1.6. Final Review Report
Regional Energy Demand Analysis Portal (REDAP)

ERA-Net Smart Energy Systems Co-Fund 2019

30th March 2022

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Niall Conway,
REDAP Project Manager & Owner,
Spatial Outlook Ltd.

31st March 2022

Addition Sections and Figures

Access the Tool	
URL: **www.redap.eu** *(choose Demo to redirect to login domain)*	
Username: **demo**	
Password: **Demo_123!**	

PART 1/2

Information on REDAP

Key Quotes

> *Energy Demand: The amount of electrical power that is consumed by a customer and is measured in megawatts (MW). In a general sense, the amount of power that must be transported from transmission network connected generation stations to meet all customers' electricity requirements. This includes any losses (line or transformer)*
>
> Eirgrid, 2019

There is a need to combine measures to influence the spatial pattern of development, urban structure and overall mobility, with low carbon technology measures.

Government of Ireland (2019)

Communities can update their local political leaders in order to share intentions, requirements and future strategies.

OECD

Good data is an essential component of effective policy-making on energy efficiency.

International Energy Agency

Regular, robust, inclusive, country-led reviews will be fundamental to achieving the Sustainable Development Goals, given their complexity and breadth.

United Nations

Introduction

REDAP

energy demand. understood.

REDAP aims to set the standard for energy demand monitoring & reporting for 2030 and beyond. It's about regional and sectoral integration.

REGIONAL ENERGY DEMAND ANALYSIS PORTAL

This research project aims to develop a robust, secure, and extendable system for analysing building and mobility energy demand at the regional level. REDAP intends to provide clear, consistent and comparable data insights to support the complex decarbonisation activity of front-line energy planning experts.

REDAP estimates and visualizes the characteristics and distribution of energy demand for the building and mobility sectors. It identifies areas with high intensities of energy use (incl. heat demand densities, approx. associate energy costs, type of fuel consumption, consumer profile etc) as well as enable integration with real energy data from municipal buildings. In doing so, REDAP aims to help inform synergies and efficiencies at the local level (e.g. district heating), as well as energy retrofitting and heat-pumps strategies. The transport module will enable an analysis of energy demand (per transport mode) in a given region. The insights could also be used to understand the energy relationship between the transport and building sectors, as well as the demand on the grid systems. These insights could be used to inform the rollout of car-share, electric vehicle charging infrastructure, and other sectoral decarbonisation strategies.

BENEFITS: REDAP aims to help governments drive efficiencies, lower emissions and reduce costs. This includes being able to manage, control, and coordinate regional energy assets, to maximise the potential of renewable generation and energy storage, and to decarbonise the heating and transport sectors.

PARTNERS & FUNDING: REDAP is an ERA-Net-Smart Energy Systems initiative project which is funded by the Austrian Research Promotion Agency, the Sustainable Energy Authority of Ireland, and the Swedish Energy Agency. Project partners include the Austrian Institute of Technology (AIT) (Centres for Energy and Mobility), Codema (Dublin's Energy Agency), the National University of Ireland Galway, SME project-managing partner Spatial Outlook Ltd., and Chalmers University of Technology (Sweden). Need-owners include Codema, the Energy Agency of the Regions (Austria), and City of Gothenburg (Sweden).

Project Timeframe: Nov 2019 - Mar 2022   **Website:** map.redap.eu

Total Budget: €1,265,904

General

The REDAP project can be divided into distinct work packages. This includes the following titles:
1. Project Management
2. Dissemination
3. Building Stock
4. Mobility
5. Software/Technical System

The objective of the two-year transnational REDAP project has been to demonstrate the potential for a joined-up, data-driven decision-support system. Six key objectives of the REDAP project:

1. Automate the building-stock-focused process.
2. Incorporate into REDAP a transport energy demand analysis methodology.
3. Develop an improved reporting methodology for delivering energy demand insights to end-users.
4. Develop REDAP as a secure, online, database-driven, standardised, extendable, accessible system.
5. Encourage knowledge transfer between the partners and ERA-Net Knowledge Community.
6. Explore potential government replication, market, and partnership opportunities for REDAP.

Background: Why REDAP?

Understanding demand is the only way that it will be possible to decarbonise supply options. REDAP is about simplifying this process. The following are a list of justifications for REDAP.

- Geopolitical Instability and a corresponding decrease in energy security across the bloc.
- European Union Green Deal
- Climate Action Plan 2019 - leadership role of the public sector.
- The Programme for Government - Just Transition.
- Local Govt Empowerment & Community Engagement.
- Strong Governance, Robust and Evidence-based Policy at all levels
- Industry Needs: TSO/DSO, Eirgrid, IDA, IBEC.
- Drivers: lifestyles, data centres, energy communities, waste regions, etc.
- New technologies (enablers): Storage, generation, supply.

The R&D Approach

The general methodology of the project has been based on the principle of data management and a structured, albeit flexible model. This was focussed on accommodating the evolving needs of the end-user, as well as ensuring that the partners could use a 'trial and error' approach where necessary. The specific stages of the research includes **collating** information and know-how, integrating this into a theoretical and digital framework (e.g. data schemas), **develop** the methodology and system for generating and delivering the data insights respectively, **testing** the system with the need-owners, and finally, **outputting** the data insights in the correct manner. It is intended that this logical model will be followed in any post-project improvements, so that REDAP can continuously onboard new information and become a 'living' business intelligence system.
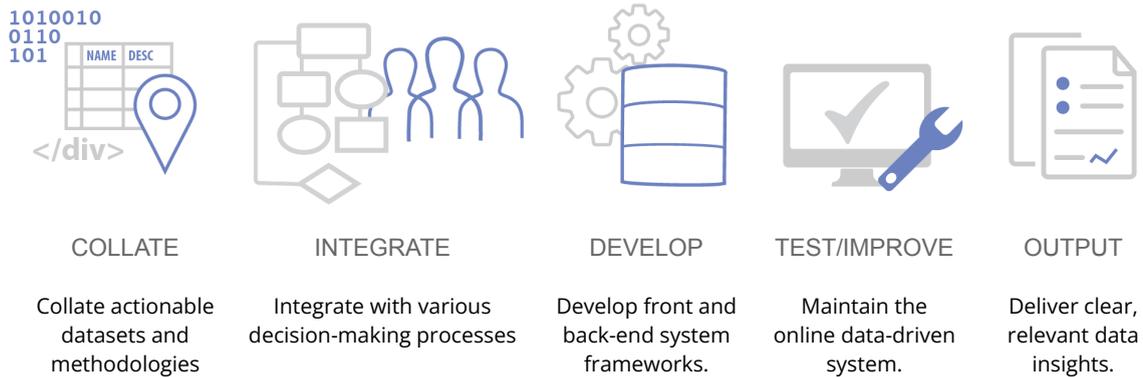

COLLATE	INTEGRATE	DEVELOP	TEST/IMPROVE	OUTPUT
Collate actionable datasets and methodologies	Integrate with various decision-making processes	Develop front and back-end system frameworks.	Maintain the online data-driven system.	Deliver clear, relevant data insights.

Fig. Integrating human, technical, and data components. Iterative R&D process define in the work packages.
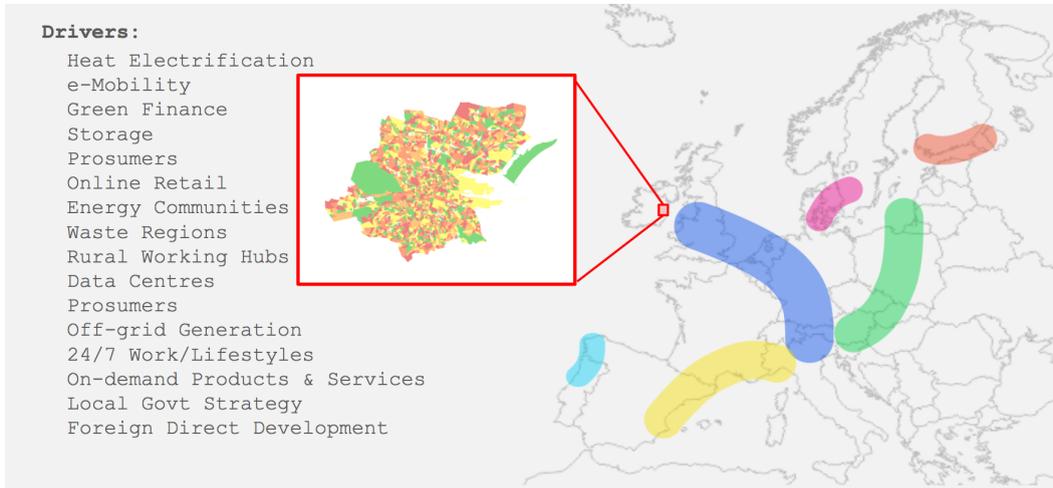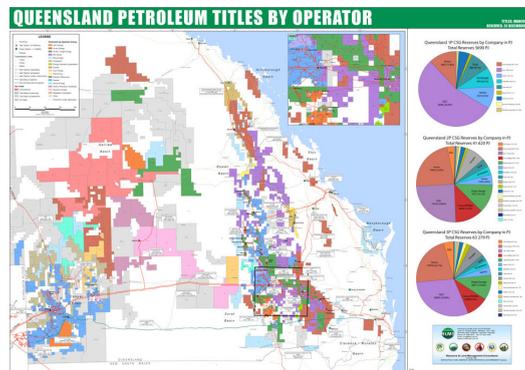
Data-driven Reporting
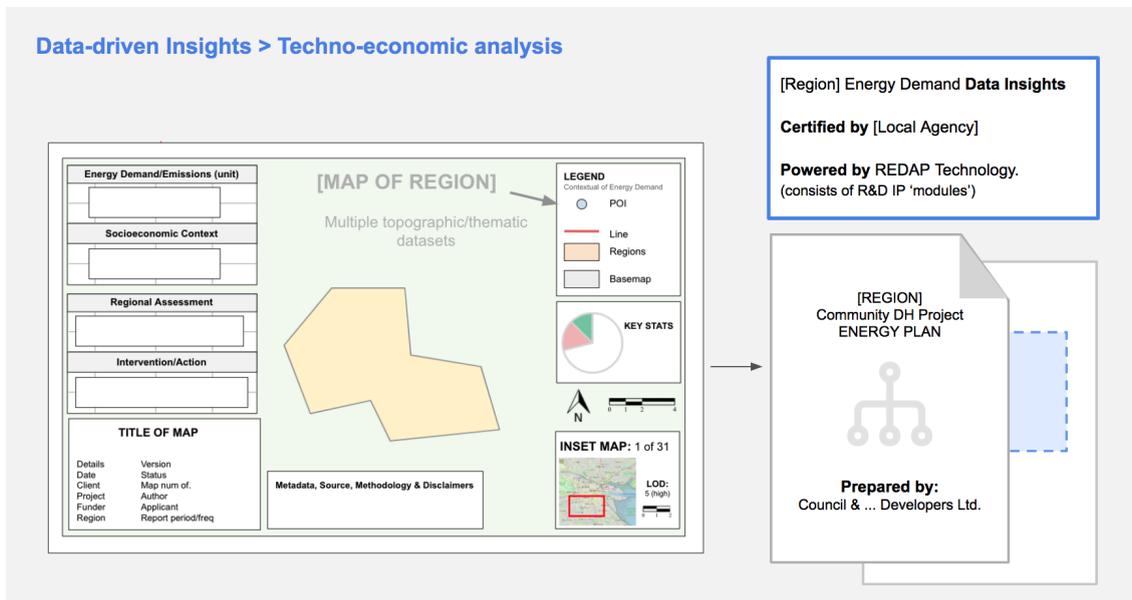
In addition to the monitoring component, a key objective of REDAP has been to develop a reporting system for end-users. To this end, the technical work-package has configured an online and offline system for generating both user and data-driven reports. It is intended that these reports could help fulfill a range of reporting requirements - including for strategic planning, community engagement, and/or policy-making input purposes. Future improvements of REDAP could focus on the development of API capabilities (i.e. to enable 'live' data feeds from various data sources.). Spatial Outlook Ltd also suggests that the REDAP-generated regional reports, maps and data could be certified by a local energy agency and/or planning authority.

Energy Demand: Characteristics, Distribution, Patterns

Traditional corridors of industrialisation across Europe can be used to understand the general patterns of energy demand across Europe. In 2022, it is important to consider how new drivers of energy demand, patterns of development and technologies will reshape these energy-demand centres? This should be driven by a spatial and geographic analysis at both the macro and micro-levels. The following map represents the 'Blue Banana' conceptualised region, as well as other similar-shaped European patterns of industrialization.

Drivers:
- Heat Electrification
- e-Mobility
- Green Finance
- Storage
- Prosumers
- Online Retail
- Energy Communities
- Waste Regions
- Rural Working Hubs
- Data Centres
- Prosumers
- Off-grid Generation
- 24/7 Work/Lifestyles
- On-demand Products & Services
- Local Govt Strategy
- Foreign Direct Development

A Fossil Fuel Industry 'Digitalisation' Approach

'Prospecting for Decarbonisation Opportunities'
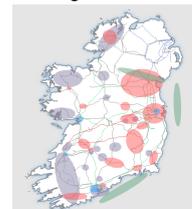Fig. A typical Oil and Gas industry tenement and titles map.

In-depth data analysis underpins decision-making in the fossil fuel industry, including in Queensland, Australia where 'mega-projects' involve a range of geographic considerations and a wide network of government, industry and community stakeholders. With experience in delivering the above geospatial (mapping) insights to decision-makers in the fossil fuel industry, Spatial Outlook Ltd., stakeholders can use the REDAP system, to 'prospect' for decarbonisation opportunities.
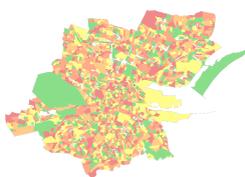

SEAI large energy users and waste regions

IDA companies and Covenant of Mayors signatories

L-R: Waste Regions, Dublin Demand.

EirGrid Regions

'Digital Twin' Principles and possible Exploitation Model

A key motivation behind REDAP is to realise the development of a digital replica of the Irish energy demand landscape. However, despite the often casual use of the term 'digital twin' by industry, it requires a much deeper and more precise understanding if it is to be adopted as an actual decision-making framework. This is defined in the 'Gemini Principles' which are now guiding the development of the UK's National Digital Twin.

PURPOSE Must have a clear purpose	Public good Must be used to deliver genuine Benefit in perpetuity	Value creation Must enable Value creation And performance improvement	Insight Must provide Determinable insight into the built environment
TRUST Must be trustworthy	Security Must enable security And be secure itself	Openness Must be as open as possible	Quality Must be built on data of an appropriate quality
FUNCTION Must function effectively	Federation: Must be based on a standard connected environment	Curation Must have clear Ownership, governance And regulation	Evolution Must be able to adapt as technology and society evolve

Fig. The Gemini Principles, as defined by the Centre for Digital Built Britain (2018).

1. Building Stock Workpackage

Purpose
Building stock energy models (BSMs) have long been used to assess the energy demand and environmental impact of building stocks, where they have been used for policy assessment, analysis of renovation strategies, urban energy planning, among other applications. In recent years, especially the field of urban building energy modelling (UBEM) has become more and more popular focusing on modelling the spatial distribution of building energy demand through building-specific BSMs that model each building in a city or region individually. This development has been possible through an increase in computational power as well as the widening availability of building-specific data on building stocks such as 3D city models, building registries, and/or energy performance certificate data, which enable a spatially differentiated description of building stocks and its energy demand. However, availability to the required datasets is also a limiting factor to the widespread use of spatial BSMs, as access is often restricted, or certain data is missing completely. Moreover, the underlying datasets are often faulty, incomplete and fractured, and therefore extensive data processing and cleaning is required in order to make use of them in building stock energy analysis. This makes the application of spatial BSMs a complex and time-consuming task preventing its wider application especially in smaller regions where resources for energy demand assessment are limited.

The purpose of the building stock modelling related research carried out in REDAP was therefore to develop data source adjusted approaches for spatial building stock modelling as a basis for regional energy demand analysis.

Data sources
The data sources and structure of building stock energy data differ widely from country to country and from case to case. Using building stock modelling approaches, data from these different sources can be combined in order to assess the spatial distribution of building energy demand in a region. Some of the main data types used are listed below:

- Building and dwelling registry: Statistics and data based on the official building and dwelling registry (available as aggregate statistics or individual records)
- Company registry: Statistics and data based on the official company registry (available as aggregate statistics or individual records)
- Cadastral maps: GIS data of the official cadastral maps containing building footprints, ideally linked to building registry
- Energy performance certificate database: Database of energy performance certificates or an analysis thereof
- Survey/measurement studies: Survey studies of part of the existing building stock, helps fill in missing building characteristics
- Building standards: (old) energy requirements for buildings and components
- Architectural history data: Description of old construction practices based on which the energy standard of old buildings can be derived
- Subsidized retrofit and RES projects: Database of subsidized renovation work and renewable energy projects
- Zoning regulation: Map of the existing zoning regulations (i.e. where what is allowed to be built)
- Renewable energy source availability: Spatial data of available renewable energy sources
- District heating/Gas network data: GIS data of extend of the existing district heating/gas network

Methodology
The methodology for spatial building stock modelling is split into two parts, building stock generation and building stock energy and greenhouse gas emission assessment. The latter was carried out using an established building stock model (Nägeli et al., 2020, 2018) and the research focused on the

development of different approaches for building stock generation. Three different approaches to building stock generation tailored to different levels of data availability have been applied and tested in the three REDAP case studies:

Maximum approach - Building-specific BSM (Gothenburg, Sweden): The approach builds up on geo-referenced data of the individual buildings in the stock based on building registries, 2D building footprints and/or 3D building volumes, which have to be merged aligned and completed to fill in missing datapoints.

Medium approach - Sample-based synthetic BSM (Dublin, Ireland): The approach builds up on aggregate statistics on the structure and makeup of the building stock on the level of statistical areas as well as a dataset of detailed microdata on the building level for some buildings (e.g. from a database of energy performance certificates or a surveying study). The spatial data is used to distribute the sample micro data over the study area using iterative proportional updating approach and missing building attributes are estimated to fill in missing datapoints.

Minimum approach - Sample-free BSM approach (Waidhofen and er Thaya, Austria): The approach builds up detailed aggregate statistics on the structure and makeup of the building stock overall as well as the distribution of the stock on the level of statistical areas, but does not include any microdata. The aggregate statistics are used to first reconstruct a sample building stock using iterative proportional fitting. This sample can then be used to follow the rest of the methodology of the medium approach.

Key findings and challenges:

- Synthetic building stock modelling (SBSM) approaches are valid techniques to replace building specific data in cases where this data is not available. Therefore, a SBSM approach is more flexible in its application than building-specific BSMs as it builds upon statistical data that is ubiquitously available.

- Because SBSM approaches use a more simplified representation of a building, i.e., a building that is at least partially synthetically reconstructed, the synthetic data is often cleaner and more uniform compared to the building-specific BSMs. Synthetic data it easier to handle compared to more complex building level data, which is often incomplete or faulty and therefore requires extensive data cleaning and processing before it can be used in a BSM.

- Building-specific approaches, while generally can be considered more accurate compared to synthetic approaches, come with higher costs for data processing and data validation and they are often incomplete as buildings have to be excluded due to invalid or incomplete data.

- As SBSM approaches build upon data that is generally publicly available, they may be more quickly deployed in a new region compared to a building-specific approach as no sensitive data is used that may need to be specially sourced or may otherwise be restricted in its use.

- The quality of the generated synthetic building stock and the obtained result from synthetic building stock modelling approaches still heavily depend on the quality of the input data. While additional data can be added through the building characterization, the representativeness of the spatial distribution is limited to in the quality and content of the base dataset.

- The level of detail in the spatial analysis in SBSM approaches is limited to the spatial aggregation of the input data (e.g., statistical areas or grid cells). Moreover, in contrast to building-specific BSMs, the finest level of detail in spatial aggregation (i.e., the building scale) is missing as buildings are not referenced to a specific location but rather to a specific area (e.g., grid cell).

- The SBSM approaches make use of stochastic methods to spatially distribute and characterize buildings. Hence some errors and deviations in the composition and spatial distribution of the synthetic building stock compared to the input data may occur.

2. Mobility Workpackage

2. Incorporate into REDAP a transport energy demand analysis methodology.

Purpose of R&D

Assessing transport energy demand for a region essentially relies on knowledge and data about mobility demand, expressed as transport routes, travel modes (e.g. private cars or public transport) and trip purposes of personal mobility (e.g. activities such as work, shopping, leisure, returning home). Such knowledge about typical mobility patterns in a region is an essential piece of information for computing load profiles and planning of locations and capacities of charging stations for electric vehicle car parks.

Traditional travel surveys for personal mobility collect information about people's travel behaviour by asking survey respondents to fill out trip diaries, either paper-based, supported by telephone or online. Representative traditional travel surveys are usually rarely performed due to the high costs of recruiting and taking care of survey respondents. The data about mobility demand might therefore be outdated by several years.

A promising alternative to traditional travel surveys is the communication infrastructure of a cell phone network, which provides extensive information about the travel movements of a large proportion of a population: Every mobile device connecting to the mobile phone network generates digital traces in the network of the mobile network operator (MNO). The analysis of such signals between mobile phones and antennas contains valuable information that can reveal which trips people make. The analysis of these signals is passive in the sense that no particular app is required on a person's smartphone. One major objective of REDAP R&D was therefore to advance data science algorithms for analysis of cell phone signals to obtain transport energy demand.

Data Sourced

Traditional travel surveys for personal mobility: The three traditional household surveys of Austria (Österreich Unterwegs 2013-2014), the Swedish survey in the Gotaland region around Gothenburg (Resvaneundersökning 2017) and the Irish National Household travel survey 2017 served as basis for estimating transport-related energy demand in the three REDAP regions.

Cell phone data: Due to privacy concerns and legal privacy regulations, telecommunication providers often provide only aggregated MNO data to third parties to perform mobility studies and research. Such aggregated data do not contain traces of device signals, but only MNO data summarised in, for example, 15-minutes intervals and in a geographical region. In REDAP, full access to disaggregated signal data was possible:

- MNO signal data for Austria, procured from an Austrian provider as planned in the REDAP proposal
- MNO signal data for Ireland and Austria, provided in-kind for the project from an international provider in summer 2021 (project addendum).

Vehicle Fleet: In order to distinguish between electricity and gas/diesel demand, information about the electric vehicle (EV) share was collected from official sources in Ireland, Austria, and Sweden.

Overview of Methodology

Traditional travel surveys for personal mobility: While the reports with the survey results and insights are usually publicly available, access to the raw mobility datasets (i.e. the digitalised cleansed data of the questionnaires about travel behaviour, including weight factors for extrapolation) is usually not immediately possible: access to raw datasets is in general strictly constrained to non-commercial (research) projects. No agreed common data format exists for such surveys, and therefore varies between regions. Consequently, three specific tailor-made functions to import the raw data and compute parameters (e.g. km per car, distribution of arrival times at home)

for all three regions were implemented and validated against the official reports.

Cell phone data: The rationale of travel mode inference in cell phone data is to match traces in a telecommunication network to a transportation network (public transport line, road segments). The traces of communication signals in a mobile phone network are, however, sparse and noisy with respect to the transportation network, making route matching a very challenging data science problem. The low spatial and temporal location resolution together with their uncertainties implies that passive travel mode inference will only be successful in extended areas, and for a limited set of travel modes, for example public transport vs. motorised traffic. It is, for example, very hard to distinguish between cycling and car traffic at the inner city block level, despite a higher density of antenna compared to rural areas. Dedicated indoor antenna deployed at public transport transit stations can provide additional clues**.** The approach can be summarised as follows

1. Segment signalling data in to trips and stops
2. Match trips with transport network extracted from OpenStreetMap with probabilistic approach addressing uncertainties
3. Compute link flow volumes
4. Estimate total mileage of car trips per home location

SoA / Beyond State-of-the-Art
The role of mobile phones as a proxy for human movement and the vast amount of data generated by such devices provide much potential to analyse mobility. Mobile phone data were already used to compute origin-destination matrices and traffic volumes, identify traffic incidents and characterise land use. With the beginning of the COVID-19 crisis, MNO data analysis was an important data source for 1) quantifying the relative importance of mobility in the stages of the virus outbreak in different European countries and 2) measuring the impact of COVID-19 confinement measures on human mobility. Such studies rely on a set of mobility indicators derived from origin-destination matrices, but do not include analysis of travel modes of a population. The contributions of REDAP are novel and efficient route matching methods for large scale cell phone data. .

Key Findings
- While the sampling frame of traditional national travel surveys is designed to obtain a representative sample of a population, data from a relatively small and rural area such as in the Austrian use case is sparse or even non-existent in some districts. A clear argument for either performing a regional survey or to use alternative sources such as cell phone data.
- While survey respondents of traditional travel surveys provide trip start and trip end locations, whenever a survey organiser shares trip data to third parties, the starts and ends are anonymised by aggregation to regional (county) level due to privacy reasons. In Ireland, the resolution on a county level was considered as being too coarse for useful planning applications in Dublin. Using cell phone data allowed to aggregate to a finer resolution.

Challenges
- As for traditional travel surveys, there currently exists no standard data format for representing mobility patterns. While this is no technical challenge per se, it requires importing and processing of raw data on a case-by-case basis.
- The major challenge with developing big data analytics techniques for mobile phone data is quantitative evaluation and validation of results. This is due to the lack of a ground truth evaluation dataset against which results could be compared: one does not know how all the subscribers of an MNO really moved. Ground truth data of existing scientific literature is based on small data collection campaigns, where a few people collect reference data. Data from traditional household surveys are obsolete.

Recommendations
- Standardised data format for mobility patterns (e.g. Mobility Data Space of the EU).
- Quantitative evaluation and validation of mobile phone results would require a large data

collection campaign, where a large sample of people collect ground truth reference data.

Load Profiles

Load Profile is a broad term that can refer to a number of different forms of data. It can refer to demand and consumption data, or it can be a reference to derived data types (such as Regression and Profile Coefficients). However, all these data types have one thing in common; they represent the pattern of electricity usage for a customer segment of the electricity supply market. A load profile gives the Half-Hourly (Settlement Period) pattern or 'shape' of usage across a day (Settlement Day), and the pattern across the year (Settlement Year), for the average customer of each Profile Class. It is the proportion of demand in each Settlement Period that matters in the Settlement system. Figures 1 and 2 depict a typical daily and yearly pattern of demand for the average domestic unrestricted customer (Profile Class 1). Source: www.elexon.co.uk/documents/training-guidance/

3. Technical (GIS) Workpackage

3. Develop an improved reporting methodology for delivering energy demand insights to end-users.

4. Develop REDAP as a secure, online, database-driven, standardised, extendable, accessible system.

Note: some of the functionality listed below is online demonstrable in an offline setting. Also features may require further configuration beyond the project timeframe.

1. **Standardised Process of Monitoring and Reporting**: REDAP is a dynamic, database-driven, multi-user tailored reporting system. It enables users to see exactly what they need to see (incl. geographic contextual data) in a well-structured manner.
2. REDAP includes templates for **data-driven report generation** (e.g. authored by local government, energy community, energy agency). These offline maps are available online/offline and are configurable according to permissions/access/roles.
3. **Meta-data Management.** This non-core feature represents a basis for data governance. It enables decision-makers to better understand the quality of the data and it can be managed by the users themselves (i.e as a basis for data policy).
4. Potential to **incorporate other R&D output** which could help to understand past and present energy demand as well as to model future energy demand scenarios. Examples used in the system include historical raster datasets for reference (e.g. **European Heat Atlas raster data**).
5. REDAP offers potential to **Rate Infrastructure Suitability**. This non-core process demonstrates how planning could become even more data driven and incorporate additional authoritative datasets (e.g. government open data). This rating process is based on a range of governance, energy system, and/or socio-economic contextual data.
6. REDAP uses scripts to join infrastructure and projects with **energy/heat demand calculations**.
7. The tool can **connect multiple users** to the energy demand analysis insights. This non-core process enables collaboration with data suppliers, aggregators, analysts, etc. Database editing rights can be configured on a per user/region basis.
8. **Styles can be embedded** in layers or on a project theme level. This includes point clustering category filtering, as well as optional **SVG styles** for more relatable icons (esp.for PDF reports). REDAP also includes basemap layers (e.g. **Google Satellite** which enables digitising features).

9. Workspaces include **editable contextual data** that can be used to understand general demand drivers. Examples incl: smart energy infrastructure, district heating networks, project regions).

10. **Embedded documentation** ensures that users can receive training on topics such as**:** 1. Data Interpretation and Analysis, 2. Core System Functionality: incl. user admin/roles/permissions. 3. Incorporating external datasets (e.g. online/offline functionality), 4. Report Generation (e.g. editable data, sources, templates).

Screenshots of REDAP tool
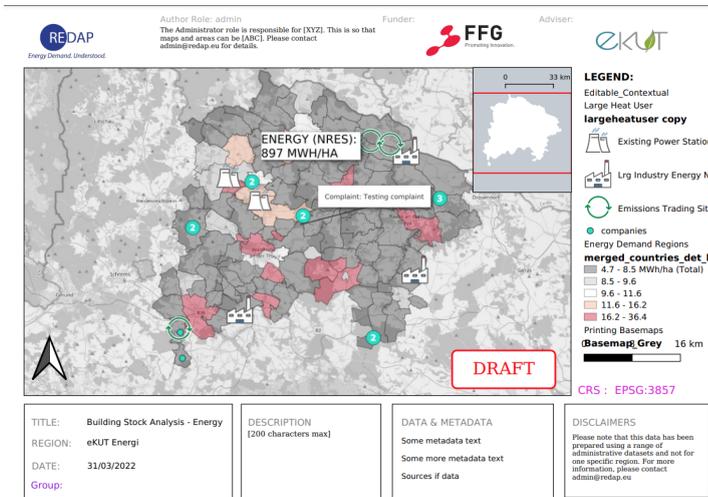
Online & Offline (non-core) Report Generation

REDAP allows users to print cartographically tailored mapping output both from the online portal and from desktop systems.

This will enable users to communicate ideas and discuss key issues in a more impactful way.
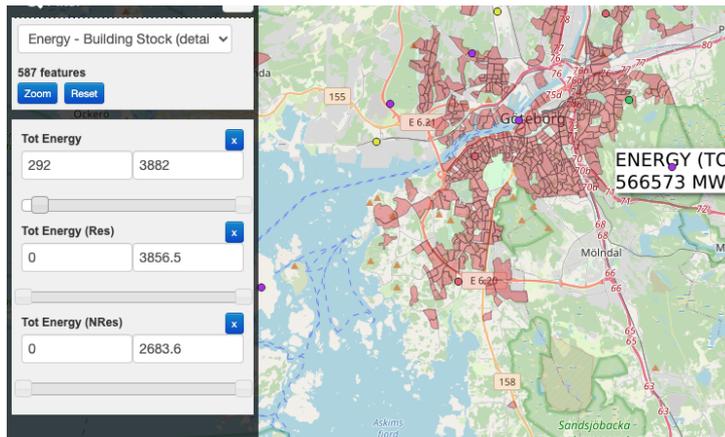
Data Analysis Functionality

REDAP can be configured to let users analyse attribute information in different ways.

The example on the left shows a slider scale - just one example.
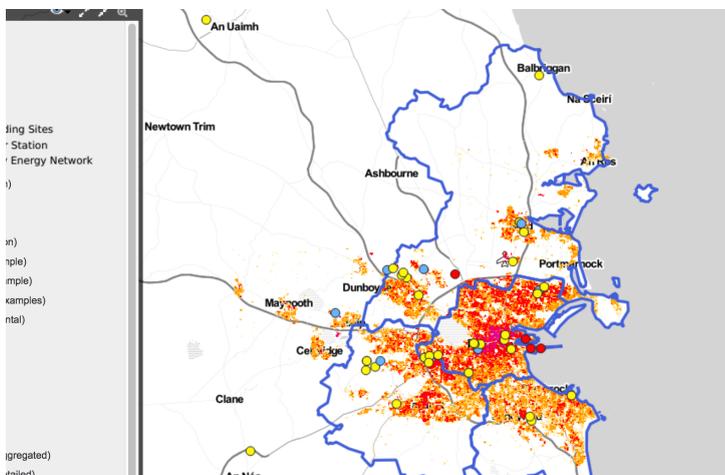
External Data Integration

Pending permission from data custodians/owners, REDAP can 'draw' in data from different sources. This enables a better understanding of context and background research.

This approach will eventually eventually allow for deeper analysis from different perspectives.
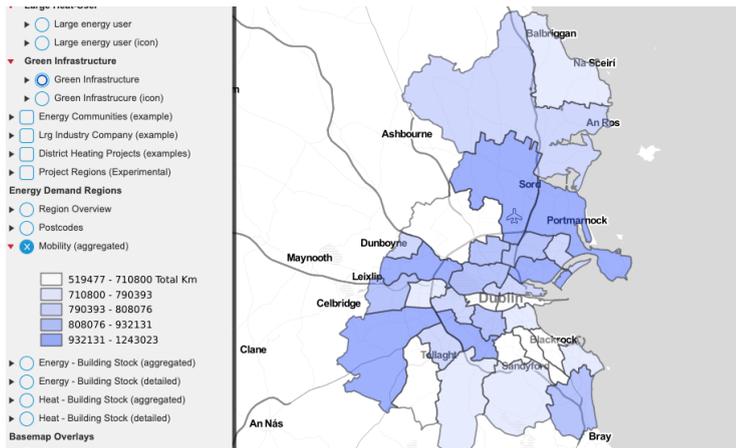
Mobility and Building Stock

In addition to the building stock energy demand insights, REDAP is able to display mobility datasets.
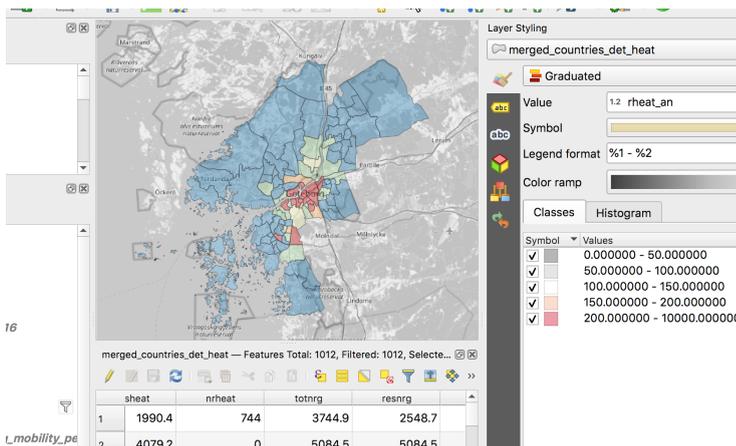
Note: certain aspects of this research are pending further configuration.
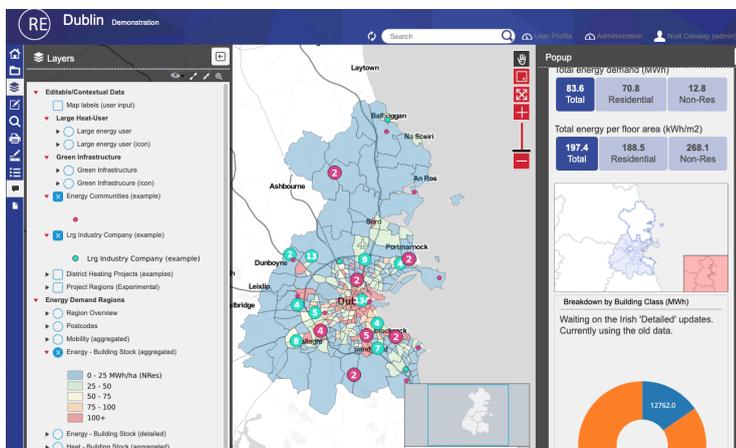
Dynamic Visualisations

In REDAP, the data which is displayed in the attribute tables is linked to the data which is displayed in the map and in the visualisation shares.
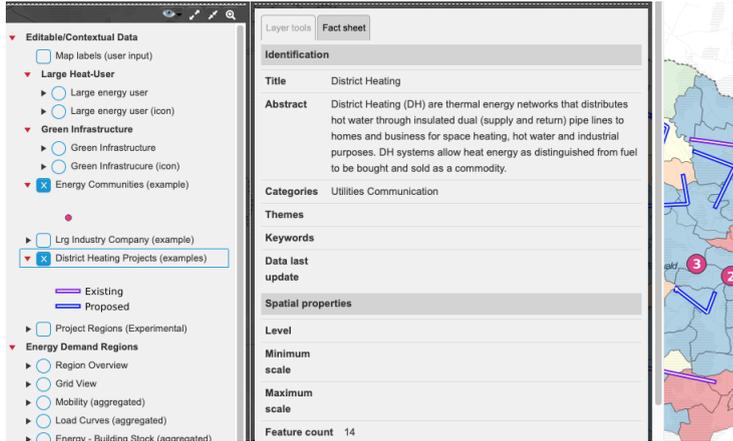
This allows users to understand the same data in different ways.

Database Connection (non-core)

Upon configuration, REDAP data can be access by need-owners and other stakeholders for further (offline analysis).

This can be configured in accordance with data policy and required permission and privacy settings.

Metadata Management (non-core)

Being able to understand where data comes from and it level of accuracy is critical to any good decision-making.

REDAP enables these types of attributes to be created and updated by end-users.
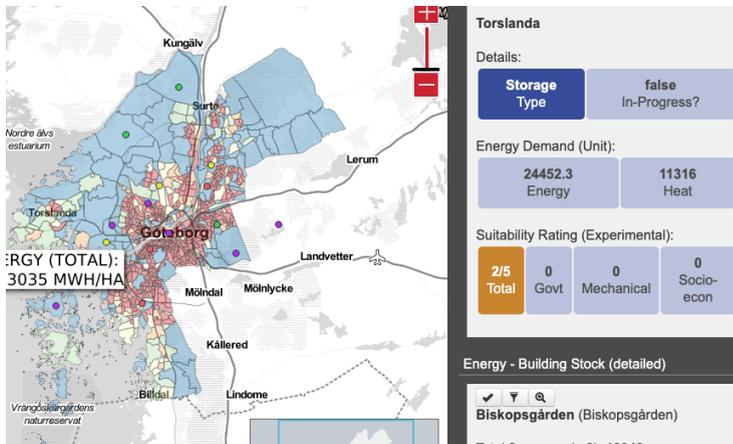

Infrastructure Rating Functionality (non-core)

REDAP demonstrates the basis of rating the suitability of infrastructure to specific regions and sub-regions.

This is based on analysis of a range of governmental, technical and socio-economic datasets. This aspect itself could accelerate numerous decarbonisation business-cases - for industry, government and communities.

NB: this functionality is for demo purposes only.
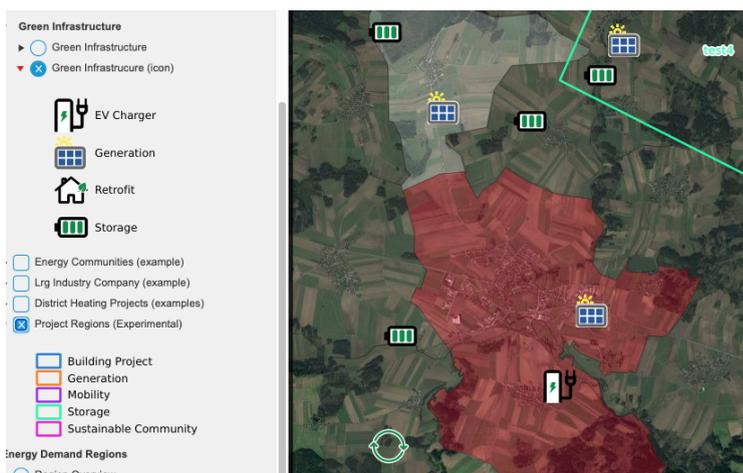
Print Icons

Since not all people interpret maps in the same way, REDAP has been configured with a range of relatable icons.

This approach for could form a basis for further 'gamification'.

Website

The REDAP website has been configured with suitable information and updates. This will serve as a centralised portal through which users can access the data insights.

Permission Configuration

Through the REDAP portal, administrators can configure permission settings on a group and users basis.

This will ensure that all data is secure, well managed and accessible to the people who required it.

Infrastructure Rating Scripts (non-core)

Just like Google, REDAP is configured with inbuilt predictive text input functionality.

This ensures that users can analyse their respective regions with ease.
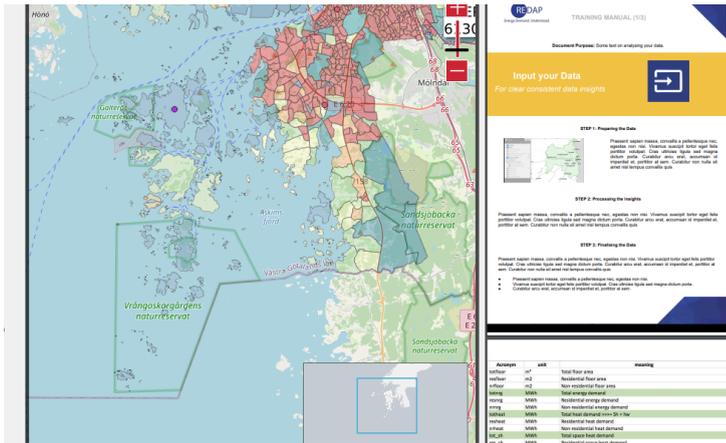
Training Material

REDAP is configured to show training functionality in the browser.

This means users can learn about the various tools, functionality and analysis process while they navigate the system

This training material will become more intuitive as the system develops.
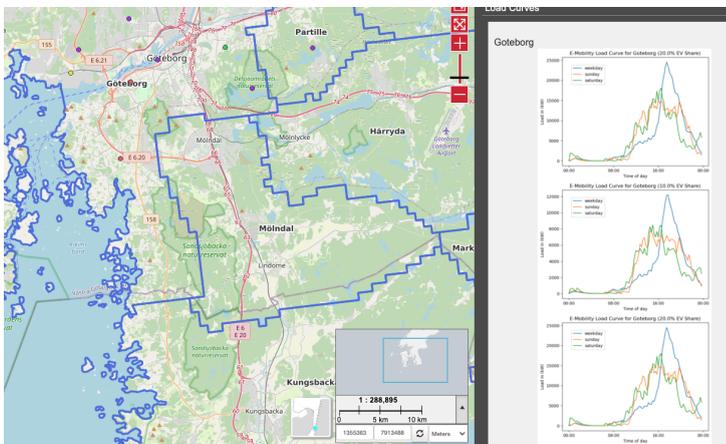
Load Curves

The AIT has performed experimental research on the topic of load curve analysis. The following graphs represent the load curves at various different EV share scenarios.

These static images could be upgraded with more dynamic, interactive charts (as per the original REDAP version one system) post-project.
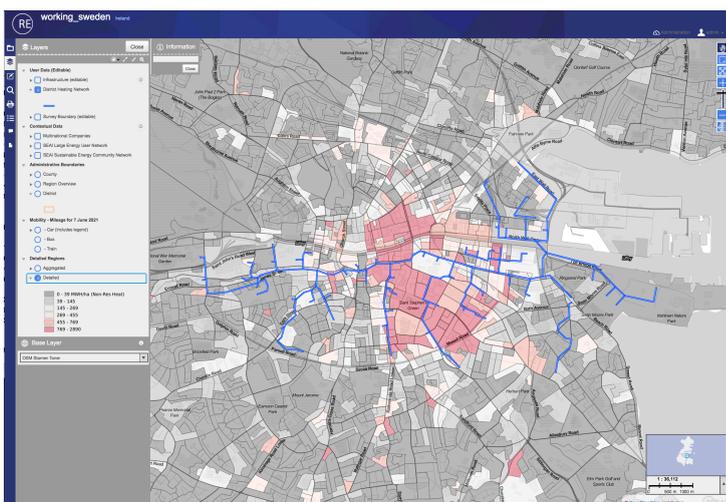
District Heating Network

REDAP is configured to allow for the display of infrastructural information. In this picture we can see a digitised district heating system network for Dublin city centre. Other data includes historical data such as the Heat Atlas (in a raster data format).
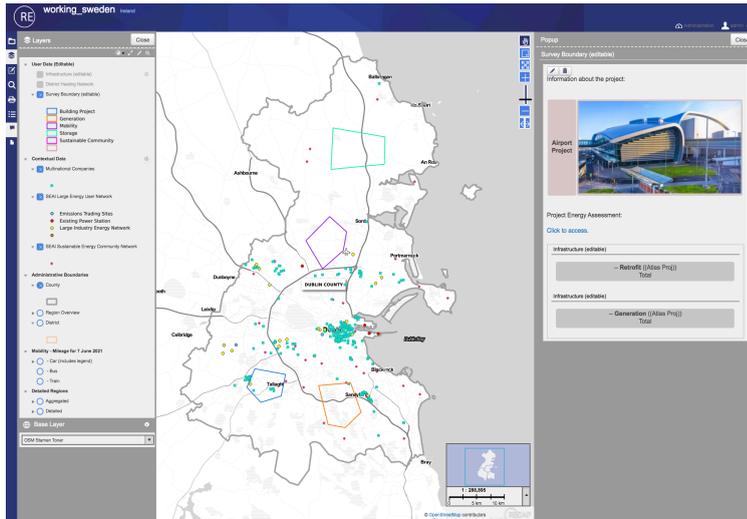
Data Relationships

The popups can also include information on the contextual information. An example of this is the infrastructure features displayed in the map. As well as attribute information this could include other media such as photos, videos and hyperlinks.

Potential Case Studies

In Ireland, the output of the R&D could, in theory, be used by Codema (Dublin's Energy Agency), on behalf of the four Dublin local authorities. The data insights could therefore be used to inform the Dublin Energy Masterplan, the council's emissions reporting requirements, the Covenant of Mayors reporting, as well as the region's transport electrification strategy.

Since the data insights derived through REDAP will typically be communicated in the form of maps, tables, charts and other graphics, it will be possible to include REDAP data insights as report 'placeholders' in other energy plan and policy documents. Also, since the REDAP methodology will be regionally replicable, the process could be applied to other rural/urban regions - meaning that the wider energy demand 'landscape' can be understood.

Integrating Data Insights into Policy & Strategy

REDAP data insights could be built into a range of local and high-level policy and strategy. For example, the data could serve to populate relevant appendix items with information on the best-available energy demand breakdown. The following are examples of reports which may require energy demand insights.

This includes the following Irish examples (and equivalent in Sweden in Austria):
- Greater Dublin Area Transport Strategy (2022-24)
- SEAI National Heat Study (2022)
- Codema's Spatial Energy Demand Analysis (SEDA) reports for local authorities (since 2015)
- National Network, Local Connections Programme (2021)
- Five Cities Demand Management Study (2021) - commissioned by the Irish Department of Transport
- National Energy and Climate Plan (NECP).
- SEAI Large Energy Users Network.
- SEAI Near Zero Energy Building (NZEB), Building Energy Rating (BER), EV Charging programmes.
- SEAI Sustainable Energy Communities Programme.
- SEAI Local Authority Renewable Energy Strategy (LARES).
- National Broadband Strategy, Rebuilding Ireland - Housing, National Transport Strategy.
- Projects of Common Interest (PCIs)

In addition, REDAP data insights could be restructured for actors involved in complex procurement and tendering activities.

Identifying opportunities for synergies & efficiencies.

By delivering energy demand insights and screening services, REDAP could help decision-makers to identify similar decarbonisation opportunities, as well as to perform more in-depth scenario and 'techno-economic' analysis at the national, regional and micro-levels. By engaging in this digitalisation realm, government could 'reset' its current energy planning approach in delivering on its 2030 targets, so that the focus is on sustainable, inclusive and decarbonised development.

A Digital Economy? To meet increased demand for power from data centres, which is expected to account for 31% of the total Irish energy consumption by 2027, the country will need to invest an estimated €9 billion in the electricity sector*. Energy demand forecasting and analysis will therefore be critical to accommodate the energy needs of data centres, in addition to that of the 400 remote working hubs which will be connected under the National Broadband Strategy.

Source: https://bitpower.ie/images/Reports/2020_Q1_Update_Report.pdf

In December 2020, South Dublin County Council (SDCC) announced a public-private collaboration with Amazon AWS to provide heating from the Tallaght-based **data centre** to local homes and offices. The project is predicted to reduce carbon emissions in the local authority's area by nearly 1,500 tonnes per year, while SDCC plans to provide the heat source to between 3,000 to 5,000 residential units – mainly apartments – in the medium term. In doing so, the scheme will help mitigate fuel poverty in the area, attract more innovative businesses and development, and help inspire educational programmes and start-up opportunities in renewable energy solutions. Considering that AWS is providing the recycled heat free of charge under its broader sustainability commitments, and the potential value of the region's industrial waste heat (est. €1.2bn per annum), best available data must be used to plan for its redistribution. Source: Codema, Irish Times.

As the demand for energy from data centres is expected to double between 2019 and 2028 in Ireland, these types of efficiency services will become more important. For example, demand analysis could be tied in with housing and grid planning strategy..

Urban Regeneration and Decarbonisation

The Cranmore housing programme in east Sligo is an example of climate action, **urban regeneration** and community engagement. It also demonstrates how detailed, geographically-linked energy demand data could drive further decarbonisation. As part of the regeneration masterplan, the local building stock was upgraded and the combined carbon savings (as calculated using air quality monitors) was traded on the Emission Trading Scheme (ETS) programme. These financial savings were subsequently offset against the cost of a new community centre. This presents a significant opportunity for energy communities assuming that a suitable information and decision-making mechanism can be established.

Housing, Decarbonisation, Climate Action

In Ireland, a range of 'geospatial' digitalisation activities could be harnessed to align the urban planning and energy planning fields. This includes the following: **Strategic Development Zone** Draft Planning Energy Masterplans are generally prepared by local governments with financial support from the SEAI. These plans comprise an overarching energy strategy for the SDZ lands (e.g. Clonburris, Dublin) and require energy demand mapping, through economic appraisal, along with a detailed comparison of energy provision regarding viability, energy supply, and emissions.

At the national level, the Irish government, through the National Climate Action plan, requires a **Decarbonisation Zone** be established in each county. A DZ is a spatial area in which a range of climate mitigation, adaptation and biodiversity measures and action owners are identified to address local low carbon energy, greenhouse gas emissions and climate needs, to contribute to national climate action targets.

Much of the transformative change in Ireland will be overseen by **Climate Action Regional Offices**, which coordinate and support local government. Actions undertaken by each CARO will be decided on an annual basis by a work programme and will be primarily developed with reference to various national mitigation and adaptation goals. These goals could be further aligned with central DSO/TSO energy planning strategy as well as building standards (e.g. Near Zero Energy Buildings, Energy performance in Buildings Directive (EPBD)).

Aligning Digitalisation and Investment Frameworks?

The EU taxonomy is a classification system, establishing a list of environmentally sustainable economic activities. It could play an important role helping the EU scale up sustainable investment and implement the European green deal. The EU taxonomy would provide companies, investors and policymakers with appropriate definitions for which economic activities can be considered environmentally sustainable. In this way, it should create security for investors, protect private investors from greenwashing, help companies to become more climate-friendly, mitigate market fragmentation and help shift investments where they are most needed.

The taxonomy is usable by both EU legislators and member states, as well as financial market participants. The taxonomy elements are ultimately aligned with a coherent information chain and demonstrate the importance of classification and data-driven decision-making. From a digitalisation perspective, the taxonomy's energy sections could be digitalised in such a way that it is aligned with the energy demand (i.e. energy market) insights.

Taxonomy Technical Report
June 2019

"the science or technique of classification"

(Collins Dictionary)

District Heating Price Dialogue

"Price dialogue between customers and district heating companies"

https://www.prisdialogen.se/om-prisdialogen/
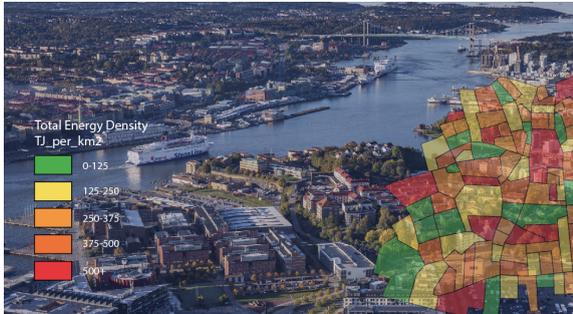
The Swedish price dialogue is a model that includes both local dialogue and central testing of price changes for district heating. It is defined as:

"A well-functioning heating market presupposes both well-informed customers and suppliers who openly report how they change their prices. That is why Riksbyggen, Sveriges Allmännytta (formerly SABO) and Energiföretagen Sverige have jointly developed the Price Dialogue - between customers and district heating companies.

The purpose is to strengthen the customer's position, to achieve a reasonable, predictable and stable price change for district heating and to contribute to increased confidence in the district heating suppliers' pricing. The price dialogue is a development and deepening of the collaboration that the organizations presented in 2011.

In 2012, district heating suppliers and district heating customers, in a couple of locations in the country, collaborated on a dialogue about price changes according to the Price Dialogue model. The price dialogue office is now in place, the model is fully developed and it is possible for district heating suppliers to apply for entry.

Communities: 'Representing' Energy Demand

Legislation such as the EU Clean Energy Package is presenting opportunities for innovation and engagement at the local and regional levels. This includes increasing involvement of communities in the decarbonisation and energy discussion. Digitalisation projects such as REDAP can help community stakeholders to understand and 'represent' their region's respective demand and to thereby better engage with relevant stakeholders.

"Energy communities organise collective and citizen-driven energy actions that will help pave the way for a clean energy transition, while moving citizens to the fore. They contribute to increasing public acceptance of renewable energy projects and make it easier to attract private investments in the clean energy transition. At the same time, they have the potential to provide direct benefits to citizens by advancing energy efficiency and lowering their electricity bills. By supporting citizen participation, energy communities can moreover help in providing flexibility to the electricity system through demand-response and storage."
https://energy.ec.europa.eu/topics/markets-and-consumers/energy-communities_en

The Energy Community Distribution System Operators in Electricity (ECDSO-E) Coordination Group was informally established and supported by the Secretariat in 2014. The article discussed issues to do with energy security, the impact of the pandemic and issues of concern to the twelve Distribution System Operators from the Energy Community region. (Source: https://www.energy-community.org/aboutus/institutions/ECDSO-E.html)

The electric load curves research represents a key element for the sector coupling of building and mobility energy demand analysis. This issue is gaining more importance for the urban energy system with the increased penetration rate of EVs and the electrification of end-use. In particular, the offline analysis process can deliver updatable scenarios on general load profiles, including the number of electric vehicles, and expected electric peak load. These serve as practical use-cases for applying energy demand insights. These insights are also highly relevant to decision makers in the grid network planning and stakeholders involved in the European Single Energy Market. In addition, these micro and macro-level insights are highly relevant to grid operators such as Eirgrid, Svenska kraftnät, Austrian Power Grid AG.

In a research study, AIT created e-mobility load profiles for an Austrian grid operator in the course of the annual European Resource Adequacy Assessment (ERAA) process. The European association for the cooperation of transmission system operators requires these and other energy-relevant e-mobility inputs from its member countries.

ENTSO-E Transmission System Map

Regulatory Matters

A whole-of-system energy demand analysis approach can be extended to the data centre industry which is coming under increased scrutiny from regulators. For example, in 2021, the Irish Commission for Regulation of Utilities (CRU) specified new requirements for data centres. In the 'CRU Direction to the System Operators related to Data Centre grid connection processing', the CRU has decided that connections will in future be determined by ability to bring on "site dispatchable" power. This includes both gas-fired electricity generation that can be used on demand and deployed/adjusted at the request of grid operators according to market needs as well as power storage mechanisms. (Source: www.cru.ie)

Identifying target regions for decarbonisation?
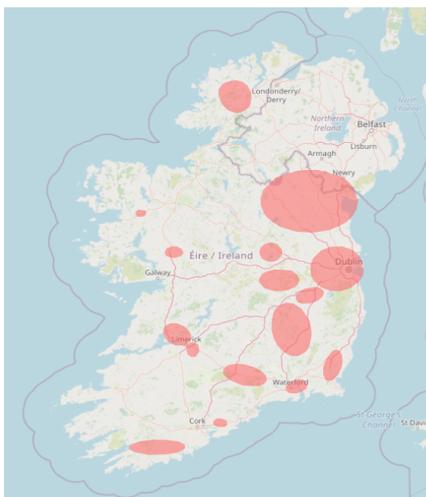
Fig. Digitised from
Transmission Development Plans 2015 and 2018-27

Centralised Plan-led, Delayed Transition,or Coordinated Action?

Transmission System Operators are using scenarios as a way of identifying the future needs of the grid, including to tackle the current record all-time levels of energy consumption (incl. Eirgrid's two 'Amber Alerts' warnings in Dec 2020). These scenarios are based on the grid usage, while the influencing factors include the scale and location of electricity consumption, generation, interconnection and storage. In addition to demand increases, other key considerations include regions with increased fault levels, areas of interconnection, and increased generation. The map on the right represents areas with increase energy demand in the Eirgrid TSO market.

It is envisaged that, REDAP could eventually support regulatory 'sand-boxing' activities, including through the input of data related to demand response, sector-coupling, and utilities. From a purely geospatial/regional-perspective, the following frameworks for innovation experiments could be explored:

- *Pilot project / Innovation lab*: an innovation project to test and develop new technologies, services, processes as well as business models in the frame of current regulation.
- *Experimental Regulatory Sandbox (ERS)*: an innovation friendly regulatory space for new technologies, services, processes as well as tariff and business models to be developed and tested.
- *Regulatory-Innovation Zone* (RIZ): an "in-field" laboratory for new regulation before it is rolled out. Different regulatory options can be tested, and practical implementations issues and side-effects of new regulation can be explored and addressed.
- *System Innovation Zone (SIZ): a wider framework* that is aimed at testing system innovations (co-evolution of technical, social, market and regulatory changes).

Source: ERA Regulatory and Market Development Spotlight 2018 Edition

Marketing Regions

Some interesting feedback received by the workshop participants from Sweden in 2021 was that REDAP could be used as a tool for regional marketing purposes. In particular, that energy demand could be used to 'profile' regions, including the general characteristics, distribution and patterns of energy demand across the regions. Regional marketing can be defined as *.the practice of applying different marketing mixes to accommodate unique preferences and competitive conditions in different geographical areas.*

These types of data insights are delivered via the Investingothenburg.com site. Business Region Göteborg AB (BRG) is a wholly owned, non-profit subsidiary of Stadshus AB, which is wholly owned by the City of Gothenburg, which represents thirteen municipalities in the region.

In Ireland, regional marketing aligns with the activity of the Industrial Development Agency. IDA is a semi-state body responsible for attracting high-performing foreign direct investment to the country. With companies becoming increasingly 'climate conscious', regions need to attract multinational corporations by addressing key ESG principles and metrics in a transparent manner. This could include energy demand data statistics and strategies to meet this demand through engineering synergies and efficiencies.

Sources:
https://www.investingothenburg.com/insights
https://www.idaireland.com/about-ida/driving-recovery-and-sustainable-growth-2021-2024

Results & Exploitation Intentions

Spatial Outlook Ltd offers to energy agencies and local governments, an online system which is secure, database-driven, (and because it is open source) cost-effective and extensible. The system can deliver updatable, quantitative information on mobility and building stock energy demand, as well as a suite of functionality for monitoring, reporting and analysis. Spatial Outlook will also offer services to translate energy planning workflows into repeatable processes and to integrate internal/external contextual datasets. As a result, users can both understand the drivers of this consumption and represent their region's energy demand in greater detail. REDAP, therefore, represents a 'tool' for simplifying internal data management and decision-making, for developing internal capabilities, and for generating internal engagement and momentum.

To make this exploitation work, Spatial Outlook Ltd. proposes to operate on a behind the scenes basis as a digital product and service provider - i.e. to implement ongoing system improvements and support frontline users. In Ireland, for example, this includes aligning REDAP with specific plan-and-policy-making efforts (e.g. Climate Action Plans, Energy Masterplans, and Spatial Energy Demand Analysis). It also includes mitigation practices such as baseline energy and emission inventories for both local authorities obligations and covenant of Mayors commitments.

The following graphic presents a general proposal for putting the consortium partner's IP modules to use and for involving the partners and end-users in the process.
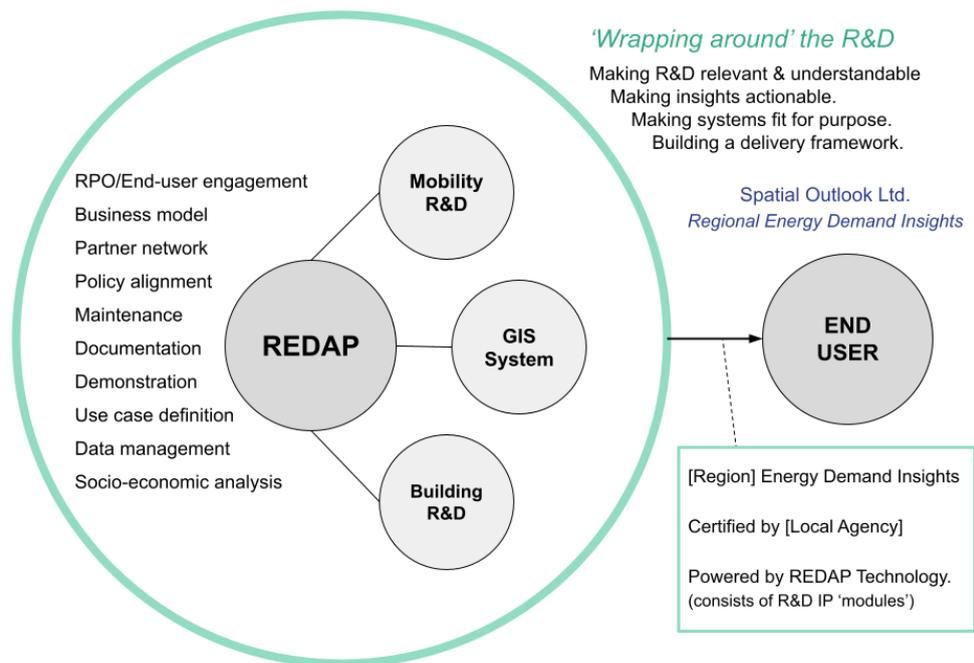
Project Managers Key Findings from the Research

Holistic Analysis at the EU Level
The integration of the building and mobility analysis has been a focus of the research. This is because, within an increasingly electrified system, the sectors and drivers can't be considered in isolation. As demonstrated, unrelated datasets (e.g. census, EPBC, cellular) can be harnessed, repurposed and integrated so as to generate actionable, authoritative insights. This is an opportunity for Single Energy Market-wide analysis and policymaking.

Aligning the Information & Electricity Value Chains:
Data is a key component of optimised central and regional energy systems. Therefore, the 'commodification' of data involves understanding the purpose and use-cases which it can serve to end-users. For this reason, it is important to address a range of policy, regulation, and local strategies and to make the data insights relevant. In the case of REDAP, energy demand data has been displayed alongside curated contextual (geographic) data. Schema design to allow for regional data interoperability would require more work in any REDAP version.3.

Data and Domain Expertise
In developing an optimised system, it is important to distinguish between spatial and non-spatial data, and to understand how variables, functions, views, etc can be used. The software components, like the physical system, need to address the following criteria: **Correctness:** it produces the right results and exhibits the right behaviour. **Usability:** the user can easily perform the desired functions. **Maintainability:** it can be easily maintained and updated. **Availability:** it is available when it is needed. **Useful:** it performs a task that someone wants performed.

Data about Data
Since decisions need to be made with confidence, metadata is important. This is why the REDAP partners documented details of the data sources and accuracy in the Building Stock and Mobility work packages. The technical partner also devised an offline POC process to establish data policy/procedures which are aligned with user/group permissions. In addition, the classification of datasets and correct use of data disclaimers is important.

Geospatial Approach and Standards
In mapping the 'energy demand landscape' the application of geographic concepts, data and systems has been of critical importance. For example, the 'regional' focus (i.e. areas with shared characteristics) is critical, as are considerations such as topographic and thematic mapping. The Open Geospatial Consortium (OGC) standards (used in geographic information systems) present limitless data management and analytical potential if adopted.

Involving Domain-experts
The involvement of need-owners with a genuine need and interest in collaboration is key. Ongoing and regular engagement ensures that the tool is designed for both easy-to-use and for continued use. This requires training on setting up and (regionally) replicating the tool/database/methodology. This also involves helping end-users to disseminate results at different spatial scales (data dependent), so that different stakeholders can use the tool for different purposes. Domain expertise is required to both operate the tool and to interpret the energy results.

Public sector engagement.
Since the REDAP results are highly applicable to the government stakeholders, the industry/SME partners rely on engagement within reasonable timeframes. The project manager recommends that the public sector should progress the conversation beyond the demonstration phase and understand project exploitation/viability-matters.

Trial-Error Approach
The reality of R&D is that issues can arise and contingencies need to be put in place. As a result is it important to redeploy resources in order to complete the core work package commitments. This has been reflected in the four month project extension, during which time the online tool was reconfigured (for usability/optimisation reasons).

Commercialisation
A key lesson from this project is that it takes time to develop a demonstrable output system, especially since the work packages often progress at varying paces. It is only possible to understand what has been developed at an advanced stage and to, subsequently, devise an appropriate marketing strategy, vision or 'sales pitch'.

Research Matters
A key project management challenge is coordinating multiple work packages, roles and interests. Therefore, it is important to have access to relevant material (e.g. DESCA, protocols) which simplify the process. For example, the various 'Living Documents' could apply database (semantic) relationship principles, which will ensure that knowledge is easy to reference and search. The funders should also 'map' out the R&D engagement process.

Why understand energy demand?

Demand analysis makes sense on social, economic, environmental & governance levels..

De-risking Policy

Policy for housing, transport, industrial and regional development can be costly - meaning that objectives, supports and actions need to be carefully aligned, stress-tested and future-proofed. Understanding the drivers of demand helps ensure least-cost, least-friction decarbonisation.

Synergies & Efficiencies

Similar to fossil fuel exploration, there are big opportunities for local synergies and efficiencies at the local level. Includes recycling and distributing waste heat from industrial sources.

Climate Security & Action

Our warming planet presents a range of extreme,unpredictable climatic risks. Since this threatens our communities and our livelihoods, developing mitigation, adaptation and resilience strategies which understands the local context are of key importance.

Serving Public Needs

Energy insecurity, energy poverty and car dependency should never be considered 'normal'. With better information about local needs, governments can help ensure citizens have access to quality, sustainable, and affordable housing and transport services.

Grid System Pressure

Modern digital lifestyles places major demand on electricity grids. To help ensure essential needs can be supplied in a secure manner and that trade with the interconnected markets remains uninterrupted, off-grid capacity, (incl. battery- storage and renewable generation) within local regions is key.

Attractive Regions

Foreign direct investment and 'Green Finance' such as bonds and loans relies on a region's ability to demonstrate in a transparent manner its energy performance, targets and intended climate actions. This is especially relevant for signatories to the Global Covenant of Mayors convention.

Unlock Local Solutions

Local sustainability and inclusivity starts with government and regional representatives. Understanding energy demand enables meaningful engagement, and informed-procurement of products and services which help to 'green' local energy supply.

Monitor & Report

Local and national govts are obliged to monitor and report on emissions performance across regions and sectors. This M&R activity helps inform climate action towards meet energy targets and reducing costs of non-compliance.

Graphic: Dublin County

Conclusion & Next Steps

Digitalisation and Decarbonisation go together

Since the REDAP project began in 2019, European countries face greater insecurity than ever imagined possible.

For this reason, it is important that governments, industry and communities adopt a smarter, more agile problem-solving approach. This starts with understanding demand. It involves reconceptualising the energy challenge as a digital opportunity, so that we can achieve our decarbonisation objectives in a least-cost, least friction manner. In a practical sense, this is simply a matter of economics - supply and demand. If there is a market then it should be identified, analysed and met.

For Spatial Outlook Ltd, the REDAP approach is based on experience in the highly-scrutinised oil and gas industry, wherein every decision is made over quality information. The logic behind REDAP, therefore, is that this proven, efficient process can be 'turned on its head' for decarbonisation purposes.

The REDAP approach demonstrates that yesterday's approach to understanding demand does not work. Today, decision-makers need to apply business intelligence techniques in order to derive standardised and consistent data. This involves a range of technologies (including open source tools and online frameworks). It also involves repurposing and integrating data from a wide range of sources - so that both the demand, the context and the drivers of the demand can be understood.

In terms of feedback to ERA-Net, I believe that the research ecosystem should balance well-modularised work packages with high-quality, focussed engagements organised through the Knowledge Community. There should also be greater transparency around the national IP protocol and knowledge transfer arrangements. Application processing timeframes should be clarified and guidance around budgetary matters would be helpful. In addition, the meaningful commercial exploitation supports should be considered, especially since a proof-of-concept is often only finalised at later project stages.

In conclusion, the energy challenge is not a technological one. It is an organisational challenge which comes down to resources, skills and commitment. In terms of research, it requires an understanding of which domain knowledge can be applied and which collaborations should be developed.

Since replicability has now been demonstrated, the project manager recommends that building stock modelling in particular be revisited post-project and completed at the national level. Projects like REDAP could have a real-world impact if implemented correctly and could serve multiple business-cases. It could help decision-makers to understand opportunities for synergies and efficiencies which may otherwise be overlooked, it could help standardise demand policy-making across Europe and it could form the basis of tomorrow's green knowledge economy. In other words, this is the type of research that should be advanced.

On behalf of the partners, thank you for supporting this project. The R&D stages have been challenging at times, (especially considering the lack of face-to-face) however, we hope that our results will be of value. If the funding agencies wish to build on the outcomes REDAP in a real-world setting, then I am currently available to discuss.

Niall Conway,
REDAP Project Manager & Owner

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REDAP
energy demand. understood.

Spatial Outlook Ltd. - *Digitalisation and Energy Planning Consulting Services*

Urban & Regional Planning (MSc), Software Development (HDip), Technology Commercialisation (Dip), Sustainable Development (MA), Geography & Sociology (BA), Community Development (Certificate), Professional Training (QQI Level 8)

RESUME

Niall Conway
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Dublin, Ireland

COMPETENCIES, ATTRIBUTES, INTERESTS

- Domain knowledge of planning, energy and sustainability subjects from public and private sector perspectives incl. monitoring and reporting requirements.
- Transitioned from a knowledge professional to a digitalisation specialist within data-driven workplaces.
- Deep understanding of the use cases, application and potential of geographic information for plan/policy-making.
- Proven ability to work effectively with teams and colleagues in-person, remotely, and on a hybrid basis.
- High-quality editing and content development in media field: collaborated with a range of industry thought leaders.
- Presented to industry and govt stakeholders on energy plan/policy-making matters (ESBN, SEAI, etc).
- Experience managing multi-partner, EU R&D projects, incl. dealing with funding raising, intellectual property, technology readiness levels, and consortia matters.
- <u>Key interests:</u> ESG data and applications for effective stakeholder engagement. Organisational learning and digital skills development (i.e. enable efficiencies/impact)
- <u>Key offering:</u> to help colleagues realise the exciting possibilities of digitalisation for enhanced, flexible workflows and service delivery. I can also help develop organisation capabilities on an ongoing, incremental basis.
- <u>Key focus in future roles:</u> to advance my soft skills in team/relationship building, leadership and communication.

EDUCATION

BA, Geography/Sociology 2.1 (UCC) 2003
MA, Sustainable Development 2.1 (UCC) 2004
- Dissertation Topic: Analysis of Urban Regeneration Programme Implementation in Bantry, Co. Cork
Certificate, Community Development (UCC) 2006
MSc, Urban & Regional Planning (Major in GIS) - 2.1 (Heriot-Watt, Edinburgh) 2009
- Analysis of Scottish Flood Mapping Process and Effectiveness
FETAC Level 6, Training Needs Assessment, Design, Delivery & Evaluation (CMIT) - Distinction - 2019
HDip Science in Computing: Software Development -2.1 (National College of Ireland) - 2020
- Final Project: Data-driven system for Regional Energy Profiling: Supporting Energy Transition Leaders
Technology Commercialisation (Diploma) (awaiting results) - 2022, NUI Galway
- Dissertation Topic: The Process of Data Commoditisation and selling to the Public Sector

EXPERIENCE

Cork County Council - Planning Dept - Appeals & Correspondence Drafting Sections - ('05/'06) Cork
Cuthbert Environmental and Pollution Services, Cork - Assistant Environmental Planner Jun - Oct '08
Curtin University of Technology, Perth, Australia - School of Design and the Built Environment ('09 -'17) - Sessional/Casual Academic (by correspondence) - On Campus/Remote from Brisbane, Australia and Cork
Unidel (now Amec Australia) - multidisciplinary energy/utilities consultancy. Brisbane, Australia - ('09 -'12)
 - Incl. Secondment: **Origin Energy APLNG project** - GIS for Upstream CSG Infrastructure Electrification Project
Santos GLNG project - GIS for upstream/processing infrastructure - Brisbane, Australia - (Nov '12 - Nov 13)
Saipem - Spatial Data Specialist, GLNG Pipeline data validation. Gladstone, Australia - 2 months ('14)
Logan City Council, Planning/GIS - Strategic Planning Dept (Contract) - Contributed to a Projection Modelling Project for the Strategic Planning Dept. Brisbane, Australia - (4 months '14)
GIS Professional (Geomares Media), Editor - leading GIS industry publication (UK based) - supported by UK's Association for Geographic Information (AGI). By correspondence from Cork, Ireland (Jan '17 - Oct '18)
Irish Organisation for Geographic Information (IRLOGI), Excom Member Jan '18 - present
Various - entrepreneurial endeavours, technical skills development/projects and EU application process (2016 - 2018)
Spatial Outlook Ltd. (self-employed) lead applicant, manager, owner of Regional Energy Demand Analysis Portal (REDAP.eu) (Sep 19 - Jun 22). This ERA-Net SES co-funded research project (€1.2m) was supported by SEAI, Swedish Energy Agency, Austrian Innovation Fund. Consortium partners: Austrian Institute of Technology, Chalmers University of Technology (SWE), Codema, Dublin's Energy Agency. Project focus: analysing building stock/transport energy demand.

TECHNICAL SKILLS
Database Design (Postgres, MySQL), APIs, Git, Tableau, Geographic Information Systems (QGIS, ArcGIS), Adobe CC Suite (full), Blender 3D, Modelling/Automation Tools, coding languages (various levels): HTML/CSS, Javascript, Python.