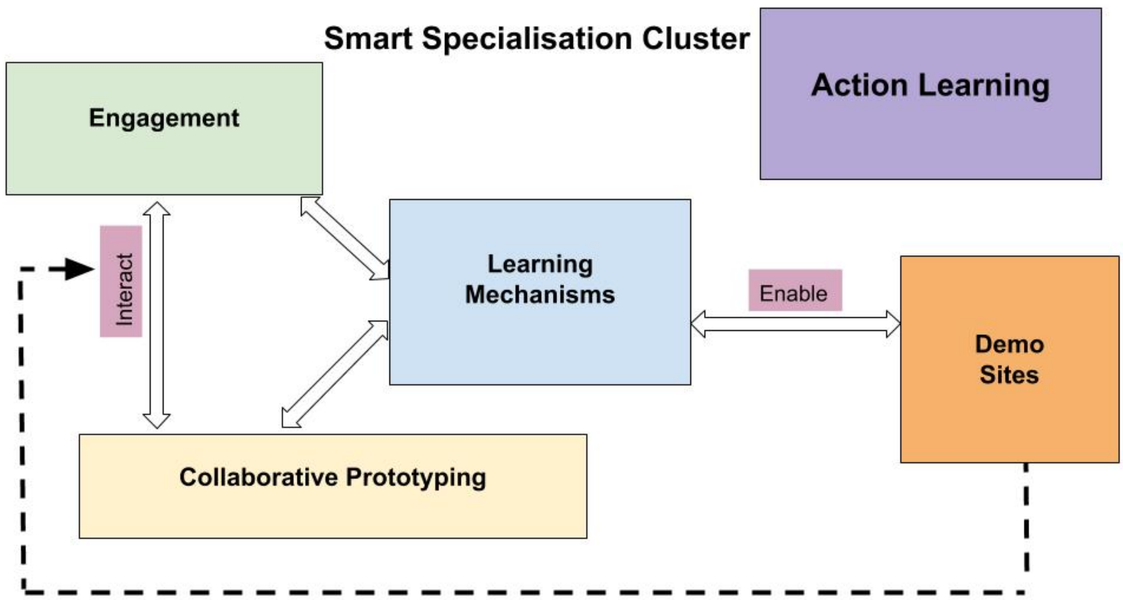

Figure 1. Demonstrating learning in action in a smart specialisation cluster.

2. RESEARCH OBJECTIVES

The question we ask is how learning through demonstration in a smart specialisation cluster can contribute to the promotion of continuous innovation in energy and water in rural Ireland and beyond. More specifically, what can be learnt from the installation of a demonstration site that can be useful for other clusters and rural communities? This question is explored in the context of the ongoing Dŵr Uisce project, an EU funded project spanning the Ireland-Wales region. The project is focused on innovation in the water and energy sector. The current inefficiencies of the water treatment, distribution and use present significant environmental and economic problems in the region.

The related objective is to explore the role of action learning (Coughlan & Coghlan, 2011) and collaborative prototyping (Bart & Pujari, 2007; Bogers & Horst, 2014) in learning activities involving "researchers" and "practitioners" in the creation of the demonstration site. The creation involves interactions between the researcher/technical leadership developing the new technology with the practitioners already operating the demonstration site.

3. METHODOLOGY

The methodological approach and data collection are presented in the sub-sections below.

3.1 ACTION LEARNING RESEARCH

The active nature of the question suggests a research design based upon demonstration of technology as an intervention, and monitoring of the results obtained in order to generate insights. Action learning research (ALR) aims to create actionable knowledge and is characterised as being situational and contextually interpreted (Coughlan & Coghlan, 2011). The ALR methodology may be described in terms of systems alpha, beta and gamma (Coughlan & Coghlan, 2011; Revans, 1971). System alpha focuses on the identification and analysis of a real problem, system beta comprises the exploration of the amelioration of the problem through cycles of action and reflection. Finally, system gamma refers to the learning processes by participants and their reflections on how their engagement with the problem has challenged their own thought processes. An action learning research design needs to conform to certain quality criteria (Coughlan & Coghlan, 2011) including:

- engagement with a real-life problem;
- collaborative with practitioners with whom researchers engage as co-researchers;
- reflective and supported by the disciplined documentation which captures the dynamics of the reflective process;
- understanding of insights for effective adaptation to other settings.

The collaboration between researchers and practitioners is facilitated through different stages and learning cycles in the monitoring, design, implementation and demonstration of technology-based solutions (Fig. 1). The improvement cycles are illustrated as collaborative directing, development and deployment of new technology. As the project progresses, the researchers are facilitating the collaboration and learning through themed workshops for the practitioners and demonstrations to other practitioners of the technology in use. Throughout, there is questioning (Q) and reflection in order to generate insights and, ultimately, for both practitioners and researchers to learn.

Correspondingly, for the researcher these different but related cycles of learning between researchers and the cluster and also how cycles are related with systems Alpha, Beta and Gamma are shown as Figure 2 illustrates. In that, the research team is enacting a series of related and connected learning cycles focused on the assessment/monitoring of a site, the design of technology-based interventions, implementation and demonstration to others of the solution, and codification of the emerging insights in terms of a contribution to collaborative prototyping.

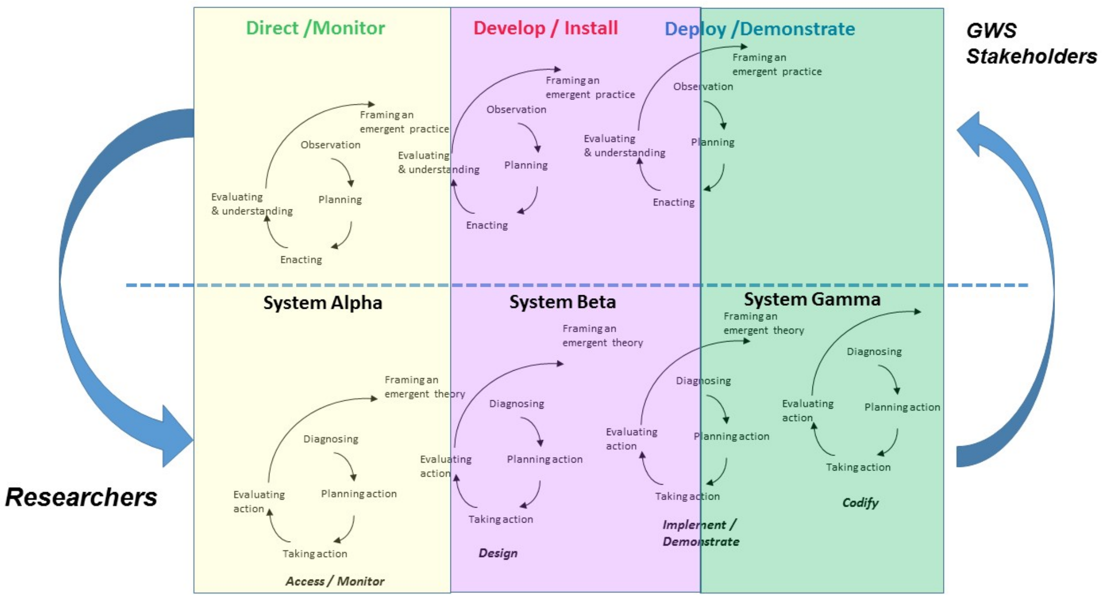

Figure 2. Action learning research (ALR) of interaction (blue arrows) and learning cycles (black arrows) occurring between researchers and GWS stakeholders in a smart specialisation cluster.

Data collection included note taking during site visits, meetings and telephone calls, emails, a conference, a sectoral workshop, technical reports, scientific publications, and a case-study.

4. Observations

Observations relating to the smart specialisation cluster and the Blackstairs Group Water Scheme are explored below.

4.1 Smart Specialisation Cluster

The Dŵr Uisce smart specialisation cluster is made up of companies, HEIs, SMEs, and energy and water stakeholders in the Ireland and Wales regions covered by the ERDF Interreg Ireland-Wales programme 2014-2020. The cluster also encompasses partners outside of this region willing to participate in events, attend demonstration sites and share and learning and practices about water and energy.

To date, the cluster has 84 official partners officially signed to participate in the Dŵr Uisce project. From those partners, 45 are receiving some form of benefit in terms of non-financial support, which includes consultancy hours, invitation to attending events (such as workshop, conferences), sharing of know-how and the network facilitate by the cluster. The benefit is classified in terms of business intelligence provision, from the research cluster to the cluster member, or the ability of participate of one of the dissemination events organised.

Within this paper, the "research team" are members of Trinity College Dublin responsible for the Dŵr Uisce project. The "GWS cluster" includes practitioners and stakeholders involved with or working within group water schemes. The demonstration site demonstrates technology, such as PAT (pump-as-turbine) micro-hydropower technology. A scheme of the GWS cluster is illustrated in Figure 3.

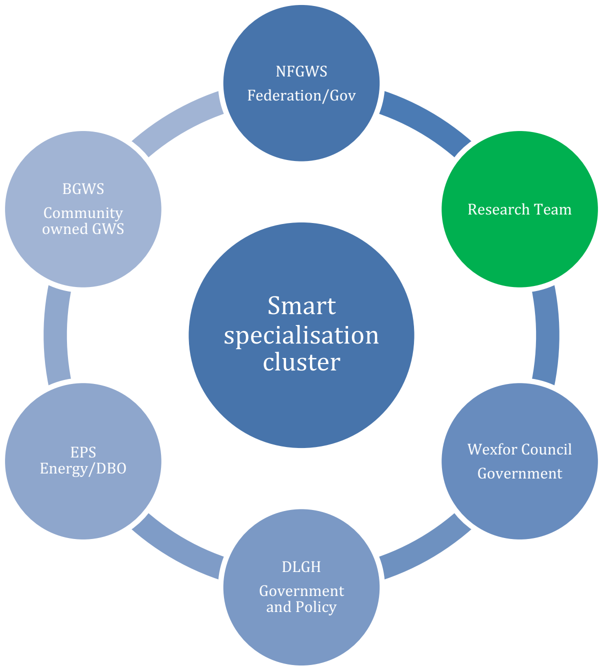

Figure 3. GWS Smart Specialisation Cluster in Blackstairs Group Water Scheme. Dŵr Uisce research team: researchers (engineers, water and environmental and business scientists), National Federation of Group Water Schemes (administrators, managers, officers), Blackstairs group water scheme (administrators, funding agencies, managers, operators), Wexford County Council (funding agency), Department of Local Government and Housing (government) –DLGH.

4.2 BLACKSTAIRS GROUP WATER SCHEME DEMONSTRATION SITE

For a period of 1.5 years, the Dŵr Uisce project assessed the potential for micro-hydropower (MHP) recovery in water networks of various Group Water Schemes in Ireland. This assessment identified Blackstairs, a community-owned Group Water Scheme, as an ideal demonstration site for the installation of PAT (pump-as-turbines technology). Blackstairs water network is a gravity flow system fed by a main reservoir located at the east face of Blackstairs Mountain, Co Wexford. With an average demand of 1500 m^3/day, 1037 households are supplied. The piping system has an approximate length of 117 km and the pipe diameters range from 50 mm to 150 mm. A total of four pressure reducing valves and eight break pressure tanks are installed throughout the network to manage pressure and to control leakage (Mc Nabola & Novara, 2018; Mc

Nabola & Ferras, 2017). This means that the water network has excessive pressure which, if managed differently, can be harvested through hydropower.

Blackstairs Group Water Scheme (BGWS) water treatment plant is operated by EPS, a design-build-and-operate private contractor. EPS is responsible for the pipework and electrical works from the intake up to the water treatment plant. The Blackstairs GWS is responsible for the water and the network from the water treatment plant to the boundary with domestic consumers. The relationship between EPS and the BGWS is contractual and has a planned duration of twenty years, approximately the lifetime of the water treatment plant. The scheme receives funding from the Government Department of Housing, Planning and from Local Government through Wexford County Council.

Once BGWS was identified as a potential demonstration site, a number of feasibility studies were conducted on the infrastructure of this scheme to determine exactly where PATs could be installed. Discussions and meetings between the BGWS, EPS and the researchers were facilitated by the researchers. These discussions focused on how to deploy PATs at locations with the highest potential for energy recovery and pressure reduction. The contractual details that would allow the site to become a demo site were also agreed.

To date, the BGWS stakeholders have monitored flows which have assisted the researchers in designing an appropriate PAT. The stakeholders are preparing to install the PAT. Correspondingly, they have directed their actions to fit with a strategy of energy and carbon reduction. In the next section, we reflect on the process by which the demonstration site has evolved and the associated learning in action.

5. ANALYSIS/REFLECTION

This study set out to analyse the interactions and learning cycles for both the researchers and GWS stakeholders in the context of design and installation of a demonstration site in Blackstairs. The cycles are analysed in terms of Revans' (1998) core strategy of action learning to resolve a complex problem (Fig. 4).

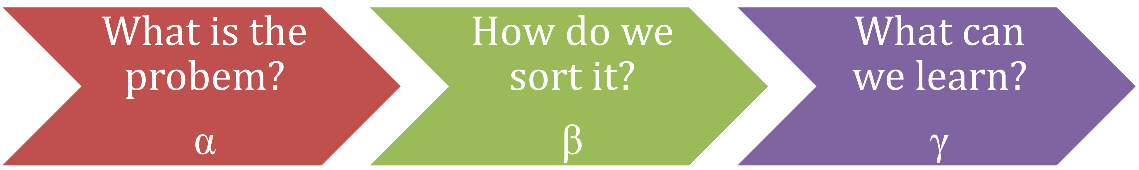

Figure 4. Core strategy of action learning to resolve a complex problem (Coughlan & Coghlan, 2011; R. Revans, 1998).

5.1 SYSTEM ALPHA-WHAT IS THE PROBLEM?

System alpha concerns the identification of problem associated with designing the demonstration site. The steps taken by the researchers were: (1) identifying a potential location in Ireland for installation of MHP technology platform, (2) finding suitable open partners that would be willing to collaborate, (3) establishing communication, (4) overcoming procedural barriers and technicalities, (5) devising an action plan, and (6) establishing a contractual relationship. Those problems were identified through cycles of accessing and monitoring by the researchers and cycles of directing and monitoring by BGWS cluster (Fig. 1). We discuss each in turn.

5.1.1 LOCATION:

The technical identification of Blackstairs as a suitable demo site resulted from several feasibility studies carried out by the research team. This process required diagnosing, planning an action, taking action, evaluating the action. Finding a location depended mostly on the researchers having access to network data from group schemes in Ireland, and conducting the studies.

5.1.2 PARTNERS:

In October 2016, the Kick Off meeting allowed the research team to network, introduce the idea of demonstration sites, and grow the smart specialisation cluster. In terms of complexity, designs and outcomes, the meeting required several interactions between researchers and other water and energy stakeholders. During the event, the team evaluated potential candidates to host a site to demonstrate the PAT micro-hydropower technology. Critical to that event was the involvement of the National Federation of Group Water Schemes (NFGWS) with the researchers. This organisation suggested that one of their schemes could host a demonstration site (Coughlan, Gallagher, Siva, & Coghlan, 2017). Later on, the Annual Conference allowed relationships in the cluster to strengthen and first steps of design of demo sites were shared.

5.1.3 COMMUNICATIONS:

The researchers assessed the feasibility to install pump-as-turbines (PATs) at BGWS networks. What this research could not address however, was the precise diameter and number of inlet pipes in locations chosen for this installation. The information gap was a problem, as it affected the trustworthiness of feasibility studies. As such, it required further interventions and communication between the researchers and the BGWS cluster. These were explored and discussed in more detail as part of system beta. During this learning cycle, the researchers were "accessing and monitoring", while the GWS stakeholders were "directing and monitoring". The aim was, respectively, to advance design and develop/demonstrate the PATs in BGWS.

5.1.4 TECHNICALITIES:

As important as the determination of pipeline configuration, a related topic in the design was access to flow data. Installation of flow-sensors in key points of the network in the BGWS needed to be addressed. In order to predict steady electric production by the PATs, the researchers needed to know flow-rates data of water going through the PATs. Although the researchers only needed to access data available and install flow-sensors to gather data which was missing, this step required a number of interactions between them and the BGWS.

5.2 SYSTEM BETA-HOW DO WE SORT IT?

System alpha helped the research team to determine what the problems were. System beta is the exploration of the amelioration of the problem through cycles of action and reflection. The net results of system beta – insights on engagement, collaborative prototyping and learning – helped to advance design and installation of the demonstration site for sharing within the cluster. For the researchers this knowledge contributed to an "emerging theory", for the practitioners this was insight on "an emerging practice".

5.2.1 ENGAGEMENT:

Since the start of the Dŵr Uisce project in 2017, a number of actions, listed in Table 1, were taken by the researchers within the smart specialisation cluster to progress the installation of the demonstration site in Blackstairs,

Table 1 Summary of cluster engagement actions to develop a demo-site.

Action	Result
Kick off Meeting (October 2016)	- National Federation of Group Water Schemes express interest in becoming a demonstration site. - Feasibility studies: 9 GWS assessed; Blackstairs selected. - 44 attendees, 11 researchers
Dŵr Uisce Annual Conference (October 2017)	- Conference paper (Coughlan, Gallagher, Siva, & Coghlan, 2017) reflected innovations and new supply relationships built up during this period. - 42 attendees, 17 researchers -Insights: participants wanted to learn about the technology platforms
Visit 1 (March 2017)	- Researchers visit BGWS and share 3 feasibility studies with GWS cluster
Visit 2 (August 2017)	- Researchers meet BGWS staff and also EPS staff. Researchers needed drawing to confirm number and diameter of pipelines, however EPS did not have the drawings.
Visit 3 (January 2018)	- Researchers meet EPS and visit various locations of network, such as intake, source, tanks and various pipelines. Later Researchers meet GWS staff and confirm number and diameter of pipelines with a senior staff from the scheme who was involved in the construction of the network so that results of the feasibility studies can be validated.
Water and Energy in Rural Communities, a Workshop for Group Water Schemes (April 2018)	- 36 attendees, 15 schemes, 3 HEI, 1 SME, 9 new signee members. Feedback collected from participants: (1) How does it work? (2) Timeline? (3) How to measure outcomes, positive outcomes, negative outcomes? (4) Risks? (5) Carbon, energy savings? (6) Infrastructure/technicalities. (6) Installation times (when, how long, during operations)? (7) Contracts? (8) Resources, financials, Who? (9) When? (10) Where? (10) How to foster collaboration?
Visit 4 (May 2018)	- Research team visit to discuss contractual terms of the demo site installation, wider access flow-rate data, tender for construction, risks and constraints, and demo sites continuity after project end.
Case-study (ongoing)	- Research team starts drafting a case-study covering relationship and contractual aspects of developing the demonstration site.
Materials published	- Technical reports and conference papers.

Actions depicted in table 1 enabled cycles of action and reflection to occur. Within those cycles, both the researchers and the GWS cluster gathered and generated data to address their respective problems. The data generated included: feasibility studies, scientific papers, web articles, a case-study about the BGWS and knowledge of how to proceed with the demo site. Both the kick off meeting and the annual conference advanced the demonstration site. On the first, a partner was identified. On the second, the cluster expanded, more partners sign up, and interest about demonstration sites is triggered in partners.

Most recently, in April 2018, the researchers developed a workshop, "Water and Energy in Rural Communities", for Group Water Schemes in Ireland. The 36 cluster event attendees represented a number of Group Water Schemes from across Ireland, and several organisations engaged in water and energy supply and research. Insights generated by the participants from their reflections during the event focused on how their engagement with a prospective demo site are included in table 1. The workshop generated an open discussion and learning in action about expectations on what should be featured in a demonstration site so that all could learn and identify opportunities for replication.

5.2.2 COLLABORATIVE PROTOTYPING:

Through the visits, workshop and conversations with various BGWS and EPS staff, the research team clarified the critical site details. For example, prior attempts to obtain pipeline configuration information by phone and email had been unsuccessful. By January 2018, however, there were still doubts regarding the pipelines. The reason was that drawings - which had been available only on paper - could not be retrieved by the scheme or by EPS. Also, as BGWS had allocated responsibility for administration to EPS, as operator of the water scheme, the staff in EPS did not always have a full picture of older pipelines. Eventually, at a meeting between researchers and the BGWS cluster in January, the location was photographed in detail and all of the critical features noted. This first-hand observation of the site by the researchers and the face-to-face discussion and support of the BGWS cluster were essential to determining the correct information required to clarify the actual pipeline configuration.

Based upon this information, the prototyping of the PAT has progressed to the next stage. A test rig has been constructed in the Trinity laboratory. Combined with online simulation, the test rig will enable learning about the specification, communication with BGWS and EPS, and integration of the specification with the demands of the site. The resulting clarity is enabling agreement on milestones for demonstration of the PAT on site later this summer.

5.2.3 LEARNING MECHANISMS:

A third aspect of the demonstration site installation, which benefited from system Beta was embodying the learning in a contractual relationship. Practically, the challenge was to identify the legal agreements to be put in place so that a demonstration site can be installed. Further, what kind of information would stakeholders and prospective visitors to the demonstration site have to receive prior to the visit, in order for commercially sensitive information to be preserved while maximising the demonstration opportunity? Staff from both BGWS and EPS were keen to help the project and proactive in discussions. However, a considerable amount of time and effort elapsed in drafting the legal agreement between the stakeholders. The learning from this process and the experience of overcoming the institutional bureaucracy were captured in a contract which emerged as both a structural and procedural learning mechanism. Among the items covered by the contract were a description of roles and specific responsibilities of the GWS scheme, EPS and researchers, clearance to access the sites by key stakeholders, sharing of benefits on cost savings, among others. It was only through a number of email exchanges and on-site meetings that research team and the BGWS cluster managed to develop a draft of the agreement needed for signature prior to the planned installation.

The workshop as an action learning research-informed intervention generated an open discussion and learning in action about cluster expectations. These expectations informed the collaborative prototyping process. The workshop participants, as future visitors to the prospective demonstration site at BGWS, provided feedback on the demonstration design and shared their expectations on what should be featured in a demonstration site so that all could learn and identify opportunities for replication. These insights help the research team to draft didactic materials and the design of the demonstration event as a learning opportunity for the GWS stakeholders.

5.3 System gamma-what can we learn?

System gamma refers to the learning processes by stakeholders and their reflections on how their engagement with the problem challenged their thought processes and allowed insights to be generated from the engagements within the cluster.

Both researchers and stakeholders in the cluster explored together how to collaborate so that a demonstration site can be installed. Practically, the need to monitor and evaluate water flow and pressure data was recognised. The monitoring process is not straight-forward and will require diligence and high level of collaboration to access and monitor the existing water production system. The evaluation will require technical reports, a case-study and reflective scientific publications. BGWS and EPS need to become more aware of how to act to enable collaboration and further the demonstration site. As such, they have access to evaluation documents generated by the researchers, and are actively involved in shaping the demonstration site.

Conceptually, insights, generated have informed understanding of how demonstration can work as a step towards continuous innovation in the water industry. A summary of these insights is presented in Figure 5.

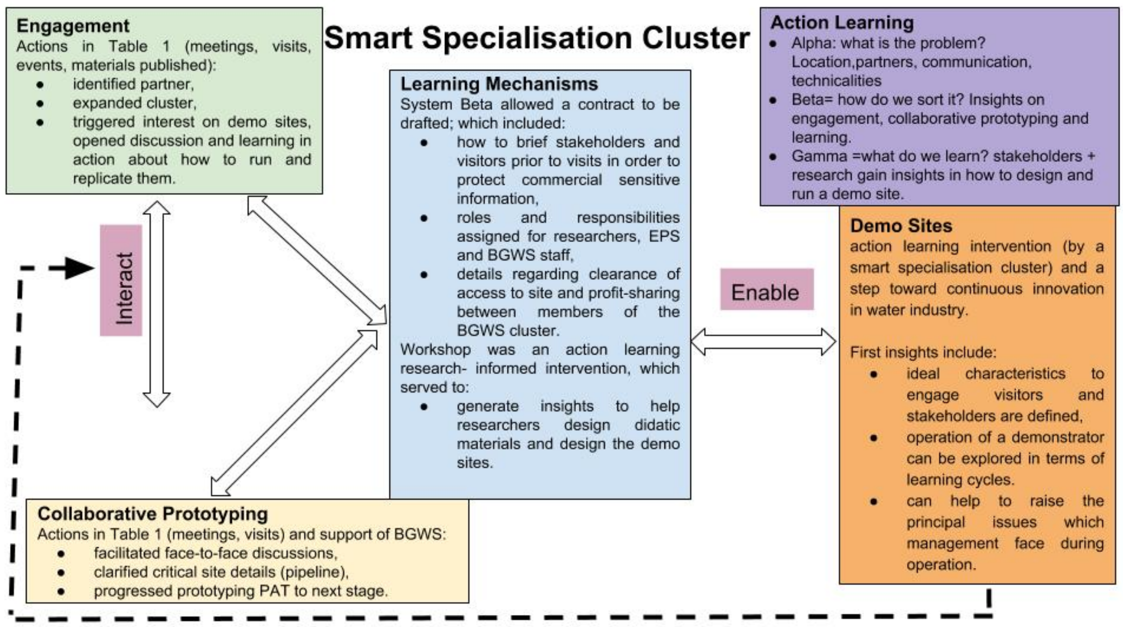

Figure 5. Insights generated when demonstrating learning in action in a smart specialisation cluster.

It is through cluster engagement, collaborative prototyping and capture of learning that a demonstration site which meets the needs of stakeholders can be deployed. The updated figure 5 is an initial framework for understanding the directing, development and deployment of a demonstrator as an action learning intervention by a smart specialisation cluster. It provides initial insights on the characteristics of a demonstration, describes and reflects upon the operation of a demonstrator in terms of learning cycles. It also provides a basis for exploring how far "seeing" a demonstration of the physical operation can help to raise the principal issues which management face as their ongoing priorities in the operation.

6. FUTURE RESEARCH

The paper presents the BGWS case and intervention as the first of a number to be undertaken in the Dŵr Uisce project. The insights derived from this first intervention can inform the design, development and implementation of demonstration at each of the other sites. All are expected to be different in terms of technicalities, location, prototyping, contract and sharing ideas and expectations. So, as the project progresses, there will be an opportunity to explore difference in process and outcome in these sites and the transfer of learning through learning mechanisms on each site. For example, the participants expected to attend the BGWS demonstration site may include those charged with responsibility for implementing another technology on their (demonstration) site. As such, how they structure, develop procedures and evolve an appropriate mind set will add a contingent dimension to the relationships illustrated in figure 5. The next steps include:

- analysing the demonstration site installation and the development of the smart specialisation cluster;
- preparing guidance and learning materials for demonstration site attendees;
- enacting the cycle of knowledge production and network generation with other demo sites and

- designing the Dŵr Uisce Annual Conference, scheduled for October 2018, as a learning event to gain further insights in the developments of demonstration sites.

7. ACKNOWLEDGEMENTS

This study was part funded by the ERDF Interreg Ireland-Wales programme 2014-2020 through the Dŵr Uisce project. The installation of a demonstration site has also been possible thanks to the data provided by and collaboration with the National Federation of Group Water Schemes in Ireland. Special thanks to EPS and the Blackstairs Group Water Scheme staff, and in particular Ms. Dympna Skelton.

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