Sustainable Energy Authority of Ireland

National Energy Research, Development & Demonstration Funding Programme

FINAL REPORT DigiBlocks

SECTION 1: PROJECT DETAILS – FOR PUBLICATION

Project Title	DigiBlocks: Digitising District Energy Performance Assessment using Blockchain
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	Name	Organisation
Project Partner(s)		
Collaborators		

Project Summary (max 500 words)
Blockchain is a distributed ledger technology (DLT) and is seen as a disruptive technology with potential across many industries by enabling open and trusted exchanges over the Internet without using central servers or an independent trusted authority. The key advantages of blockchain are its security, immutability, availability and transparency, as well as the ability to automate processes that are currently time-consuming, at reduced cost. DigiBlocks leverages blockchain technology and investigate its application to district scale energy services based on certification, traceability of energy assets, assessment of interventions, transparency of exchanges, creating new customer services and publishing district energy data.
DigiBlocks supports the transformation of the energy sector through digitisation and can support the fundamental shift in the energy landscape from a rigid centralised infrastructure towards decentralisation and decarbonisation, motivated in part by the increasing penetration of renewables and need for cities to move towards being positive energy districts. To support the transition to positive energy blocks, DigiBlocks is moving beyond building and blocks of buildings to district scale and will provide a suite of tools and services to address these challenges and provide an integrated innovative solution for district energy management, which considers the interaction and integration between the district buildings, the users/citizens and the wider energy system. The DigiBlocks provides a digital platform, tools and services that were deployed on a pilot

site to illustrate blockchain's potential both to upset current business models in the energy sector and to redefine stakeholder positions.

Keywords (min 3 and max 10)	Blockchain; Distributed Ledger Technology; Smart Contracts; Digital Platform; Energy Performance; District; Certification; Key Performance Indicators

NB – Both Section 1 and Section 2 of this Final Report will be made publicly available in a Final Technical Report uploaded online to the National Energy Research Database.

In the following Section, please provide a clear overview of your project, including details of the key findings, outcomes and recommendations. The section headings below are provided as a guide, please update or add to these as best suits your project.

By submitting this project report to SEAI, you confirm you are happy for Section 1 and Section 2 of this report to be made publicly available. If you wish to request edits to this section in advance of publication, please contact SEAI at EnergyResearch@seai.ie.

SECTION 2: FINAL TECHNICAL REPORT – FOR PUBLICATION   (max 10 pages)

2.1 Executive Summary

The Digiblocks distributed ledger technology (DLT) platform supports continuous energy auditing and performance monitoring (verification of energy flows across the district) and under the Energy Performance of Buildings Directive, EU countries have established independent energy performance certification systems supported by independent mechanisms for control and verification at building level, which DigiBlocks is proposing to scale to district level. However, as identified by European Energy related work programmes there is a need for current practices and tools for energy performance assessment and certification to become more reliable, user-friendly and cost-effective. To support the transition to positive energy blocks of buildings DigiBlocks is moving beyond building and blocks of buildings to district scale and provides a suite of tools and services to address these challenges and provides an integrated innovative solution for district energy management, which considers the interaction and integration between the district buildings, the users/citizens and the wider energy system.

2.2 Introduction to Project

The DigiBlocks research program has investigated the upscaling of energy management from buildings to blocks of buildings and ultimately districts in order to realise district scale sustainable energy services. District-scale energy management in terms of heating and cooling is not a new concept but it is gaining renewed traction from the perspective of decentralised generation, increasing renewables and rising numbers of prosumers, motivated by greater environmental awareness, volatile energy costs, technological advances, and a more robust marketplace of developers and operators. Cities driven by the need to be energy positive are actively looking at how they can shape new district-scale energy systems in order to maximise the benefits for the citizens, environment, and economy. Due to the complexity and increasing decentralisation of the energy infrastructure the way in which energy consumption in buildings is managed must change. Buildings must transition towards being viewed as active participants in the wider district-level energy panorama. The Strategic Implementation Plan of The European Innovation Partnership on Smart Cities and Communities states that measuring a city's progress can raise societal awareness for a low-carbon lifestyle, support industry in identifying new business opportunities, and help city administration in coordinating and monitoring the transformation process. The DigiBlocks district scale energy performance measurement platform offers a solution to the challenge of energy performance certification at district scale and provides new business opportunities for existing and future energy service providers across the Irish energy sector.

2.3 Project Objectives

The DigiBlocks project has developed a DLT platform as an enabler for secure and transparent sharing, distribution and auditing energy transactional data (usage, generation, wastage, sharing) across a district ecosystem. Figure 1 shows a high level view of the DigiBlocks concept, the stakeholders involved include, municipality (district administrators), building owners, ESCOs,

energy providers, aggregators, energy asset etc. Each stakeholder has ownership of a DigiBlocks node that contains functionality to enable storage, retrieval and traceability of energy transactions on the shared DLT. This constitutes a connector to facilitate integration with existing energy systems, a distributed ledger to store transactional data and smart contracts that represent a self-executing piece of business logic operating on the DLT data. In addition DigiBlocks provides management services and application support for deploy and distribute new energy services in the district.
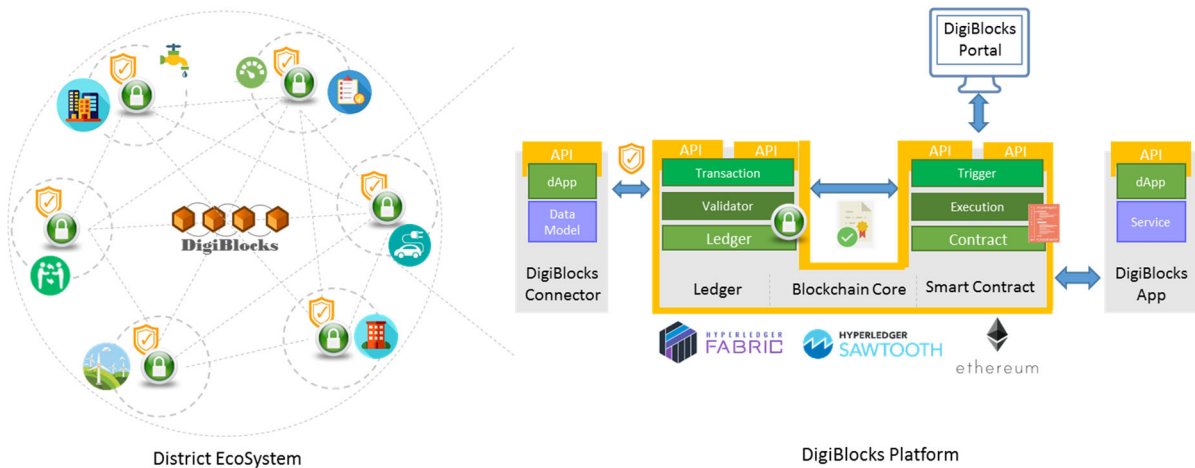

Figure 1: DigiBlocks Concept: Digitising Energy Assets in the District

The key objectives of the DigiBlocks Platform are presented below:

No:	Objective Description:
1.	**Decision Support Tool for Applying Blockchain** Develop a web-based tool that incorporates the key considerations when evaluating the potential benefits of using Blockchain. The tool will allow the user to match the most appropriate variant of Blockchain architectures (e.g. public, private, permissioned) and Distributed Ledger Technology (DLT) to specific application requirements and needs. The outcome of using this tool is a recommendation of the configuration and setup of a Blockchain instance.
2.	**A Methodology and Benchmarking Service for Blockchain Solutions** DigiBlocks will provide a benchmarking service that extends beyond current evaluation metrics (CPU, memory, throughput, latency etc.) and incorporate an approach to evaluate a Blockchain instance from a cost perspective, i.e. monitory and energy. This will allow users to estimate the ROI when applied to the energy domain. This service will be incorporated to the main DigiBlocks platform to enable continuous performance monitoring of a deployed solution.
3.	**DigiBlocks Platform** The project will develop an application independent platform that provides a secure ledger to store and track the digital representation of assets, events and states. The development is driven based on the SmartBlocks reference architecture and consists of a Blockchain/DLT backend (consensus, proof-of-work, ledger), client tools for Blockchain integration (transactions, blocks), data platform gateway for interfacing with enterprise applications and graphical user interface for visualisation and management of the DigiBlocks instance.
4.	**DigiBlocks Smart Contracts for District Energy Performance Assessment** This project will focus on applying the DigiBlocks platform for Energy Performance Assessment at District level. Specifically DigiBlocks will provide mechanisms to design smart contract templates that can be deployed on chain or off chain depending on the underlying Blockchain solution that is chosen. To achieve this the DigiBlocks platform will be extended with the design of smart contracts for the following application scenarios:

	• Continuous Display Energy Certification (DEC): Provide a smart contract that aggregates building level energy usage, generation and wastage and automatically generates and stores on chain a DEC. • Energy Service Contracting: Design a self-executing smart contract that enables the deployment of an energy service contract between building (s) owner and Energy Service Company (ESCO).
5.	**Validation of the DigiBlocks Platform** The DigiBlocks will be deployed on the Cork Campus at Munster Technological University. The validation approach will utilise the DigiBlocks benchmarking tool and the results will provide insight and updates to the decision support tool developed under objective 1.

2.4 Summary of Key Findings/Outcomes

- *Innovation 1: DigiBlocks Digital Intelligence Platform*

The DigiBlocks digital intelligence platform is an application independent platform that provides a secure ledger to store and track the digital representation of assets, events and states. The development is driven based a Blockchain/DLT backend (consensus, proof-of-work, ledger), client tools for Blockchain integration (transactions, blocks), data platform gateway for interfacing with enterprise applications and graphical user interface for visualisation and management of the DigiBlocks instance. The exploitable outcomes are an enterprise ready secure ledger for digitising assets and events and blockchain tools supporting realisation of application specific deployments in the form of smart contracts.
Innovation

- *Innovation 2:* A Methodology and Benchmarking Service for Blockchain Solutions

DigiBlocks provides a benchmarking service that extends beyond current evaluation metrics (CPU, memory, throughput, latency etc.) and incorporate an approach to evaluate a Blockchain instance from an energy perspective. This allow users to estimate the compute power and storage requirements for their specific application while also understanding the energy requirements. These services be incorporated in the main DigiBlocks platform to enable continuous performance monitoring of a deployed solution. The exploitable outcomes are a tool to help identify infrastructure requirements and estimate energy use for deploying Blockchain applications as well a contribution to a standard methodology and the definition of key performance indicators for benchmarking Blockchain solutions.

- *Innovation 3:* DigiBlocks Smart Contract Tool

Based on the DigiBlocks platform and services the Hyperledger Fabric Chaincode lifecycle management was adopted to ensure a collaborative approach to the specification, design and implementation of smart contract logic. The process initiates through the co-creation of a smart contract encapsulating the requirements of each party involved in the Blockchain ecosystem and the business logic to be executed by the contract. Once specified a smart contract developer programs this and verifies the code through testing and validation procedures. Once verified the smart contract is then deployed on the platform (e.g. DigiBlocks) and once defined conditions are met the contract auto-executes the code on chain. The contract completes with updated state of the ledger, the contract may remain active over long period of time or just for a given transaction. To support this, tools and methods for secure management are needed to minimise the risk of poorly constructed contracts (e.g. containing bugs, vulnerabilities). Approaches can vary between platforms and Blockchain frameworks, for the DigiBlocks solution the approaches taken by Hyperledger Fabric and IoTA were considered. The potential of the IOTA Smart Contracts Protocol is promising also to support inter-chain interoperability in the future, however this requires further development and traction by the IOTA community before it can be achieved. Regardless, within the context of the DigiBlocks use case we were able to demonstrate an approach that integrates key business logic into IOTA clients to emulate smart contract

execution. The benefit of efficient data storage indicates that IOTA is worth considering for the underlying ledger of DigiBlocks however Fabric is much more mature in its management and flexibility of Chaincode.

2.5 Project Impact

The DigiBlocks research program proposes to upscale energy management from buildings to blocks of buildings and ultimately districts in order to realise district scale sustainable energy services. District-scale energy management in terms of heating and cooling is not a new concept but it is gaining renewed traction from the perspective of decentralised generation, increasing renewables and rising numbers of prosumers, motivated by greater environmental awareness, volatile energy costs, technological advances, and a more robust marketplace of developers and operators. Cities driven by the need to be energy positive are actively looking at how they can shape new district-scale energy systems in order to maximise the benefits for the citizens, environment, and economy. Due to the complexity and increasing decentralisation of the energy infrastructure the way in which energy consumption in buildings is managed must change. Buildings must transition towards being viewed as active participants in the wider district-level energy panorama. The Strategic Implementation Plan of The European Innovation Partnership on Smart Cities and Communities states that *measuring a city's progress can raise societal awareness for a low-carbon lifestyle, support industry in identifying new business opportunities, and help city administration in coordinating and monitoring the transformation process*. The DigiBlocks district scale energy performance measurement platform offers a solution to the challenge of energy performance certification at district scale and provides new business opportunities for existing and future energy service providers across the Irish energy sector. Cities require a performance measurement platform that can be used for the assessment of energy efficiency and sustainability services across the district to understand the impact of individual stakeholders and projects/initiatives on its collective energy targets. The DigiBlocks platform offers this capability and can provide guidance and support to policy makers and public bodies through results, outcomes and learning from supported energy project that are executed across it. Such a platform must be flexible, user-friendly, secure, and compatible with existing city data platforms to enable third parties to offer new solutions based on evolving stakeholders requirements. The DigiBlocks platform can address these challenges and can accelerate the development and deployment of competitive energy related district scale services and in turn provide capability in the Irish marketplace for competitive energy-related products, processes and systems.

Directive 2010/31/EU on the energy performance of buildings recast, 19 May 2010 requires that building units having an energy performance certificate, with SEAI establishing a system of certification for the energy performance of building under the display energy certificate – DEC and building energy rating – BER. The DEC relates to the actual energy use of a building and can be used to benchmark against similar buildings while the BER is based on the calculated energy. A DEC is required by both privately and publicly owned large buildings and is calculated on a yearly basis. The DigiBlocks platform looks to upscale the DEC service to district scale and supports continuous data collection for energy transactions across the district meaning that a continuous DEC is available for the district rather than a static annual process for individual district units. On the residential side BER certs (required when residential units are offered for sale or letting) can be recorded on the DigiBlocks platform and included in the overall district energy performance assessment. The DigiBlocks platform facilitates the tracking of energy performance and energy efficiency against a continuous baseline so energy improvements can be assessed over varying time horizons rather than at static annual time instants. Beginning in 2010, public bodies are required by Irish Law to report on their energy usage and actions taken to reduce consumption. Under this, there are two key obligations for public bodies: 1) *Report energy management and performance data directly to SEAI each year in order to track progress towards the 2020 target*; 2) *publish an annual statement on energy performance*, describing ongoing or previous actions taken to improve energy efficiency and an assessment of the consequent energy savings. The DigiBlocks platform looks to scale this to district level and will develop tools and services for all energy stakeholder and through smart contracts can automate the logging of MPRN and GPRN energy transactions along with the calculation of relevant activity metrics depending on the stakeholder type. The SEAI monitoring and reporting replicated at district level supported by DigiBlocks will allow for an analysis of district primary energy consumption, energy spend, and energy savings achieved over flexible time horizons. The SEAI Better Energy Programme for homeowners has been very successful in reducing energy consumption and achieving cost savings. With our focus moving towards our 2030

and 2050 climate and energy targets the NEEAP states that depth of energy efficiency upgrades must increase. With any energy upgrade there is a need to monitor and validate the savings achieved. For large scale energy upgrades the DigiBlocks platform provides the capability to continuously monitor and report on the impact of these upgrades and their contribution to achieving positive energy blocks (PEBs). DigiBlocks can enable PEBs and as such Grow Ireland's national capacity to access, develop and apply international class energy RD&D by contributing to the EU Smart Cities and Communities programme. The objective of these communities is the development and support of national network for energy aware citizens. The DigiBlocks platform can be utilised by the SEAI Smart Energy Community (SEC) network to monitor and report on progress relating to SEC energy projects at a national scale. As the DigiBlocks platform is an extensible platforms future services can be customised and configured based on end user requirements relating to their energy transaction needs. DigiBlocks is a flexible and extensible DLT platform that can support solutions that enable technical (i.e. big data management, service deployment, integrated ICT platform) and other barriers to market uptake to be overcome (i.e. resources at city level, capability, third party service provider support).

Energy Service Companies (ESCOs) are seen as playing an important role in addressing barriers and market failures preventing the uptake of energy conservation measures. The ESCO market is seen as a significant potential market for DigiBlocks both as a means of managing energy use and delivering energy savings and as a tool for reporting on performance and energy efficiency gains. In tandem, the development of DigiBlocks will facilitate the growth of the ESCO and energy services market. Further opportunities for DigiBlocks are underpinned by the Energy Efficiency Directives including Directive 2012/27/EU that are designed to accelerate the spread of innovative technological solutions and improve the competitiveness of industry in the EU. Article 8 promote energy audits and energy management systems, Article 9 deals with metering, where in both cases Member States should promote mechanisms to enhance potential energy savings. DigiBlocks aligns with these principles and promotes the independent verification of energy savings at district scale. Complementary to this is ISO 50001, which is used as a worldwide leading framework to establish a more structured and formalised energy management system and achieve recognition for this through certification. DigiBlocks can be used to develop an energy management plan contributing to demand side energy management for districts. The primary customer segment for DigiBlocks is through ESCOs or more generally via service providers who take a more integrated approach to the provision of building energy management and energy efficiency as a service model. This could for example encapsulate facility management companies and energy suppliers as well as building automation or building management systems companies that can provide integrated facilities and energy management offering as a service across a district. ESCOs managing networks of buildings and blocks of buildings across districts are a key target for DigiBlocks and in particular, the expected growth and demand for ESCOs opens market opportunities for the DigiBlocks solution.

There is a significant move towards the delivery of energy efficiency projects through ESCO models, where the service provider takes a financial interest in the post installation energy performance throughout Europe and internationally and this is motivated by policy and regulatory drivers, such as the Energy Efficiency Directive (2012/27/EU), which contains strong measures to promote the market for ESCOs. According to the European Commission 117 billion euros of public and private investment per year from 2021 will be required for the delivery of the clean energies package. The buildings sector is the largest single energy consumer and about 75% of buildings are energy inefficient with scope for energy efficient retrofits. This represents a significant policy driver for building energy efficiency retrofits and a significant EU market for ESCOs. Across Europe, national energy efficiency plans in line with the EU Energy Services directive have seen promotion of the use of Energy Performance Contracts (EPCs) in the public sector. Over 40% of energy use in Europe is accounted for in buildings and a central goal of EU energy policy is to target and deliver energy efficiency gains in the buildings sector and with energy cost savings of billions being attainable through the optimised management of energy, there is a clear business opportunity for products and services that deliver the energy saving potential in buildings. This is a mature market with many large established companies providing products and services but new drivers and technologies are leading to continued growth, innovation and transformation in the market. DigiBlocks is poised to move beyond buildings and deliver district scale energy services and capitalize on this market.

In April 2016, the EU Commission issued a communication outlining its strategy for allowing the European Union to fully seize the opportunities offered by digitisation across industrial and services sectors. To address this the Digital Europe programme is focusing on digital innovation hubs, which provide easy access to the latest digital innovations and experimentation facilities to potential users,

and cross-sectorial and integrated digital platforms and large-scale pilots for experimentation and co-creation with users. The DigiBlocks platform encapsulates an integrated digital platform at district scale and can facilitate 3rd party service providers/ESCOs in becoming more competitive by improving their business/services by means of digital technology, in this case leveraging DLT technology. DigiBlocks can offer services for test and experimentation with advanced technologies in the energy sector and can act as broker between end users/companies and technology suppliers.

2.6 Recommendations

Please highlight any implications/opportunities/recommendations for Ireland (e.g., for policy makers, for the research community, for industry) based on the work carried out in the project.

DigiBlocks offers a secure platform for secure data sharing and governance and can be seen as an initial step towards the European strategy for data, with the objective being to create a single market for data will make the EU more competitive globally and will enable innovative processes, products and services. The key to a European wide data economy is common data spaces that will ensure data is available for use as part of the economy and society more broadly, while ensuring that those who generate the data remain in control of their data. While DigiBlocks has been designed for the energy market it is application agnostic and can be easily extended to other application areas such as transport, manufacturing, healthcare and public services. DigiBlocks is an opportunity for industrial and research communities as part of collaborative research activities to further explore this digital intelligence platform as a mechanism for federated data spaces to support secure data exchange, storage and governance for multiple sectors.

2.7 Conclusions and Next Steps

DigiBlocks has resulted in the development of a suite of tools and services that can be used to support energy assessment and consulting services relating to district scale data and targets. Before district or community level projects can commence, considerable amounts of data and extensive assessment are required in order to evaluate proposals. This includes data from across the region under study, which may be available across multiple data platforms (which can be open, closed or proprietary data systems). The scale of this assessment and access to the data may be beyond the resources available in the district (in terms of cost & information technology (IT) resources) often hindering the detailed assessment that is required. DigiBlocks can offer this service as a consultancy (either through an established or new ESCO) where the customer is the district administration, stakeholder group led by the district municipality or a private enterprise. The DigiBlocks open system provides the possibility for third parties to develop applications that can make use of the data in the platform. This supports the stimulation of local economic value creation by offering services to district stakeholders (citizens, businesses or municipal administrations. To continue the development of the DigiBlocks platform across multiple verticals we are exploring opportunities under the Horizon Europe programme in relation to the Digital & Industry, Energy and Security clusters, Digital Europe as well as national opportunities through SEAI and the SFI CONNECT and CONFRIM centres.