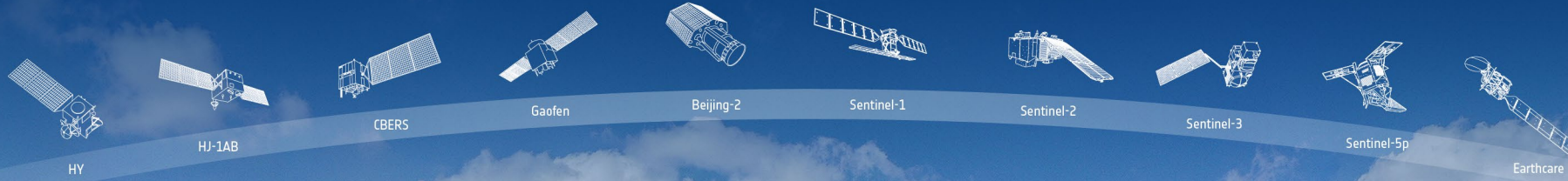




中国科学技术交流中心
China Science and Technology Exchange Center



→ THE EUROPEAN SPACE AGENCY



2025 DRAGON 6 SYMPOSIUM

14-18 JULY 2025

[PROJECT ID. 95400]

[Assessing Effect of Greenhouse Gases Emission Reduction with Variable
Renewable

Energy Implementation in Marine Climate Islands]





< Wednesday, 16/July/2025 IN ATMOSPHERE >

ID. 95400

PROJECT TITLE: Assessing Effect of Greenhouse Gases Emission Reduction with Variable Renewable Energy Implementation in Marine Climate Islands

PRINCIPAL INVESTIGATORS: [PROF. MING JUN HUANG, ULSTER UNIVERSITY, UK & PROF. XINGYING ZHANG, NATIONAL SATELLITE METEOROLOGICAL CENTRE, CHINA METEOROLOGICAL ADMINISTRATION]

CO-AUTHORS: [NEIL J. HEWITT, YAXIN BI, LU ZHANG]

PRESENTED BY: [PROF MING JUN HUANG]



- Inform on the project's objectives
- Detail the Copernicus Sentinels, ESA, Chinese and ESA Third Party Mission data utilised to achieve the project's objectives (complete slide 4)
- Detail the in-situ data measurements and requirements
- Provide details on field data collection campaigns and periods in P.R. China or other study areas
- Inform on the project's schedule, planning & contribution of the partners for the following year
- Report on the level and training of young scientists on the project achievements, including academic exchanges
- Brief overview on the European and Chinese young scientist's research (presented by the YSs, if attending the symposium)



The Climate Change Act (Northern Ireland) 2022 (Act) sets a target of an at least 100% reduction in net zero greenhouse gas (GHG) emissions by 2050 (i.e., net zero emissions by 2050).

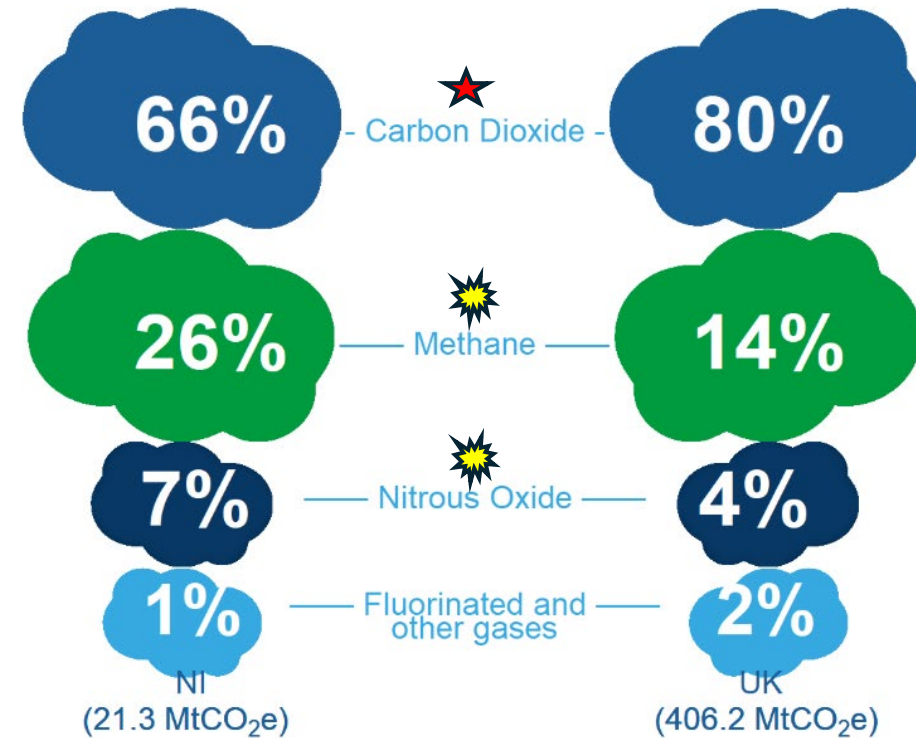
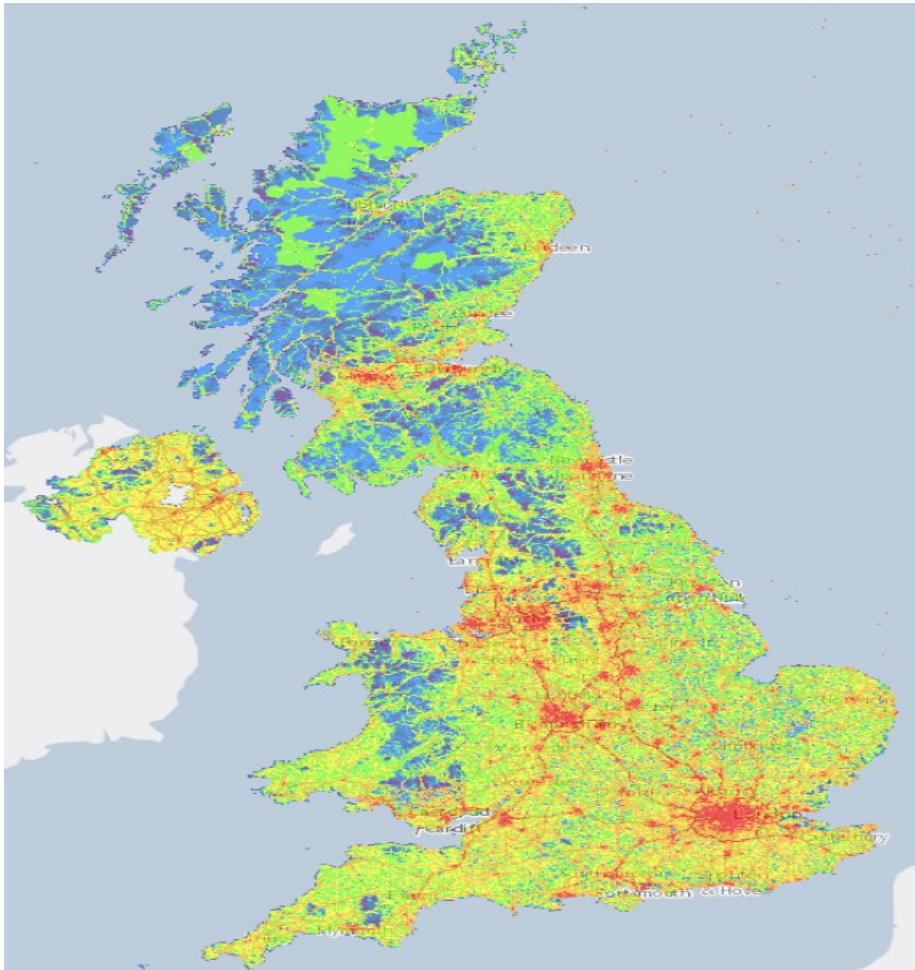
To apply Earth observation and artificial intelligence technology to retrieve CO₂ & CH₄ emissions in marine climate regions and to assess the effect of implementing REs as an energy supply, leading to CO₂ & CH₄ emission reduction.



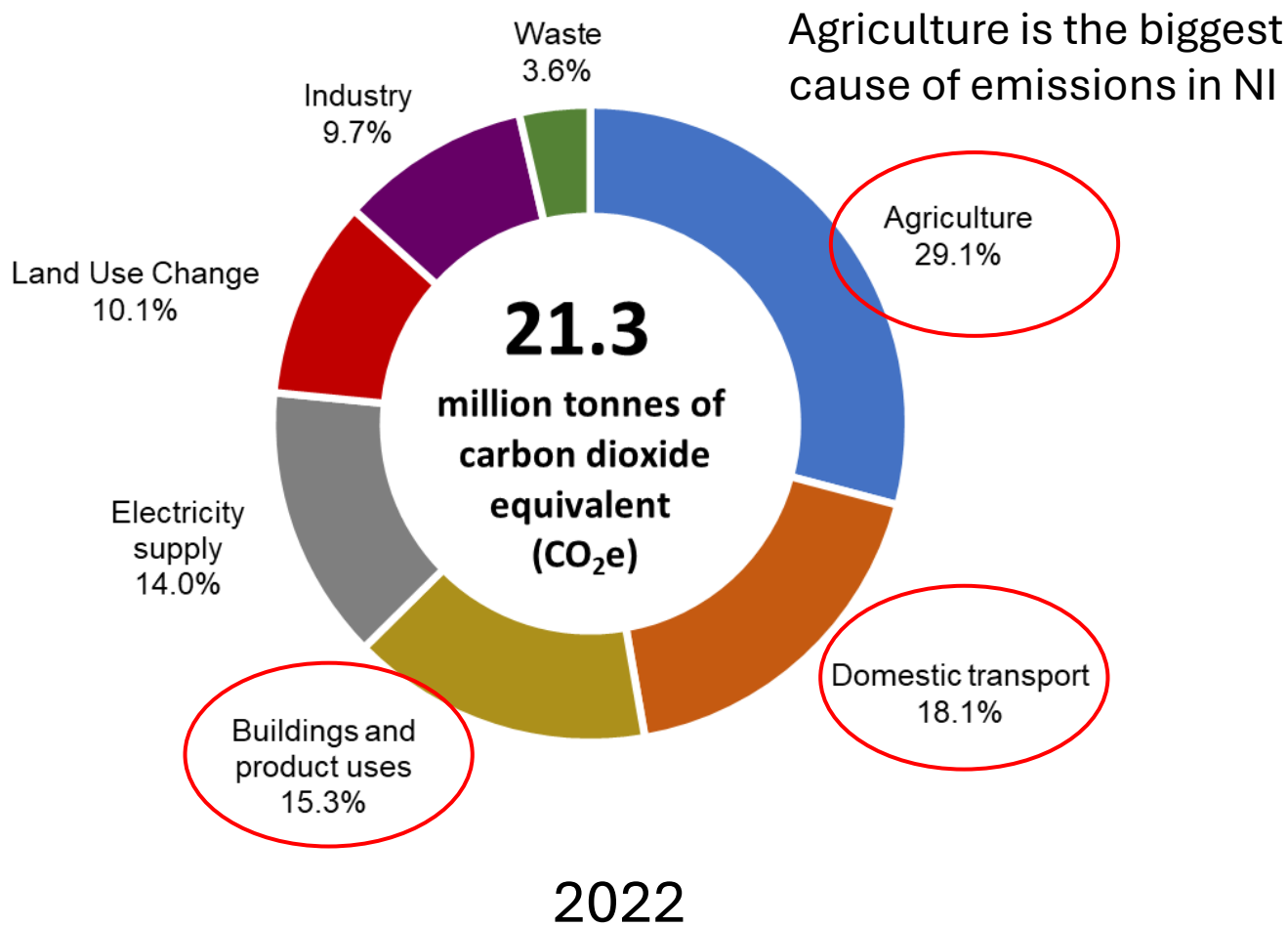
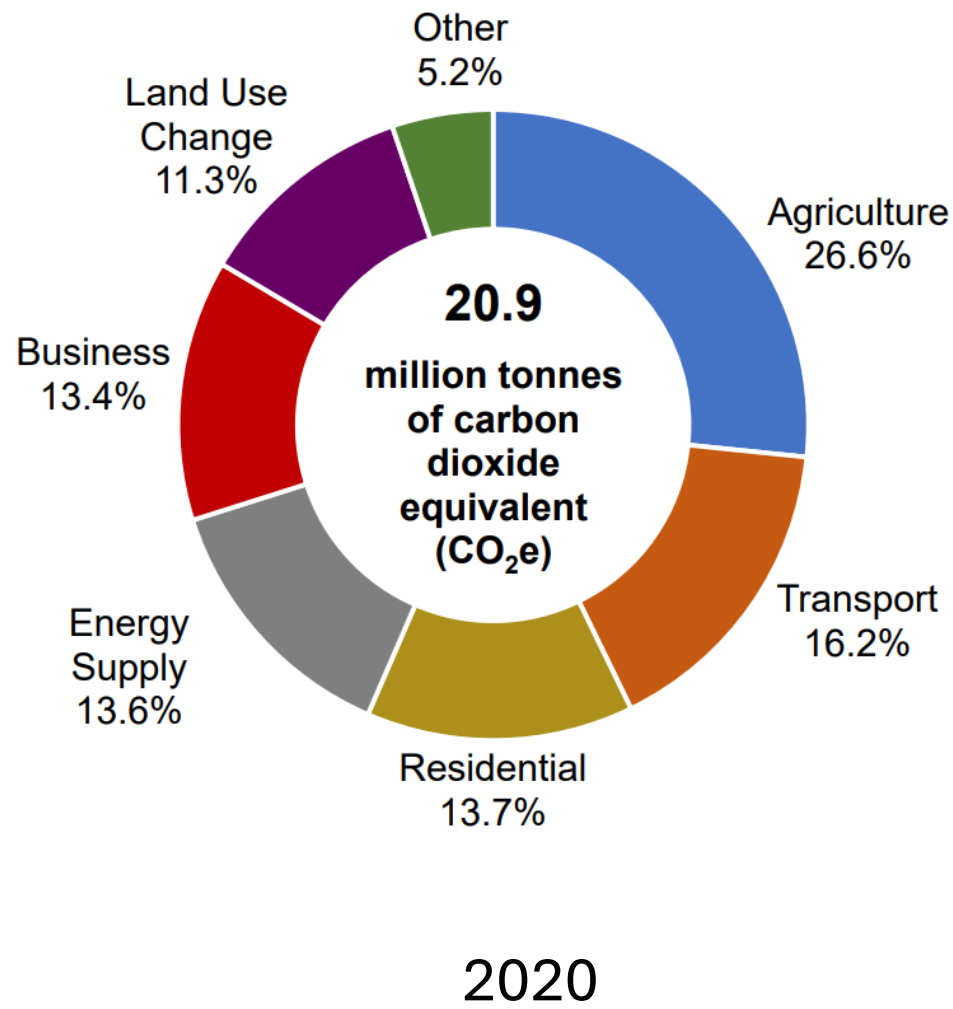
- Develop fusion algorithms for combining measurements from different satellites on required trend and temporal scales for the regions.
- Develop retrieve algorithms of CO_2 & CH_4 from satellite and combined measurements with In-situ.
- Validate and apply GHG products of satellites to estimate CO_2 & CH_4 concentration and distribution.
- Investigate the energy demanding, the greenhouse emission and installation of RE in the region of Ireland, UK and China.
- Study the effect of implementing the REs for the power generation with wind, solar and ocean sink to reduce greenhouse gas emission.
- Provide policy makers with the evidence of CO_2 & CH_4 reduction over regions that have integrated REs as energy suppliers.



Difference around GHG emissions between N.Ireland and UK in 2022



Greenhouse gas emissions by sector in Northern Ireland, 2020/ 2022





For the agriculture sector, CO₂e (29%), and rising 15% since 1990.

Whilst consolidated as CO₂ equivalent (CO₂e), agricultural emission types are:

- ❖ 70% Methane CH₄ (livestock);
- ❖ 19% Nitrous Oxide N₂O (soil); and
- ❖ 11% Carbon Dioxide CO₂ (machinery/combustion) (DAERA, 2024)

Distribution of CO₂ and CH₄ in N.I

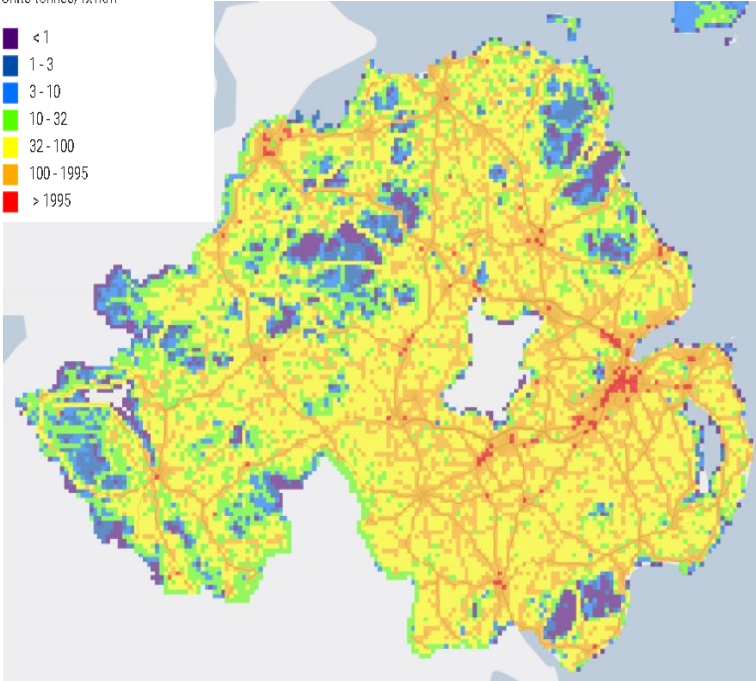
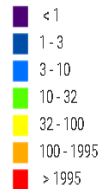


Distribution of CO₂ and CH₄ along with versus renewable technologies across Northern Ireland

Legend

Carbon Dioxide as Carbon

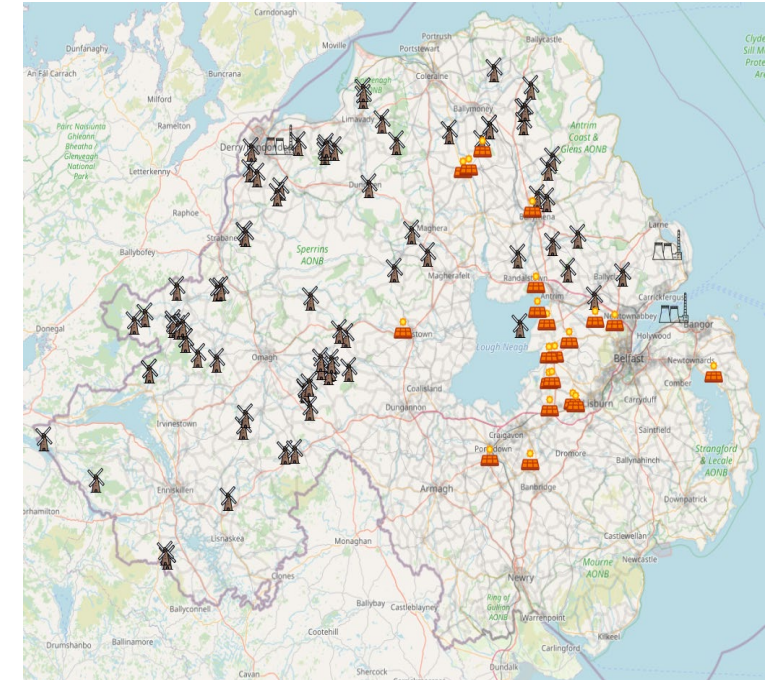
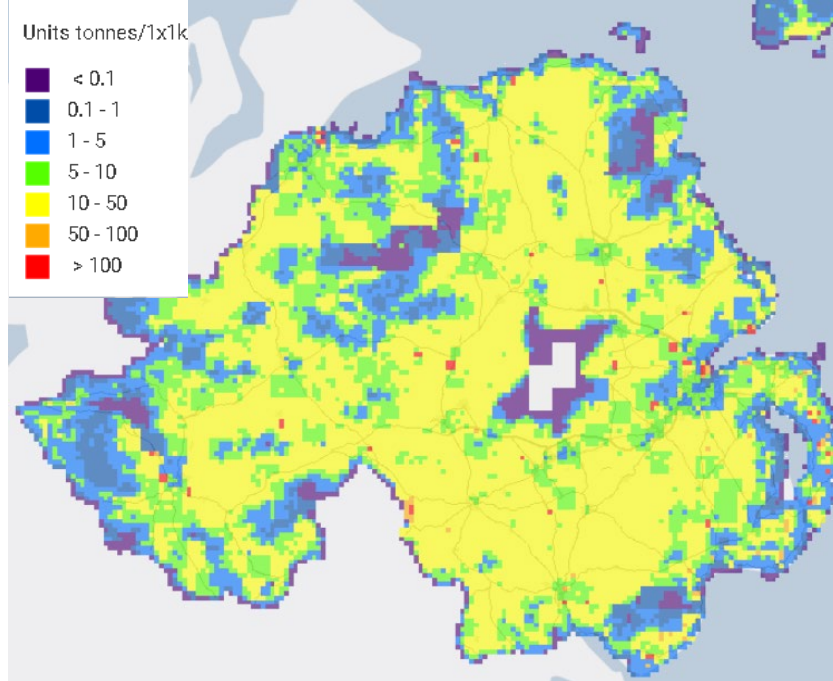
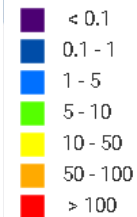
Units tonnes/1x1km



Legend

Methane

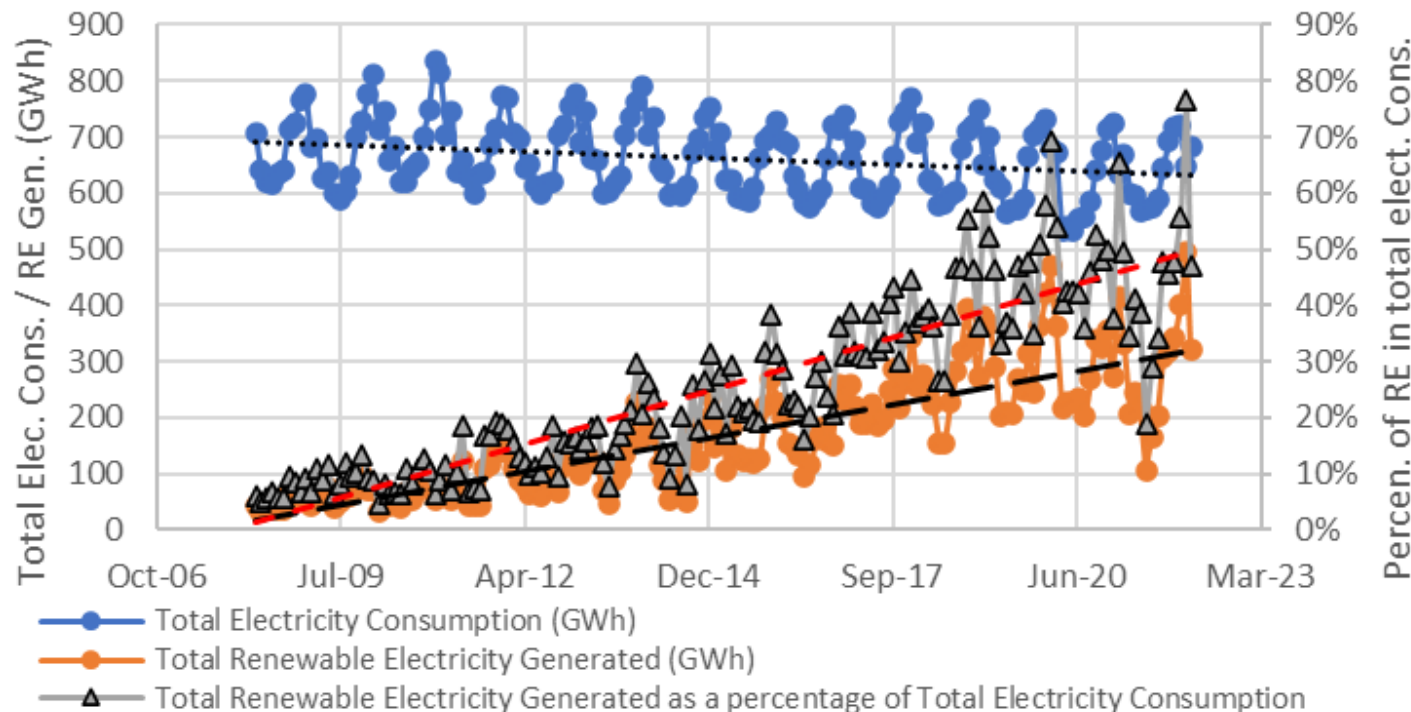
Units tonnes/1x1km



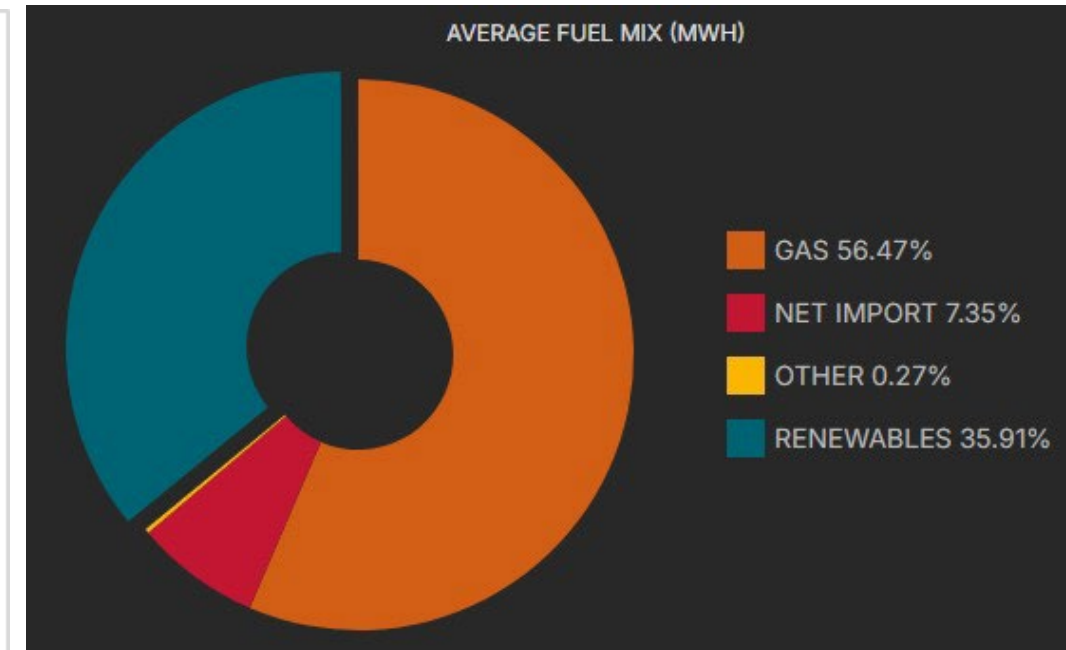


Northern Ireland Fuel mix for October 2024 (SONI System Generation Smart Dashboard, 2024)

N.Ireland Total Electricity consumption and RE Generation



AVERAGE FUEL MIX (MWh)



For the period of July 2023 to June 2024 wind accounted for **82.3%** of total renewable electricity generation.



WP1: Monitoring RE installation and availabilities in the selected regions

- The marine climate island of Ireland, UK and extending the region in China.

WP2: Monitoring GHG emission using Satellites and In-situ with proper algorithm

- Three tasks of obtaining satellite measurements from data sources, retrieving atmospheric CO₂ & CH₄ from satellite data and validating satellite CO₂ & CH₄ products.

WP3: Analysis the impact factors of GHGs emission along with the Renewable energy implementation

- Apply deep learning methods to develop long term and short term power load model, which will be used to forecast monthly ahead, day ahead and even hour.

WP4: Data analysis for using REs towards Net-Zero Carbon emission

- Artificial intelligent technologies for assisting the big data analysis and prediction.

WP5: Young scientist exchange between UK and China.

Dragon 6 Batch-3 EO Data Request



Data access (list all missions and issues if any). NB. in the tables please insert cumulative figures for no. of scenes of high bit rate data (e.g. S1 100 scenes). If data delivery is low bit rate by ftp, insert “ftp”

ESA /Copernicus Missions	No. Scenes	ESA Third Party Missions	No. Scenes	Chinese EO data	No. Scenes
1. GOSAT, OCO2, OCO3		1. Sentinel-5P; Tropomi L1B, L2		1. TanSat	
2.		2. Sentinel-4 (O3, NO2, SO2, HCHO)		2. DQ-1; DQ-2	
3.		3. Sentinel-5-P UV-VIS-NIR-SWIR L1B, L2		3.	
4.		4.MODIS		4.	
5.		5.Landsat 8/9		5.	
6.		6.		6.	
Total:		Total:		Total:	
Issues:		Issues:		Issues:	



Several satellites were designed for atmospheric CO₂ measurements:

Tansat (Chinese Carbon Dioxide Observation Satellite Mission (Dec 2016); OCO-3 (May 2019); forthcoming DQ-2.

LiDAR system has been comprehensively evaluated by comparing TCCON within 1° of latitude/longitude from each TCCON site and within a one-hour observation window.

For SNO, comparisons were made with OCO-3.

An active-passive collaboration technology has been developed by Chinese partner.

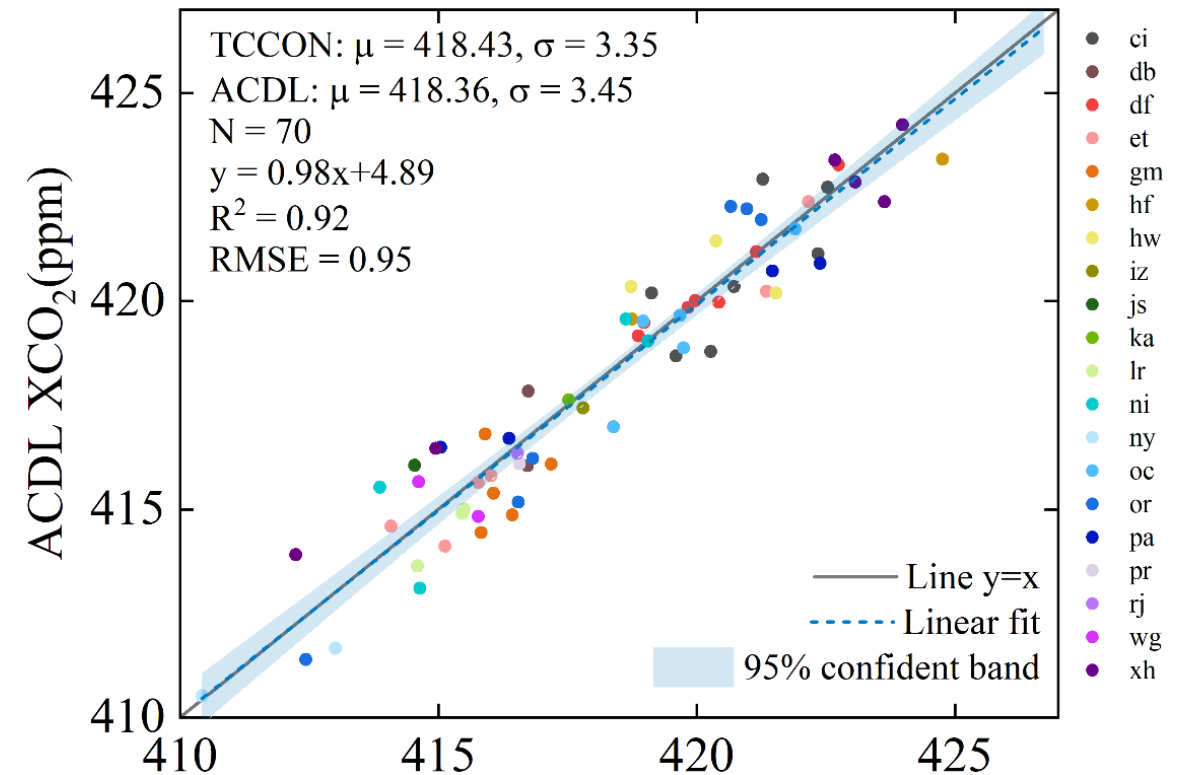
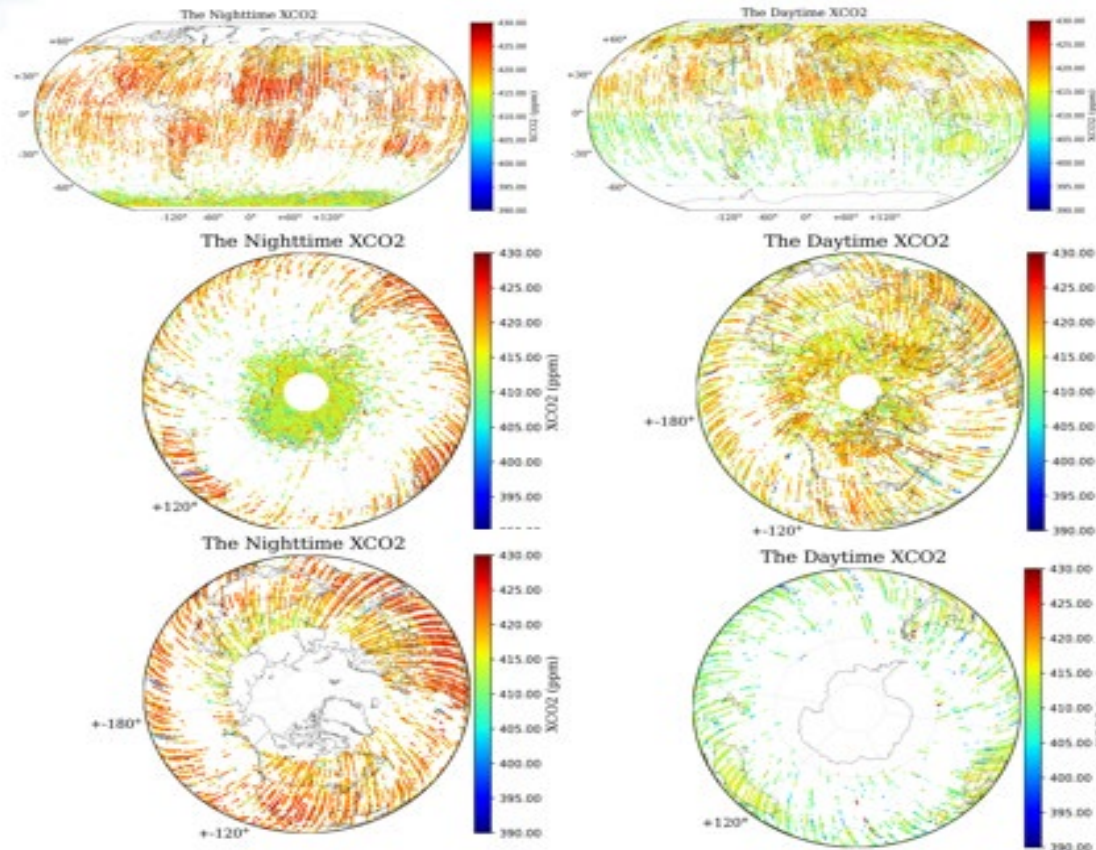
AEMS (Atmospheric Environmental Monitoring Satellite), can provide more accurate CO₂ sources and sinks.

Chinese partner has developed ACDL system for measuring the XCO₂ accurately.

Chinese partner contributions



- The AEMS (DQ-1) can measure XCO₂ at the poles and during day and night.
- Compared with TCCON, the RMSE is 0.95.



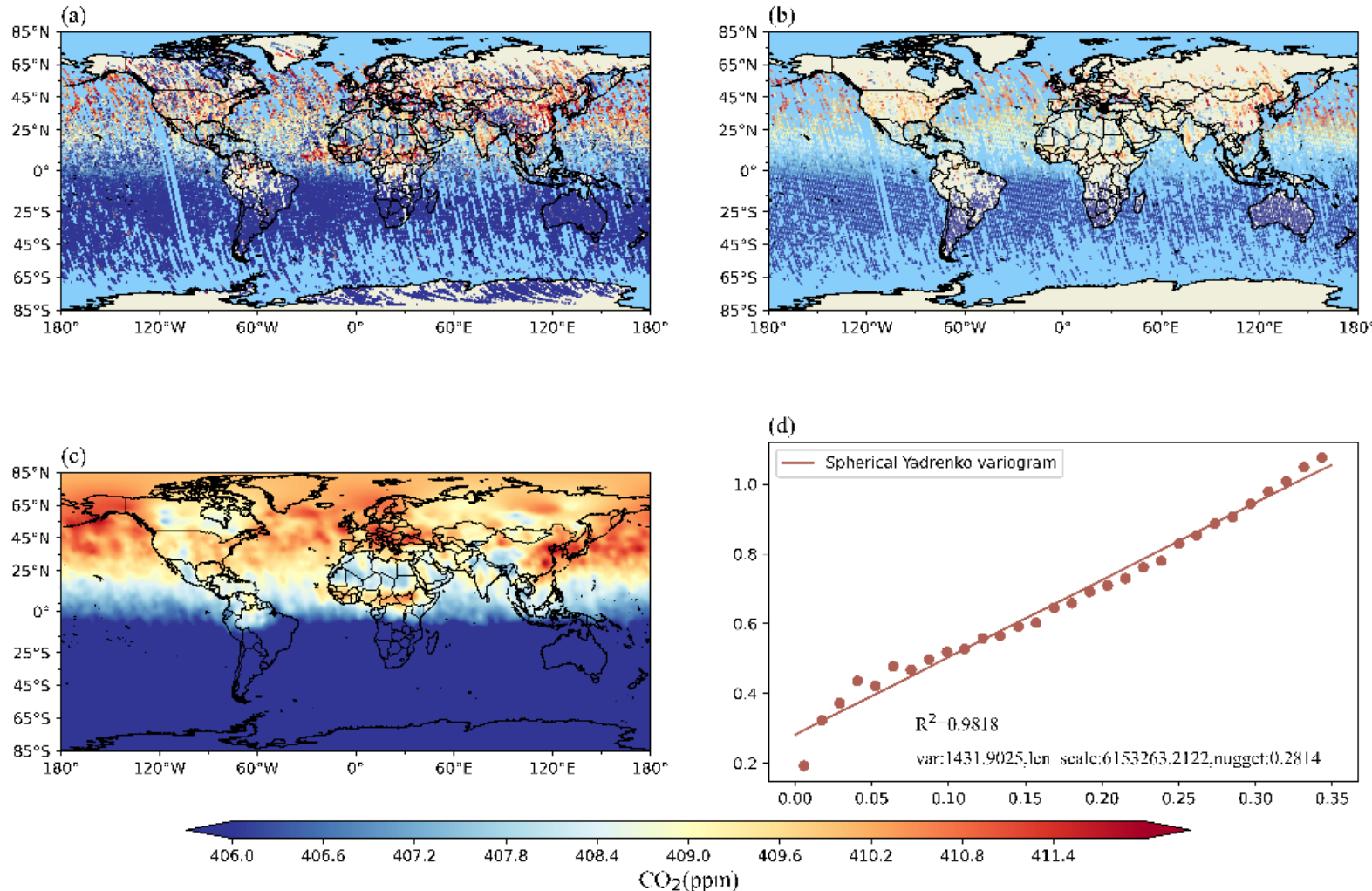
Cao X, Zhang X, Zhang L, et al. Averaging Scheme for the Aerosol and Carbon Detection LiDAR Onboard DaQi-1 Satellite [J]. IEEE Transactions on Geoscience and Remote Sensing, 2024, 62

L. Zhang et al., Does the Satellite Sensing Column-Averaged Dry-Air Mole Fraction CO₂ (XCO₂) Require Oxygen Concentration From O₂-A Band for Normalizing?[J] IEEE Transactions on Geoscience and Remote Sensing, 2025,6

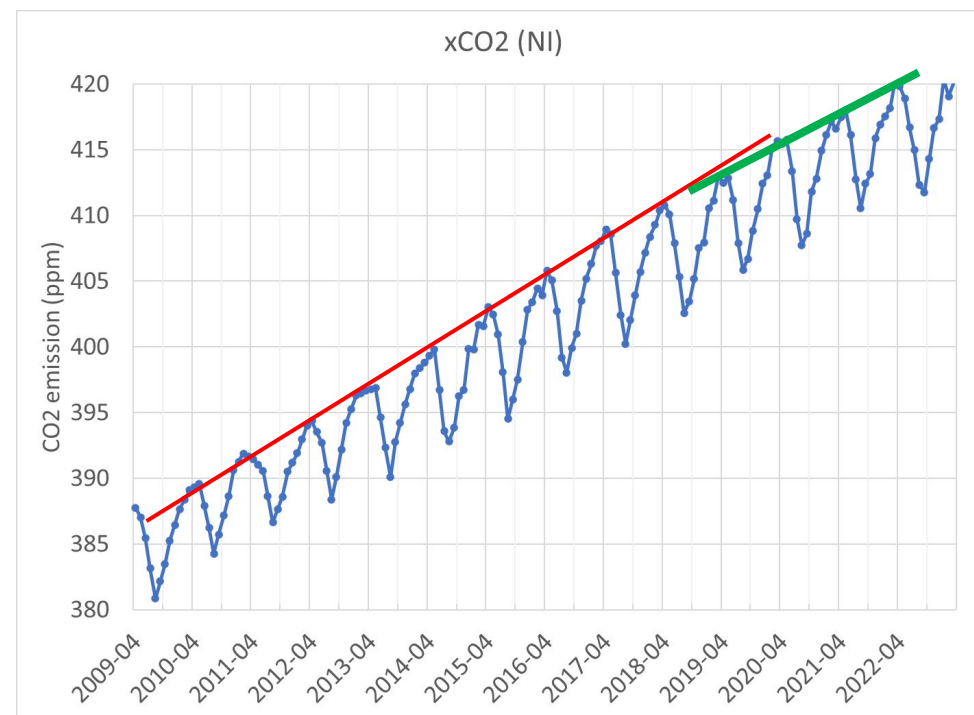
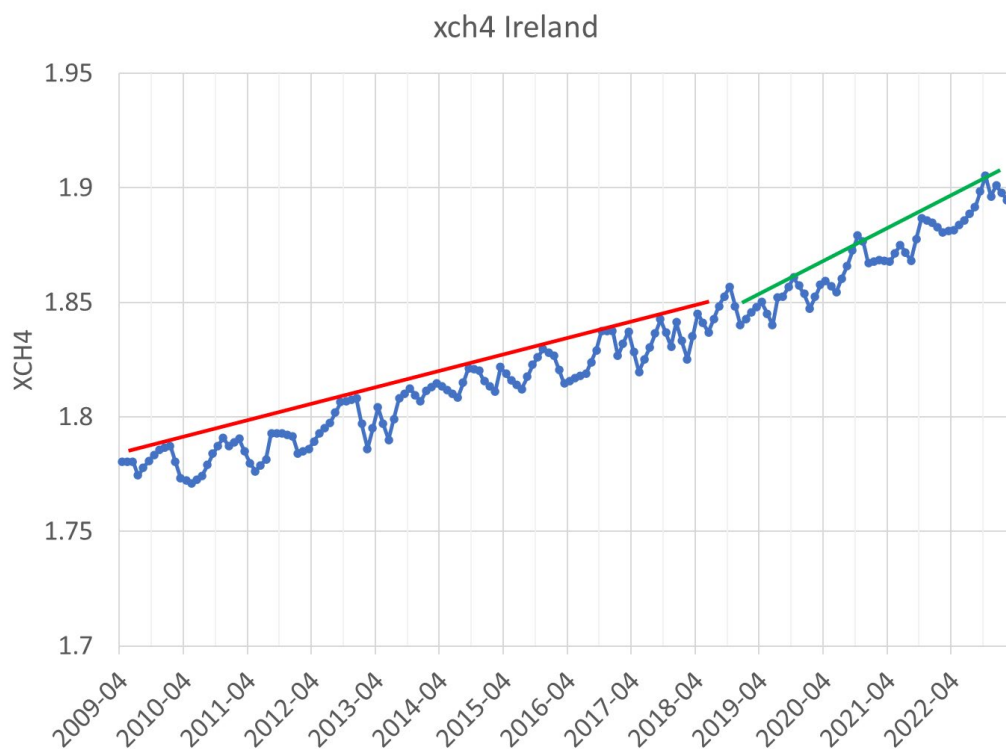
Chinese partner contributions



- Through the integration of multisource data(GOSAT,GOSAT-2,OCO-2,OCO-3,TROPOMI, Tansat and GF5B), we established a global monthly mean XCO₂ and XCH₄ dataset.



Satellite monitoring CH₄ and CO₂ emissions through the year from 2009 to 2022 in Ireland





Investigate the energy demanding, the greenhouse emission and installation of RE in the region



Develop retrieve algorithms of CO₂ & CH₄ from satellite and combined measurements with In-situ.



Training ML model to predict the current energy demand of region



Training ML model to predict GHG emission with different RE systems



Validate and apply GHG products of satellites to estimate CO₂ & CH₄

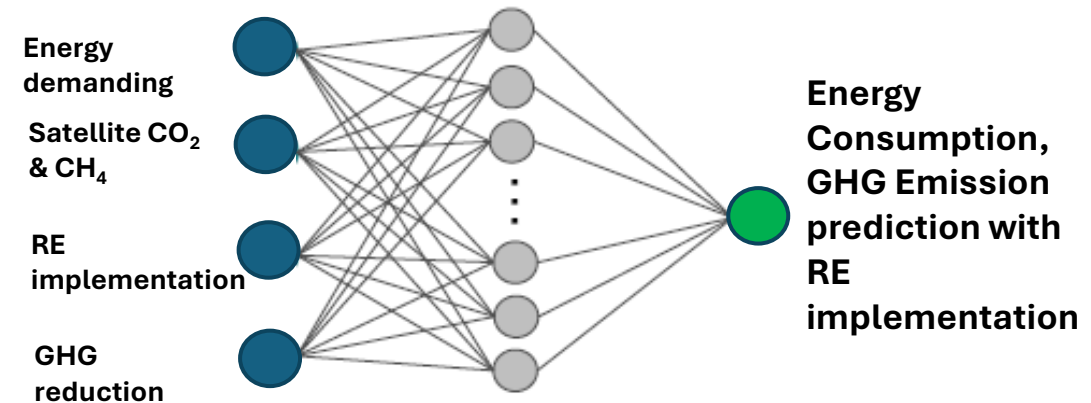


Simulate the concentration and distribution of GHG



GIS based analysis and creating energy maps for decision making and prediction scenario

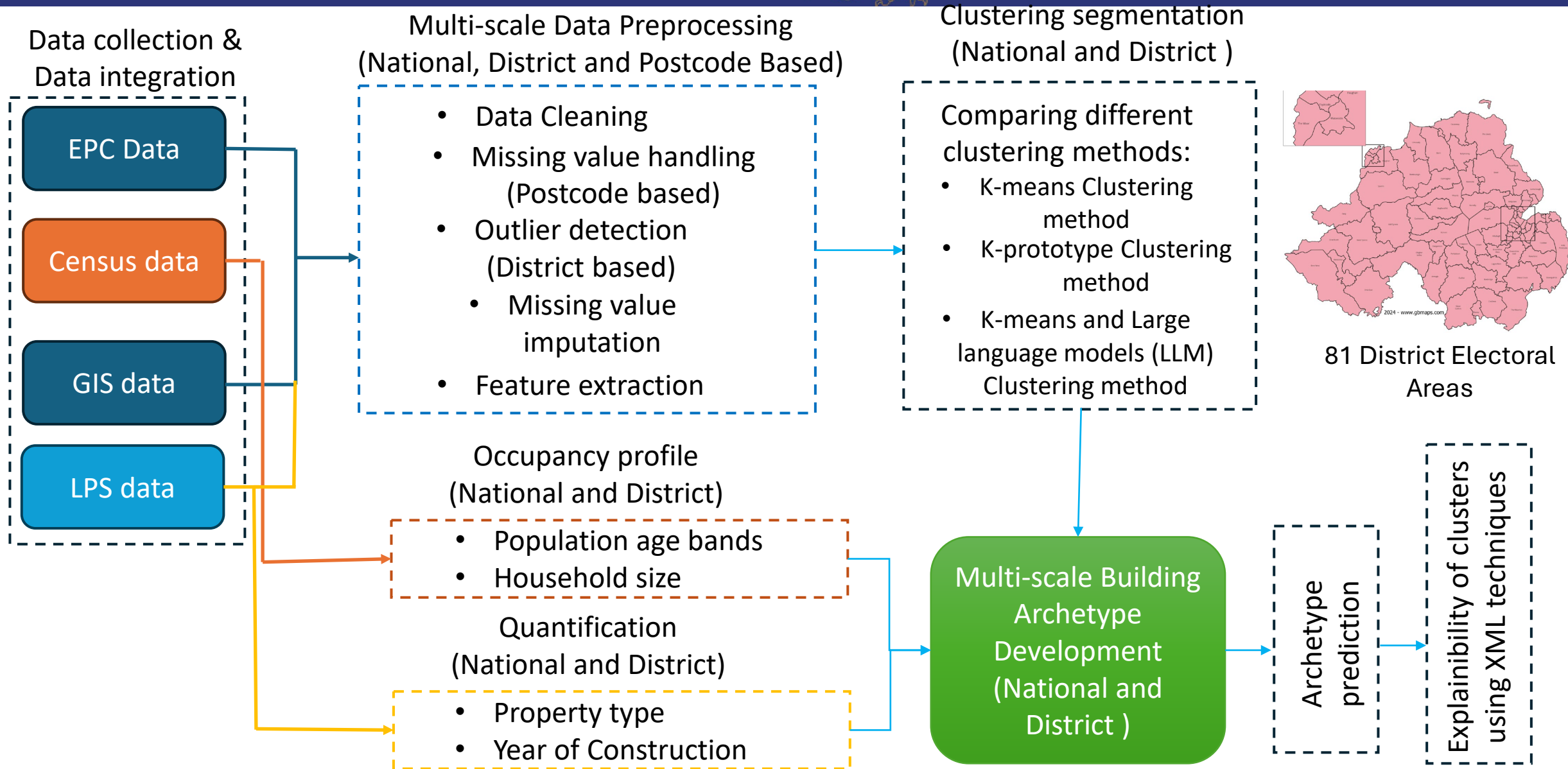
Physics-based energy simulation for developed archetypes, decarbonization assessment, and ML Prediction model development



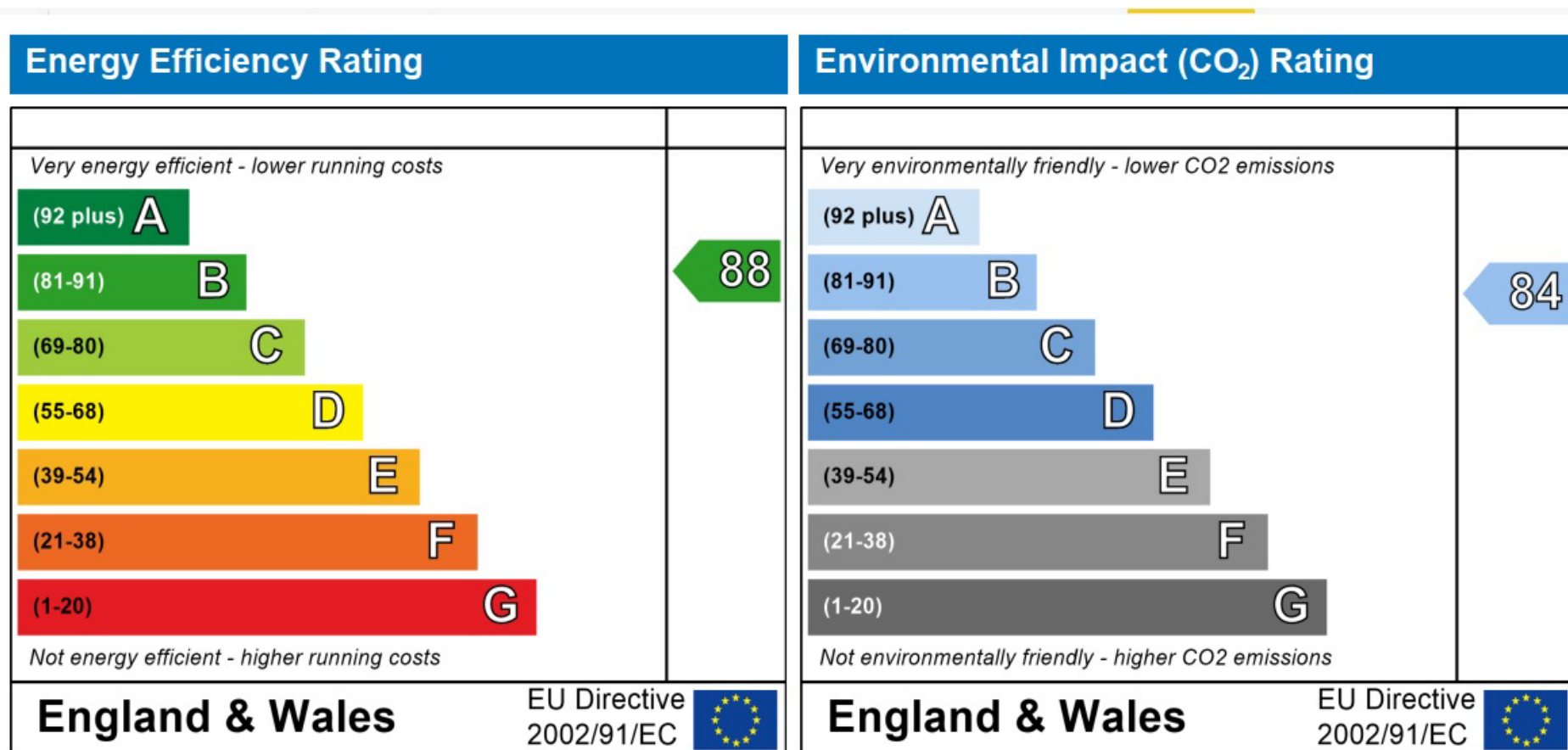


- Understanding the distribution and characteristics of the residential building stock is essential for informing housing policy, urban regeneration, and sustainable planning.
- Studying building, data-driven analysis of residential building typologies and development patterns.
- This study aims to perform a GIS-based buildings across Northern Ireland, focusing on the spatial distribution of property types, construction age bands, property sizes, energy efficiency levels, central heating fuel types, and demographic patterns.
- AI / ML technologies to provide suggestions

Building Archetype Development



Energy efficiency rating and environmental impact rating



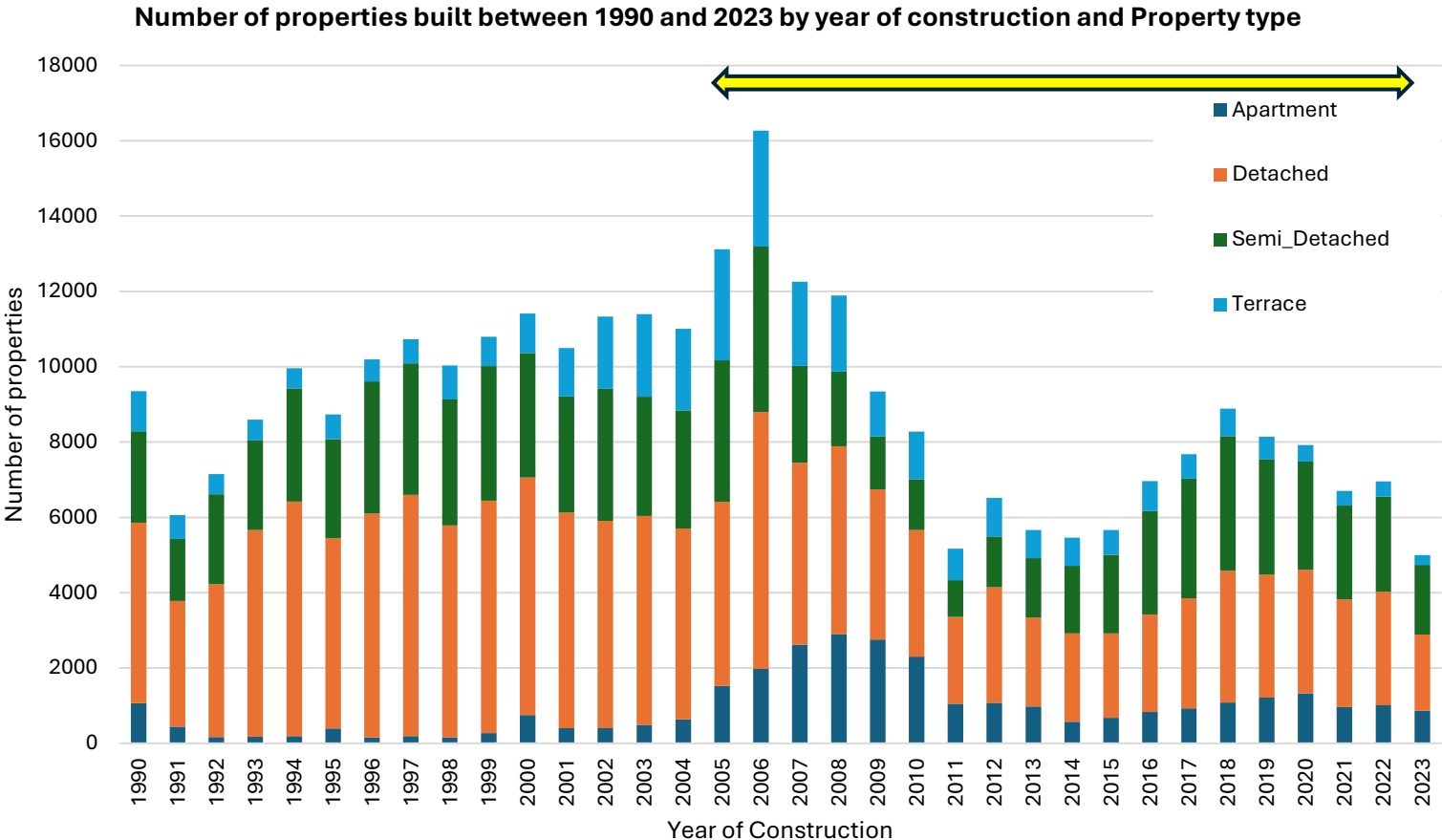
Energy Efficiency Rating (EER). This is an energy cost rating - an indicator of the comparative cost to heat and light the home relative to other homes of the same floor area.

An Environmental Impact Rating (EIR) is also provided on the certificate as a secondary rating based on a calculation of carbon emissions associated with energy use in the home.

Buildings built from 1990 - 2023



In average, 7674 dwellings were constructed per year between 2005 and 2023

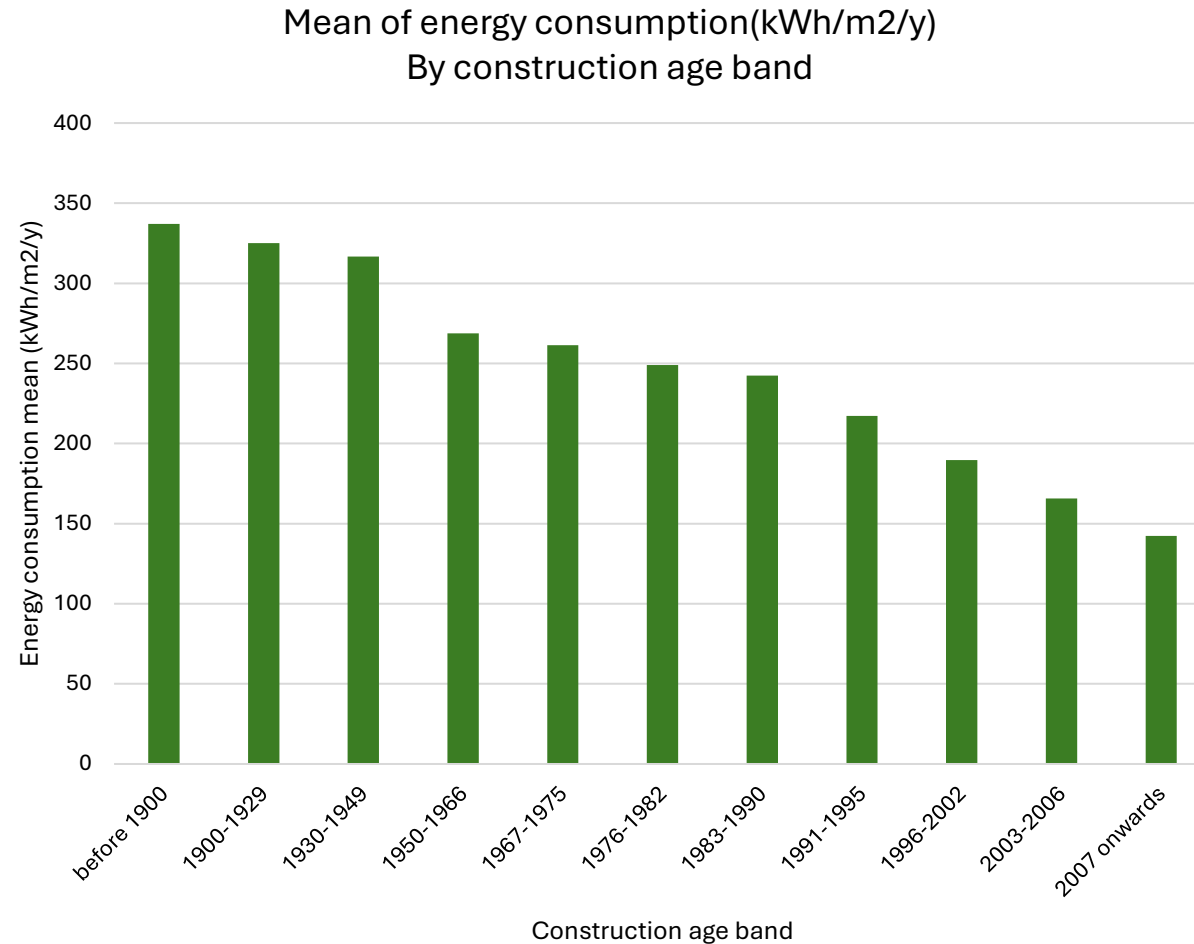


Year	Total New Dwelling Starts	Total New Dwelling Completions
2005	15,331	13,222
2006	15,226	14,098
2007	13,749	11,680
2008	7,495	9,810
2009	7,616	8,172
2010	8,228	6,715
2011	6,668	5,746
2012	5,181	5,536
2013	5,054	5,410
2014	5,746	5,519
2015	6,875	5,446
2016	7,457	6,449
2017	7,444	6,882
2018	8,624	7,642
2019	7,276	7,422
2020	6,046	6,416
2021	7,513	7,416
2022	6,596	6,838
2023	5,779	5,379
Sum	153,904	145,798

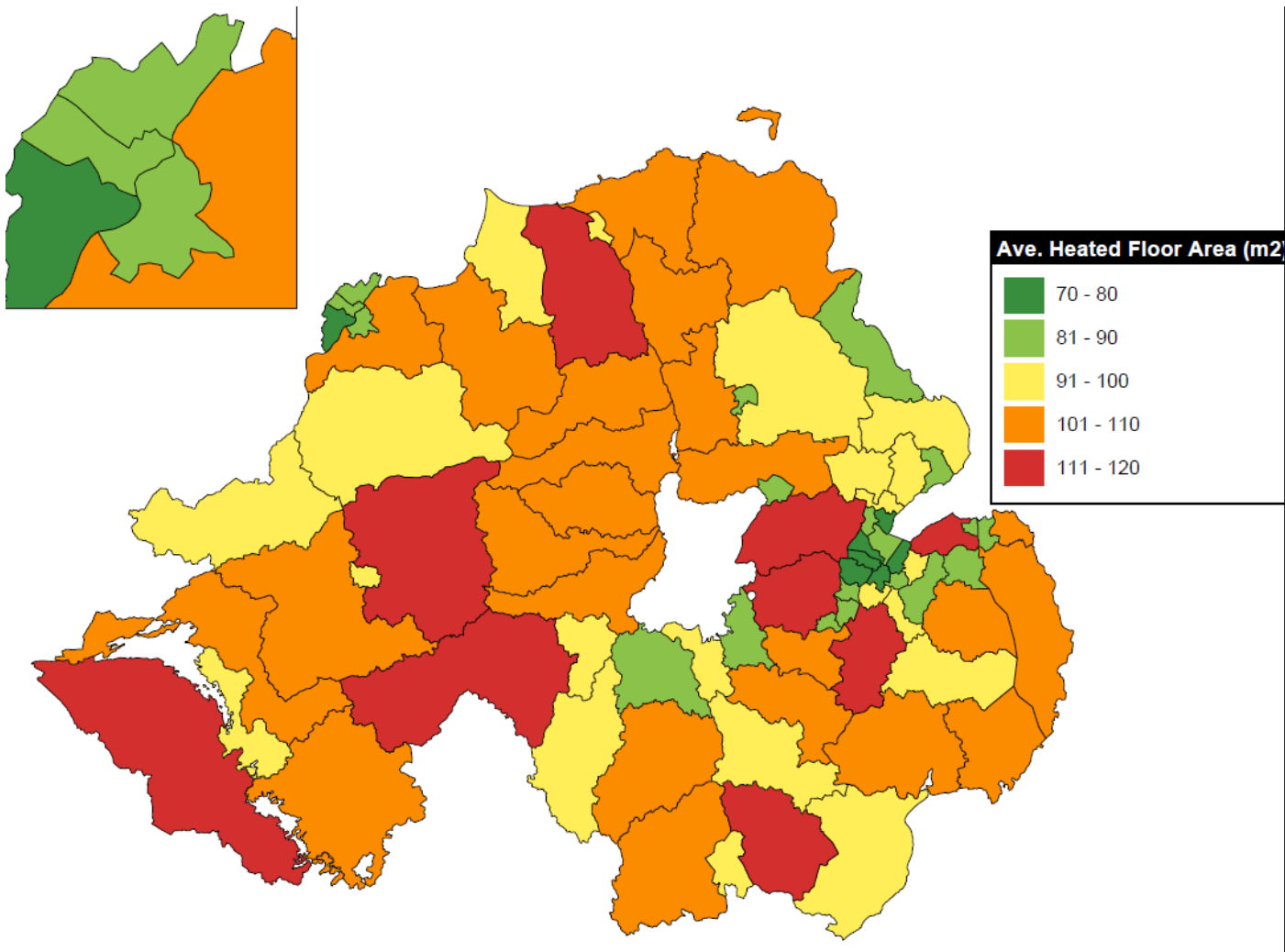
Energy Consumption from Buildings



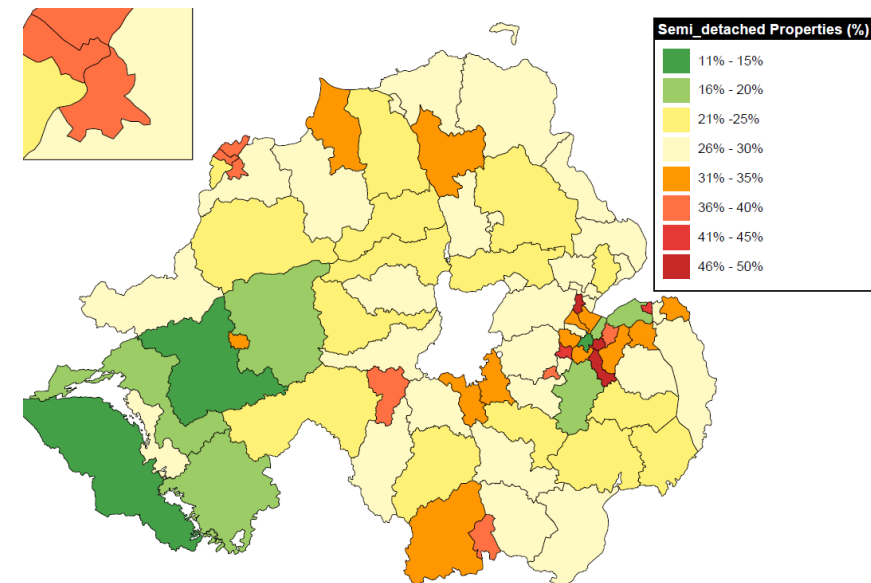
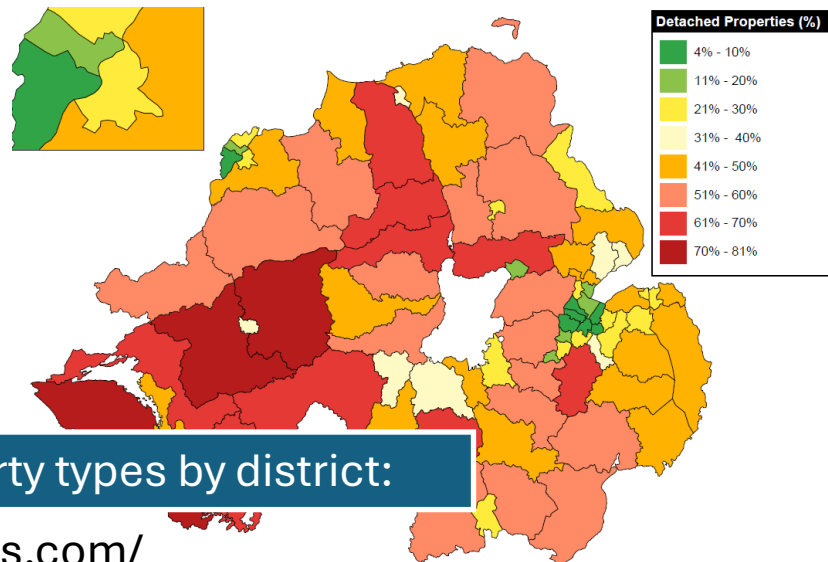
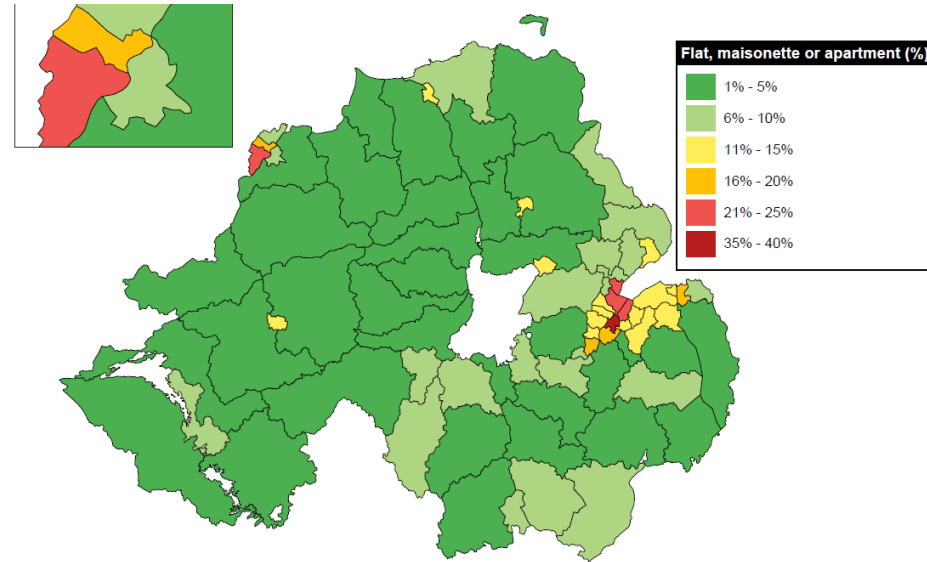
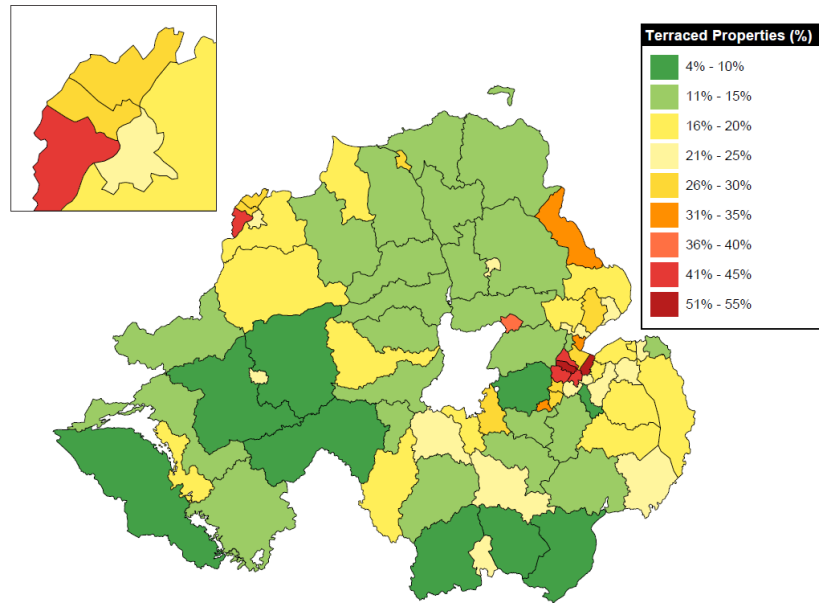
After outlier detection	
CONSTRUCTION_AGE_BAND ND	Mean of energy consumption (kWh/m2/y)
before 1900	337
1900-1929	325
1930-1949	317
1950-1966	269
1967-1975	261
1976-1982	249
1983-1990	242
1991-1995	217
1996-2002	190
2003-2006	166
2007 onwards	142



Verified total floor area



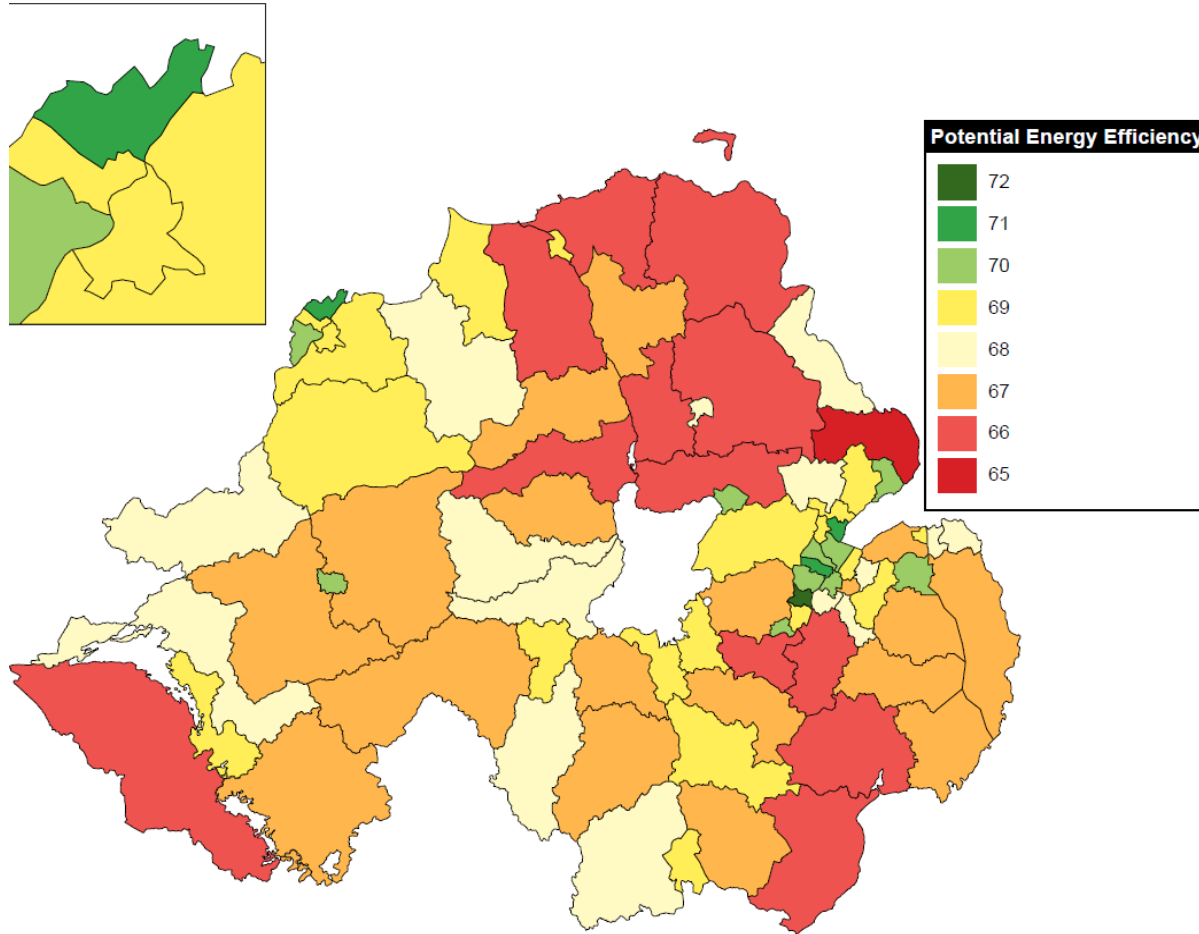
Distribution of property types by district (Census data)



Distribution of property types by district:

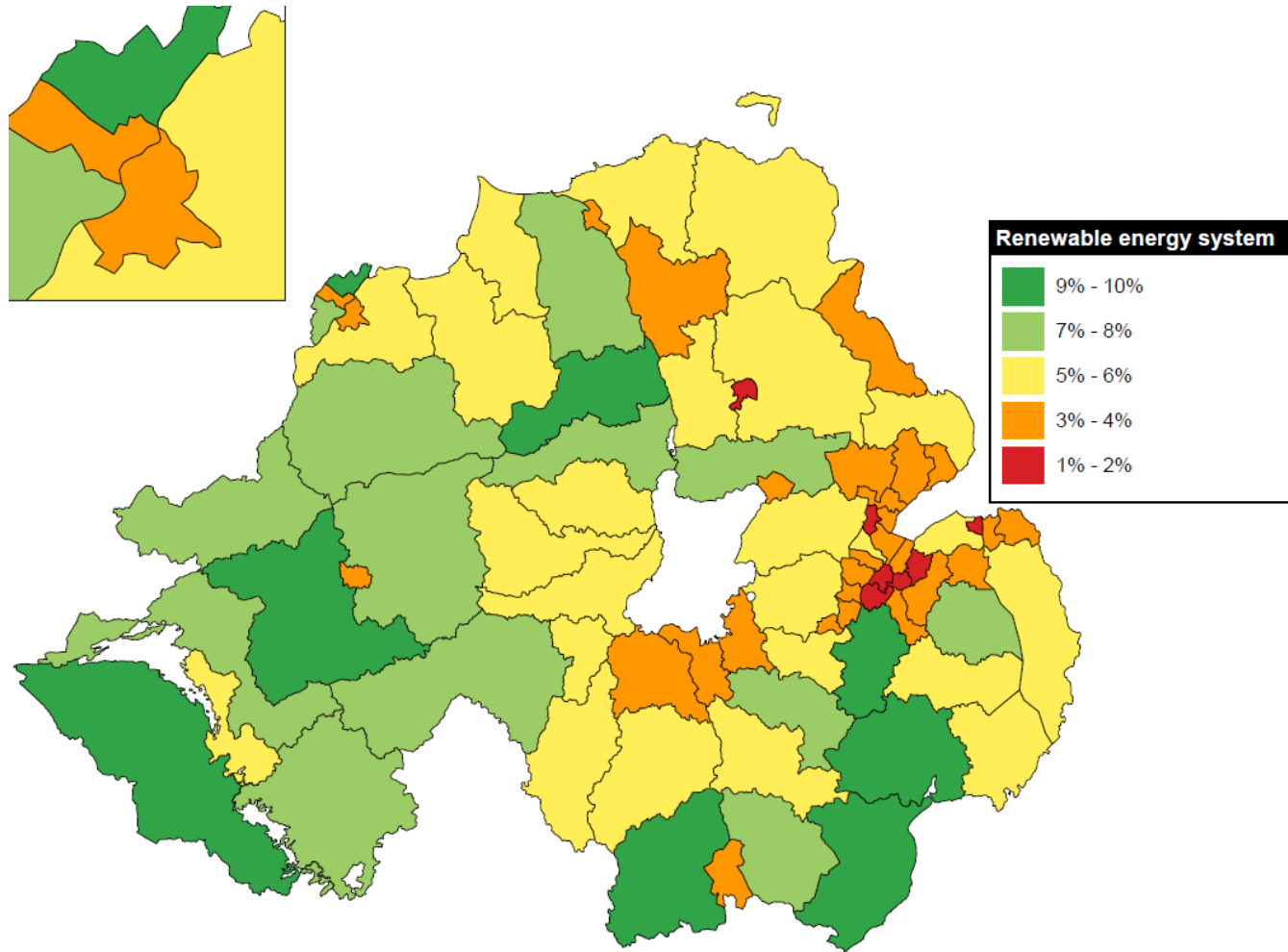
<https://www.gbmaps.com/>

Energy efficiency (EPC dataset)

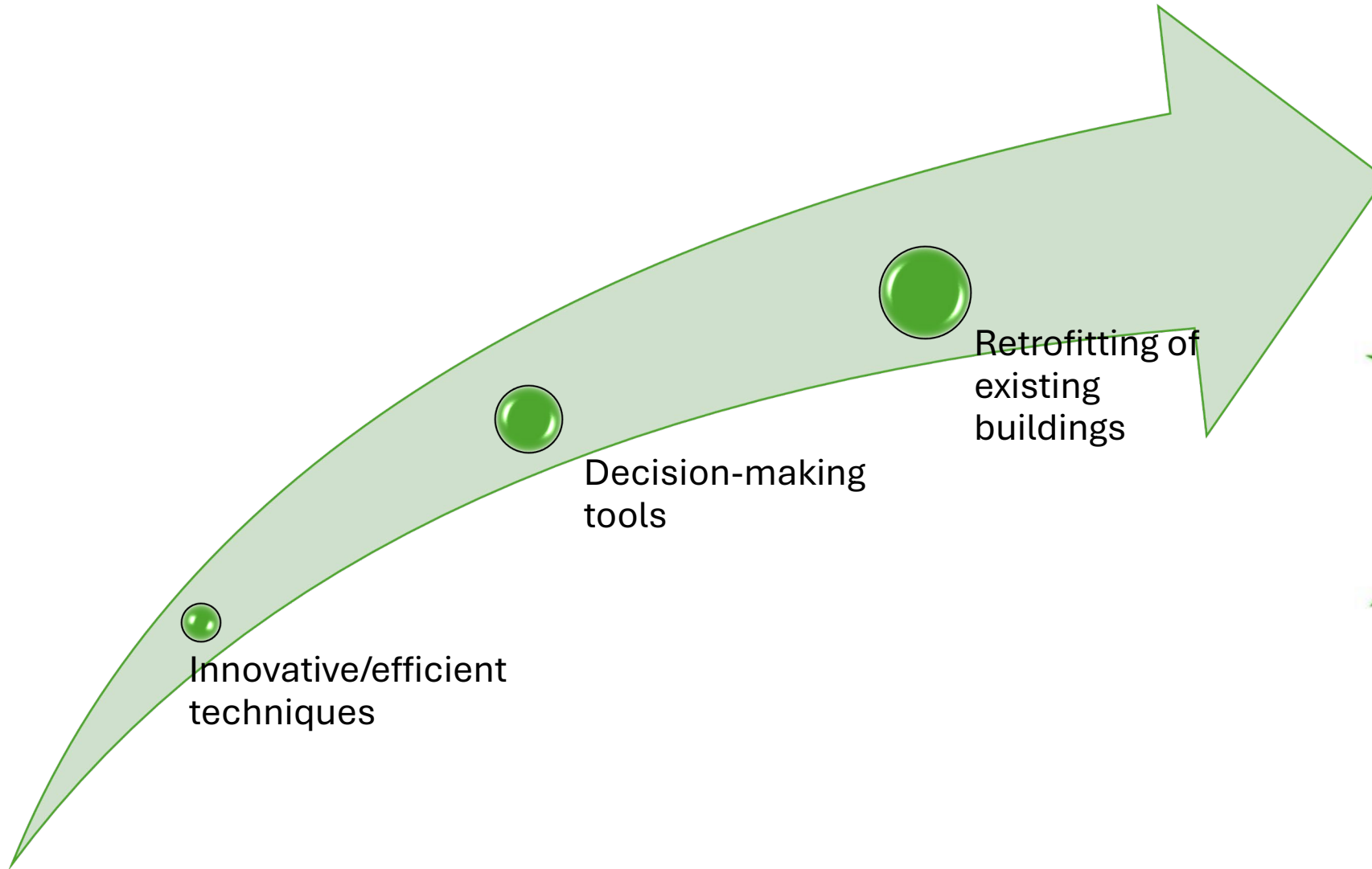


Average potential energy efficiency = 68

Central Heating by Renewable energy system



Potencial Outcomes



Enhancement of building energy efficiency and decarbonization of the building sector





❖ GIS-Based Data Analysis and Archetype Development

- ✓ The need for GIS-based data analysis that can aid in identifying and managing missing values, connecting diverse databases for a holistic view, and cleaning data with spatial context
- ✓ The need for detailed and localized building archetypes, which reflect the actual variations of the building stock in urban settings

❖ Occupant Behavior and socioeconomic data

- ✓ The need for integrating socioeconomic data, such as income levels, lifestyle choices, and demographic trends, that could enhance the predictive accuracy of energy models and help tailor energy solutions to specific community needs
- ✓ The need for a detailed modeling of occupant behaviors, such as daily usage patterns, presence at home, and interaction with building systems, that can significantly improve the accuracy of energy models

❖ Explainable Machine Learning

- ✓ The need for transparency and accountability in predictions since the black-box nature of many ML approaches can limit their practical application, particularly when decisions need to be transparent and justifiable in policy-making contexts



- The supervision of PhD students is an essential part of training new scientists in these areas
- Provide short courses for the young scientists and members of the Dragon 6 program
- Provision of summer schools and postgraduate courses
- Encourage youths to devote their efforts to participate in research activities, and present their research findings in workshops and conferences in addition to Dragon's symposiums.
- Support mutual exchange studies and field trips

European Young Scientists contributions in Dragon 6



Name	Institution	Poster title	Contribution including period of research

Chinese Young Scientists contributions in Dragon 6



Name	Institution	Poster title	Contribution including period of research

Overview of European YSs research



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Overview of European YSs research (when applicable)

Overview of Chinese YSs research



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