ENERGY ADE 3.0 WORKSHOP · TU DELFT · 22–23 JUNE 2026

Some thoughts and first results on

Building Renovation Passports

from a data point of view

Daan Schlosser, Hiba Doi, Giorgio Agugiaro

3D Geoinformation · TU Delft · RenoDAT project

License

WHY THIS MATTERS

Buildings in EU energy: use and emissions

~75%

of the EU building stock is energy-inefficient

85–95%

of today's buildings will still stand in 2050

40%

of EU energy is consumed by buildings

36%

of energy-related EU greenhouse-gas emissions

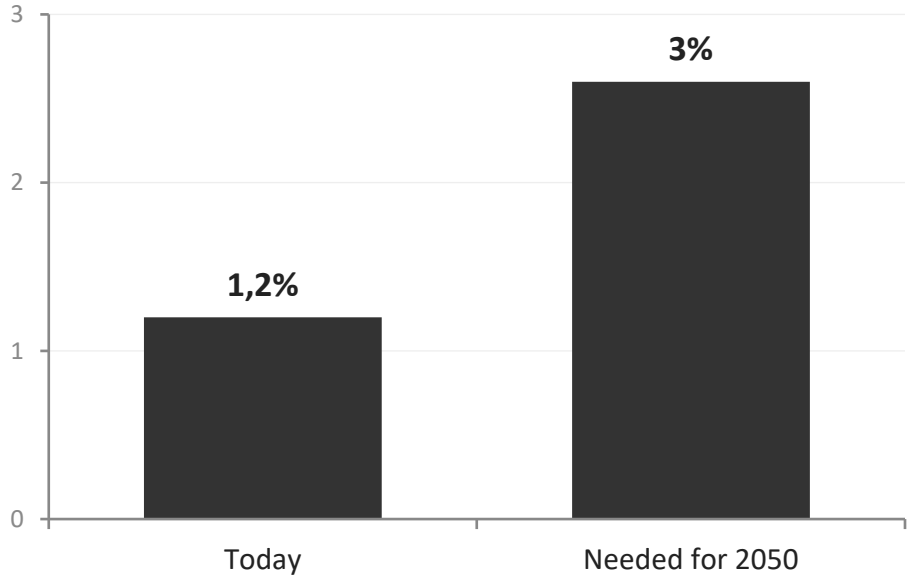
Demand keeps rising, still mostly met by fossil fuels. And **63.5%** of a building's energy goes to space heating alone, the obvious target for renovation.

The lever is renovation.

Figures: European Commission, Eurostat and the EPBD.

THE PACE PROBLEM

Low renovation rates and oneshot retrofitting



EU annual renovation rate, current vs. what 2050 targets require

60–75% cut in a building's energy demand is what deep, decarbonising renovation requires.

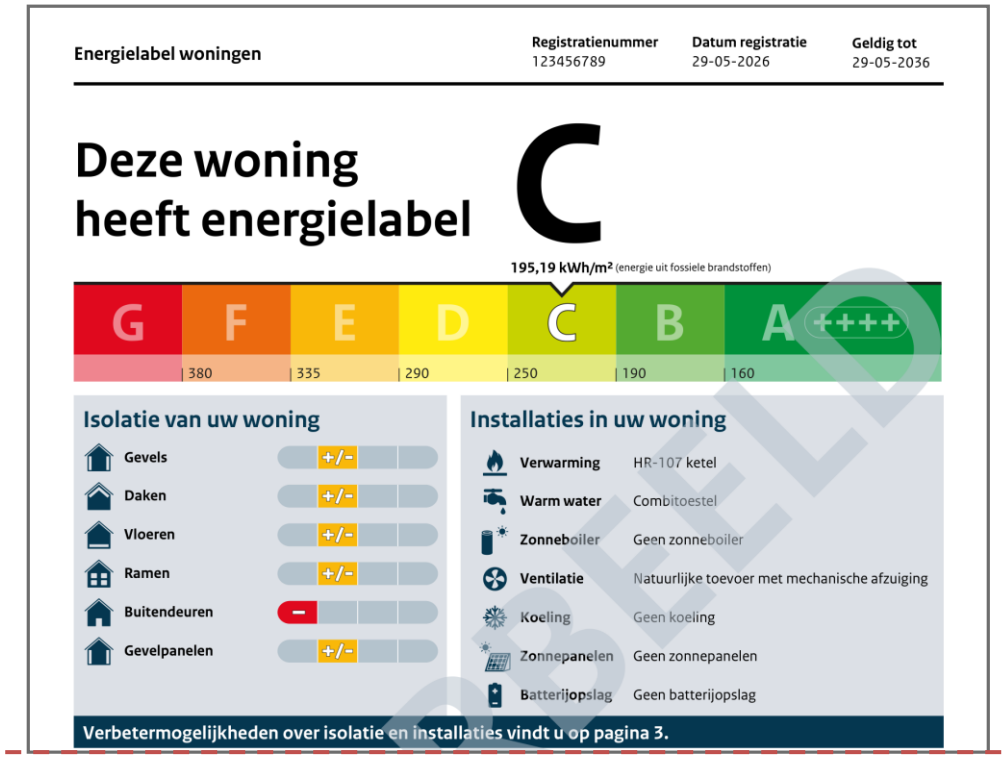
Why oneshot renovation backfires

- **The "low-hanging fruit" trap.** Ad-hoc, partial retrofits rarely reach the deep reduction, or improve comfort and air quality.
- **The lock-in effect.** An early cheap choice can physically or financially block the next, deeper step.
- **So you need a long-term plan.** Renovation is a multi-year journey, it has to be sequenced, not improvised.

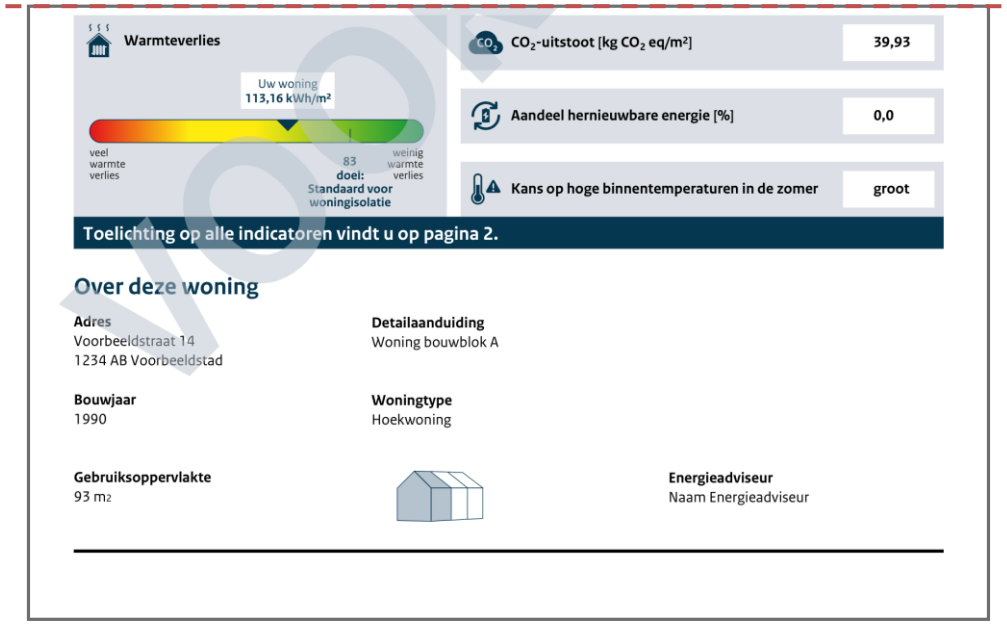
WHAT THE LABEL SHOWS

The Dutch energy label

Top half



Bottom half



New energy label for a C-dwelling, shown as its two halves. Source: Voorbeeld nieuw energielabel, Volkshuisvesting Nederland / RVO.

THE TOOL WE ALREADY HAVE

Limitations of the Energy Performance Certificate

EPC

Energy Performance Certificate

Mandatory since 2002 · valid up to 10 years

Born from the 1970s oil crises, the Kyoto Protocol, and energy-security concerns.

Useful, but not a roadmap

- **A bureaucratic tick-box.** Often produced for sale or rent and then filed away, not acted on.
- **The performance gap.** Calculated performance rarely matches real, measured energy use.
- **Generic advice, no roadmap.** Recommendations are vague, with no order or dependencies between steps.
- **Silent on money, comfort & health.** Omits costs, savings and payback, and ignores the comfort and air-quality gains that drive renovation.

EUROPE'S ANSWER (EPBD IV, 2024 RECAST)

Two data-based instruments under EPBD IV

Digital Building Logbook

The repository

One shared store for all building's data across its whole life:
certificates, the renovation passport, smart-readiness, ownership and more, so information stops living in scattered files.

Building Renovation Passport

The roadmap

A step-by-step renovation plan for one specific building.
It turns a static grade into a sequenced route to a low-carbon home, drawing on the data the logbook holds.

Both are framed by **EPBD IV (Directive 2024/1275)** and the **EPB standards (ISO 52000 series)**, which define what "building energy data" means.

WHY IT'S WORTH THE EFFORT

Benefits of structured, open building data

Interoperability

One machine-readable format, no manual re-entry or translation between tools.

Cost & speed

Cuts redundant data collection; scales renovation from manual projects to automation.

Green finance & policy

Lenders and regulators can verify and track progress at scale, with confidence.

Automation & AI

A clean, structured building stock is exactly what AI and automated planning need.

In short: Structured data replaces assumptions with objective reality and closes the performance gap.

WHERE THE GAP IS

The research gap (recap)

1 There is no agreed definition of what a BRP must hold

- Existing logbook/passport data models are often closed, only partly published, or just Excel spreadsheets
- So, you cannot tell what they cover, and each new one starts from scratch

→ no agreed, openly published list of required data

2 An open standard exists, but is untested

- CityGML 2.0 + Energy ADE 3.0 is open, formally specified, and maintained for a decade for urban energy modelling
- Whether it is good enough as a BRP data model has never been tested

→ test whether it is a meaningful starting point; even a negative result would be a useful contribution

BRP, building renovation passport · ADE, application domain extension · MSRD, minimum set of required data · DBL, digital building logbook

HOW WE TESTED IT

Research questions and approach

RQ 1 What does a passport need?

Which data attributes form the **Minimum Set of Required Data (MSRD)** a passport needs under EPBD IV and the EPB standards?

RQ 2 Can the open model cover it?

How completely do the **CityGML + Energy ADE** classes and attributes cover that MSRD, and where do the main gaps lie?

Synthesise the MSRD
from 14 European initiatives → **Map field-by-field**
onto CityGML + Energy ADE → **Test on real Dutch data**
at two scales

RQ1 · THE METHOD

Defining the Minimum Set of Required Data (MSRD)

1

Review past initiatives

Review of 14 EU logbook/passport initiatives.

Through research output, policy documents, web-platforms, software, Excel files, etc.

2

Compare them field by field

Break each model into fields; group them by meaning into 13 modules across 3 layers (repository, assessment, functional).

Match up fields that mean the same thing but are named differently.

3

Define the MSRD

Relevance filter: weigh how often a field appears, what the EU directive (EPBD) requires, and what practitioners need.

Relevant? → into the MSRD.

RQ1 · WHERE THE MSRD COMES FROM

The MSRD derived from fourteen European initiatives

Government programmes

3

iSFP, Germany
Woningpas, Flanders
CLÉA, France

EU research projects

6

EUB SuperHub
ALDREN
iBRoad
X-tendo
BUILDCHAIN
OneClickRENO

Academic & framework

2

Gómez-Gil et al.
Ecorys EU DBL

Dutch operational tools

3

Vitec Vabi EPA
BuurtWarmteWijzer
Hoomdossier

We distilled what they all agree a passport needs into one open reference set, the MSRD:

276 fields

13 modules

3 layers

RQ1 · FIELD BY FIELD

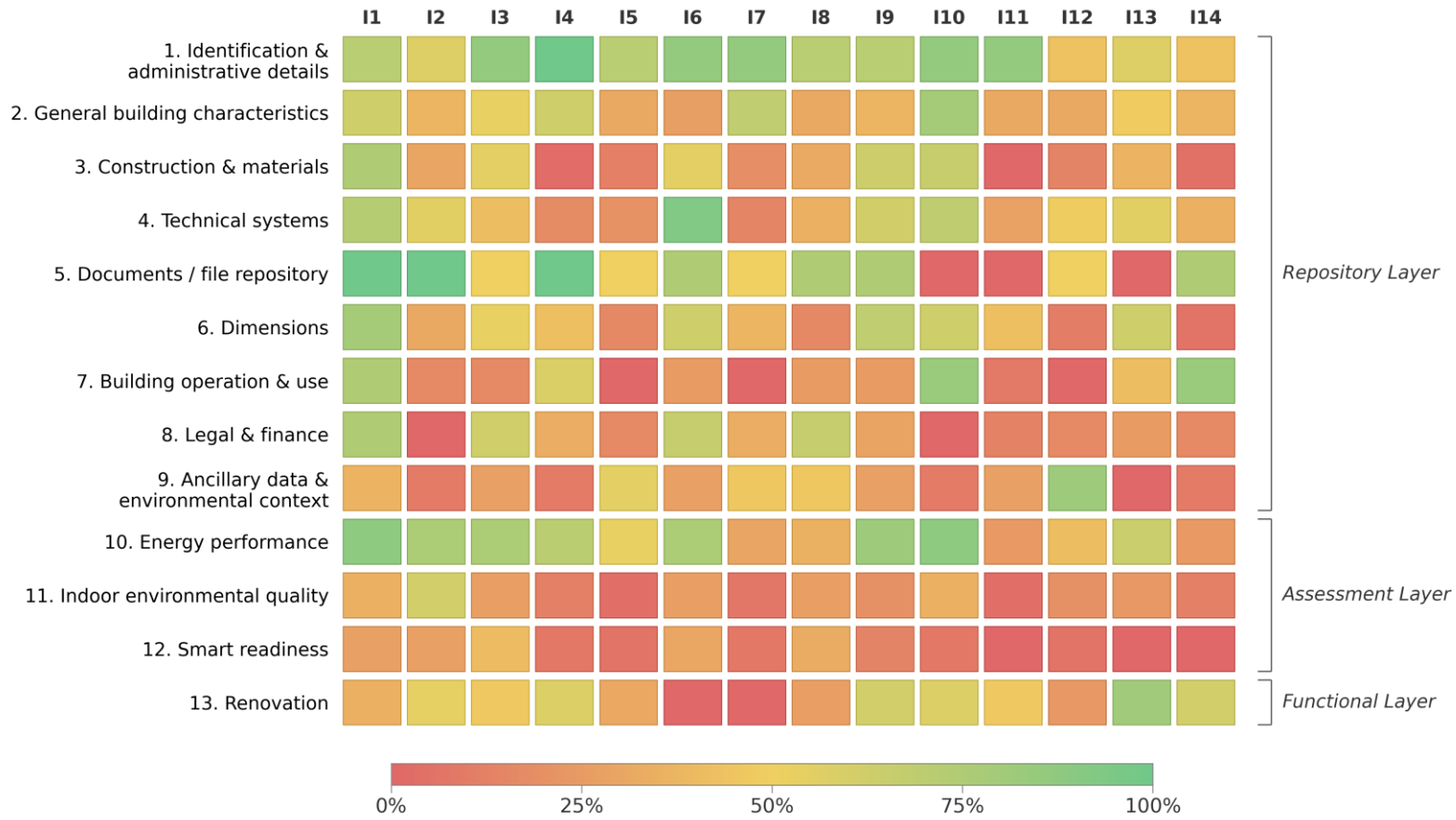
Comparing the initiatives

Feature	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12	I13	I14	Total	%	Relevant?
Building address details	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	14	100%	Yes
Building identification (Cadastral/INSPIRE)	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			11	79%	Yes
Ownership details and occupancy details	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	12	86%	Yes
Geospatial Coordinates (latitude, longitude, altitude)	✓	✓	✓	✓		✓	✓				✓				7	50%	Yes
DBL author/ assessor qualifications and information	✓	✓		✓	✓	✓		✓	✓	✓			✓	✓	10	71%	Yes
Details on the building with building-unit relation			✓	✓	✓		✓		✓	✓	✓				7	50%	Yes
Timestamps on collection, provision or modification**			✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		10	71%	Yes
Building owner address details			✓							✓		✓	✓	✓	5	36%	No

Module 1 as an example: each field against the 14 initiatives (I1-I14), its frequency, and whether it passed the relevance filter into the MSRD.

RQ1 · THE FULL PICTURE

How the initiatives cover the modules



The 14 initiatives across the 13 modules, grouped into the repository, assessment, and functional layer. Own work.

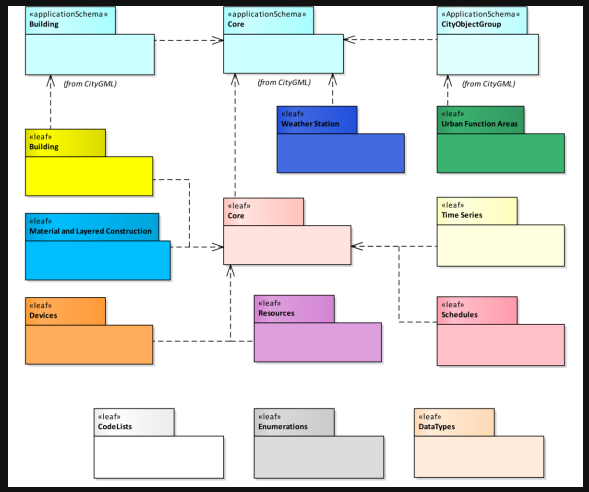
RQ2 · THE OPEN STANDARD

CityGML and the Energy ADE: an open semantic city model

CityGML is an open, international standard for describing cities and buildings, their shape, parts and meaning, not just their picture.

The Energy ADE extends it with everything about a building's energy: its construction, systems, demand and use.

- **Open & maintained 10+ years (OGC + community)**
- **Built for energy modelling at urban scale**
- **Formally specified, so coverage is testable**



The question: can this open model already carry a renovation passport?

RQ2 · MAPPING TO THE MODEL

Mapping the MSRD to CityGML + Energy ADE

Feature	%	MSRD	Module	Class	Attribute	Type
Building address details	100%	Yes	Core*	Address	Multiple	Multiple
Building identification (Cadastral/INSPIRE)	79%	Yes	Core	_CityObject	identifier	Code [0..1]
Ownership details and occupancy details	86%	Yes	Building Building	_AbstractBuilding _AbstractBuilding	bdgOwnerName bdgOwnershipType	CharacterString [0..1] OwnershipTypeValue [0..1]
Geospatial Coordinates (latitude, longitude, altitude)	50%	Yes	Core	_CityObject	referencePoint	GM_Point [0..1]
DBL author/ assessor qualifications and information	71%	Yes	DataTypes	Metadata	Multiple	Multiple
Details on the building with building-unit relation	50%	Yes	Building	BuildingUnit	N/A (done by composition)	
Timestamps on collection, provision or modification**	71%	Yes	Core Core	AbstractADEFeature AbstractADEFeature	creationDate terminationDate	Date [0..1] Date [0..1]
Building owner address details	36%	No	✗			

Module 1: each MSRD field assigned its place in the model. Own work.

RQ2 · A SECOND MODULE

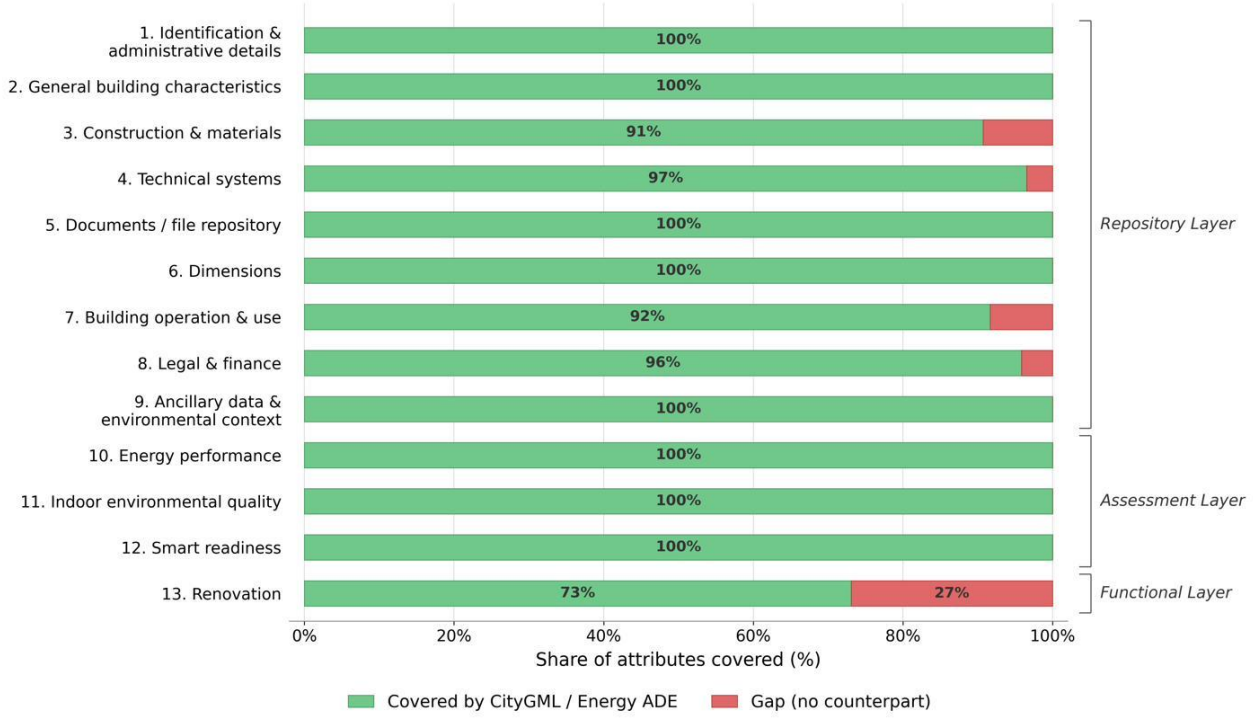
Mapping ex: Module 13

Feature	%	MSRD	Module	Class	Attribute	Type
Only general recommendation to include renovation data	21%	N/A	N/A			
Administrative (step) information						
Renovation measure proposals on specific elements	71%	Yes	Core	Intervention	action	InterventionActionValue [0..1]
			Core	Intervention	type	InterventionTypeValue
			Core	Intervention	interventionStartDate	Date [0..1]
			Core	Intervention	interventionEndDate	Date [0..1]
Textual renovation (stage) description	64%	Yes	✗			
Year of this renovation/ stage	43%	Yes	Core	Intervention	interventionStartDate	Date [0..1]
Attachable documents which relate to the renovation	57%	Yes	Core	AbstractADEFeature	externalReference	ExternalReference [0..*]
Achieved/ desired renovation depth (descriptive)	36%	Yes	✗			
Energy & resource consumption improvements						
Resource consumption (kWh) vs. pre-renovation	79%	Yes	Resources	Energy	amount	Measure [0..1]
Energy label before/after (letter or colour)	64%	Yes	Building	EnergyPerformanceCertificate	label	CharacterString
Resource demand (kW) vs. pre-renovation	43%	Yes	Resources	Energy	maximumLoad	Measure [0..1]
Energy efficiency before / after renovation	43%	Yes	Core	DeviceOperation	yearlyGlobalEfficiency	Decimal [0..1]
Finances						
Investment costs per measure/ step	71%	Yes	Resources	OtherResource	expense	Measure [0..1]
Current total energy costs per year	57%	Yes	Resources	AbstractResource	expense	Measure [0..1]
Business as usual costs (or if it can be derived)	50%	Yes	Resources	AbstractResource	revenue	Measure [0..1]
Public funding program details	50%	Yes	Resources	Energy	expense	Measure [0..1]
Public funding investment amount (available)	43%	Yes	Resources	AbstractResource	revenue	Measure [0..1]
Overall total investment costs (staged or all at once)	21%	Yes	Resources	OtherResource	expense	Measure [0..1]
Tax incentive (name)	14%	Yes	Core	AbstractADEFeature	externalReference	ExternalReference [0..*]
Reasoning & timelining						
Renovation measure priority level	50%	Yes	✗			
Motivation on why this specific measure is necessary**	29%	Yes	✗			
Estimation of the renovation works time**	14%	Yes	✗			
The first/best opportunity to do this renovation**	14%	Yes	✗			
Ideal season for executing the renovation step**	14%	Yes	✗			
Non monetary benefits						
Indication of new thermal comfort**	43%	Yes	Core	_CityObject	indicator	Indicator [0..*]
Descriptive explanation of other non-monetary benefits**	36%	Yes	Core	_CityObject	indicator	Indicator [0..*]
Negatives						
Constraints that limit/block certain renovations	36%	Yes	Core	_CityObject	indicator	Indicator [0..*]
Estimation of users' disruption**	14%	Yes	Core	_CityObject	indicator	Indicator [0..*]
Renovation risks (e.g. mold growth if not done properly)	21%	Yes	Core	_CityObject	indicator	Indicator [0..*]

Module 13: each MSRD field assigned its place in the model. Own work.

RQ2 · RESULT · COVERAGE

MSRD coverage by CityGML and the Energy ADE



Share of each module's required fields with a home in CityGML + Energy ADE

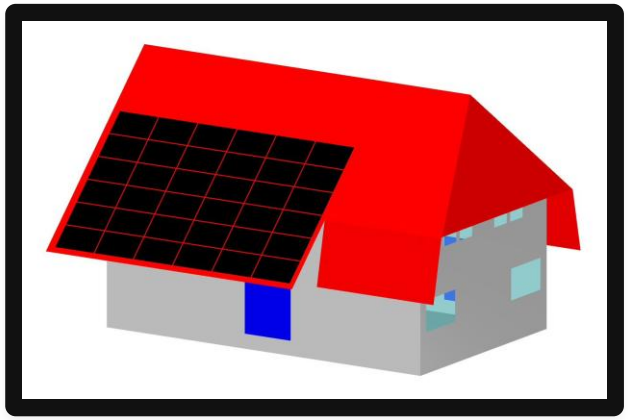
95%

of what a passport needs already has a place in the open model.

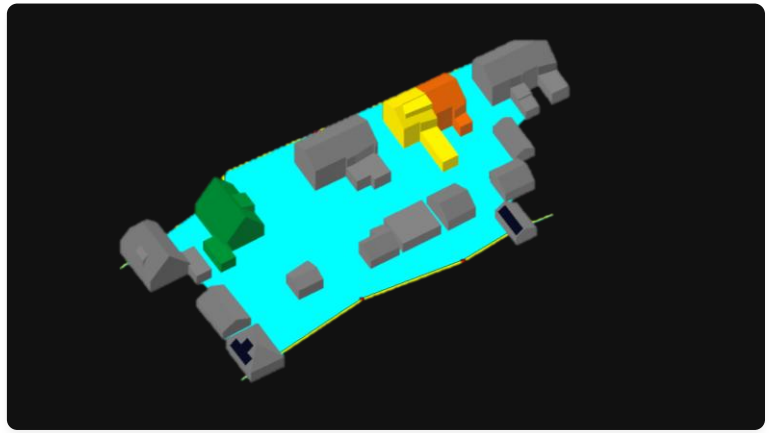
The one real gap? The staged renovation roadmap itself, the passport's defining feature, at **73%.** Gaps are localised, not spread across the model.

RQ2 · RESULT · IT HOLDS ON REAL DATA

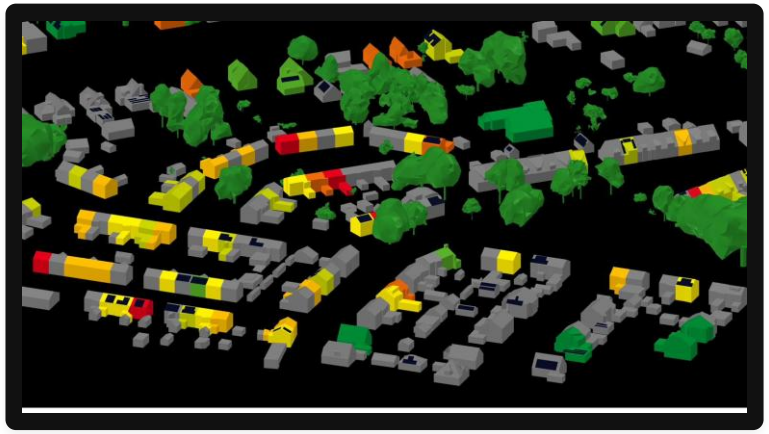
Validation at two scales: dwelling to municipality



One house · full audit depth



Urban function Area



A neighbourhood · 5 data sources merged

At the building level: an audit-depth test

INPUTS

On-site audit (ISSO 82.1 intake)

Building plans & drawings

The resident's input

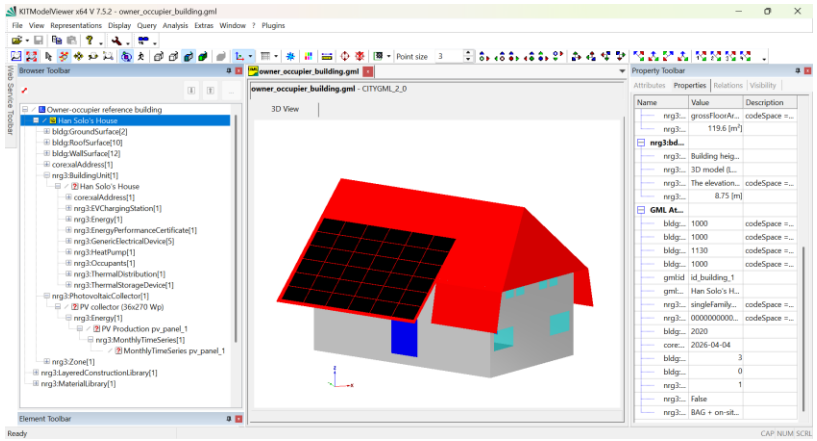
Metered & simulated series

→

Audit-depth dwelling model

one owner-occupier home, full Energy ADE detail

→



ONE OBJECT · MANY SOURCES

Storing multiple data sources for one object

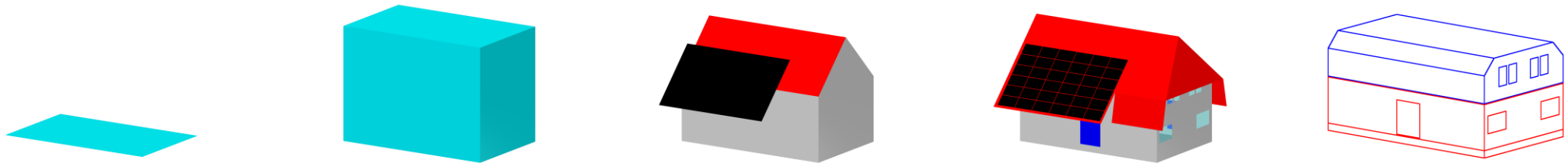
Name	Value	Description
nrg3:device → nrg3:PhotovoltaicCollector		rooftop array, 36 modules, one feature
├─ nrg3:resource → nrg3:Energy		measured PV production
│ └─ nrg3:timeDependentAmount → nrg3:MonthlyTimeSeries	42 pts	metered · 2022 to 2025 · 21,997 kWh
└─ nrg3:resource → nrg3:Energy		simulated PV production
├─ nrg3:Metadata → nrg3:acquisitionMethod	simulation	NTA 8800:2024, reference climate
└─ nrg3:timeDependentAmount → nrg3:MonthlyTimeSeries	48 pts	estimate · 2022 to 2026 · 28,356 kWh

The same rooftop solar collector carries two production histories at once, the metered output and an independent simulation, each as its own monthly time-series. Own work.

PV, photovoltaic

ONE OBJECT · MULTIPLE GEOMETRIES

Geometric representations (LoD 0–3)



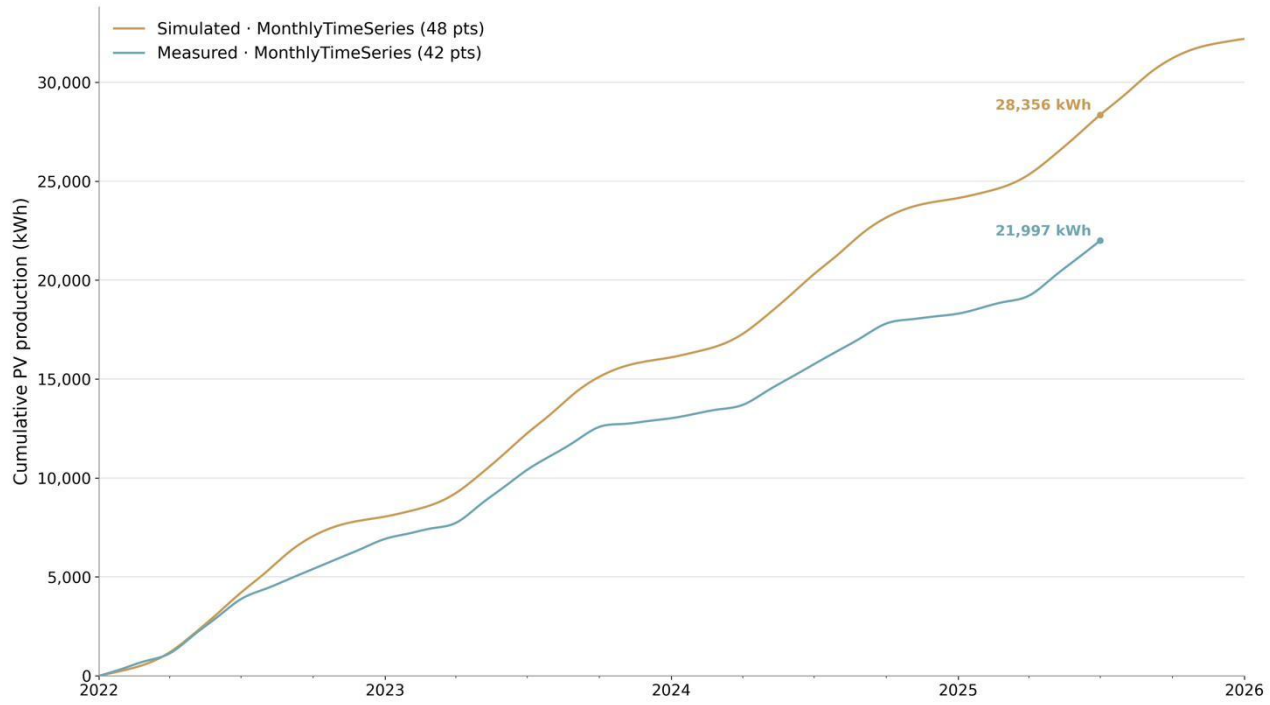
LoD0 LoD1 LoD2 LoD3 ZoneParts

One owner-occupier dwelling authored across LoD 0-3, with heated zones split into zone-parts (right). Own work.

LoD, level of detail

WHY COHERENCE MATTERS

Cross-validation in a single coherent model



Measured vs. simulated rooftop-solar production for the same house, in one file

Measured meets modelled: a lookup, not a project.

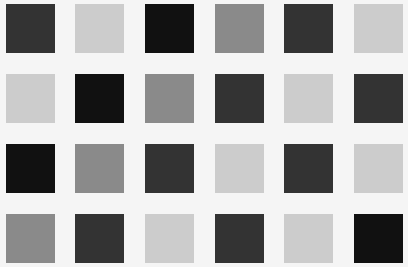
Because the real metered solar output and the simulated estimate sit on the **same building, in the same model,** comparing them is a single lookup, not a fragile join across separate datasets.

≈20% gap between simulated and measured, exactly the kind of reality-check a renovation assessment needs, now trivial to make.

USE CASES · NEIGHBOURHOOD & CITY SCALE

At the neighbourhood scale: a breadth test

OPEN REGISTERS



A whole municipality from

BAG · 3DBAG · EP-Online · BGT · CBS

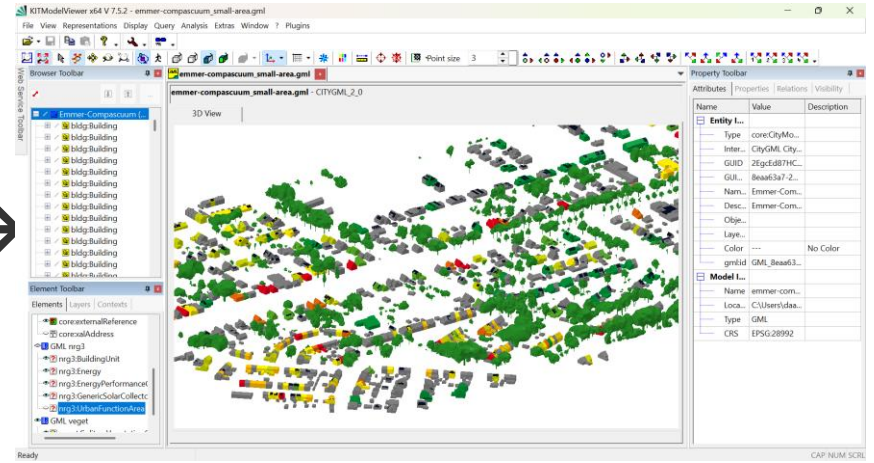
(+ solar panels, trees)

→

Integrated city-scale model

five data themes, one model

→



THE OPEN DATA SOURCES

Mapping open data sources

Source field	Mapped to	How
BAG vbo · `gebruiksdoel`	`nrg3:type` (Dutch term, own code space)	Native
3DBAG · `b3_h_dak_max`	`nrg3:bdgHeight` (qualified-attribute extension)	Native
3DBAG · LoD2 face	`nrg3:bdgBdrySurfTotalSurfaceArea` (from geometry)	Computed
EP-Online · `Energieklasse`	`nrg3:EnergyPerformanceCertificate / label`	Native
EP-Online · NTA 8800 vs legacy	`nrg3:Energy` with explicit `uom` (regimes kept separable)	Native
EP-Online · `Gebouwsubtype`	`gen:stringAttribute` (no native slot)	GenericAttribute
Solar panel polygon	`nrg3:GenericSolarCollector` + `installedOn`	Computed
CFTree · `crown_porosity`	`gen:doubleAttribute` (no native slot)	GenericAttribute
BGT · `lokaal_id`	`core:externalReference` (marks a public-space tree)	Cross-ref
CBS Postcode-6	`nrg3:UrbanFunctionArea` + `grp:groupMember` to its buildings	Native

Mappings of the six data sources. Own work.

BUILDING SCALE · ONE DWELLING

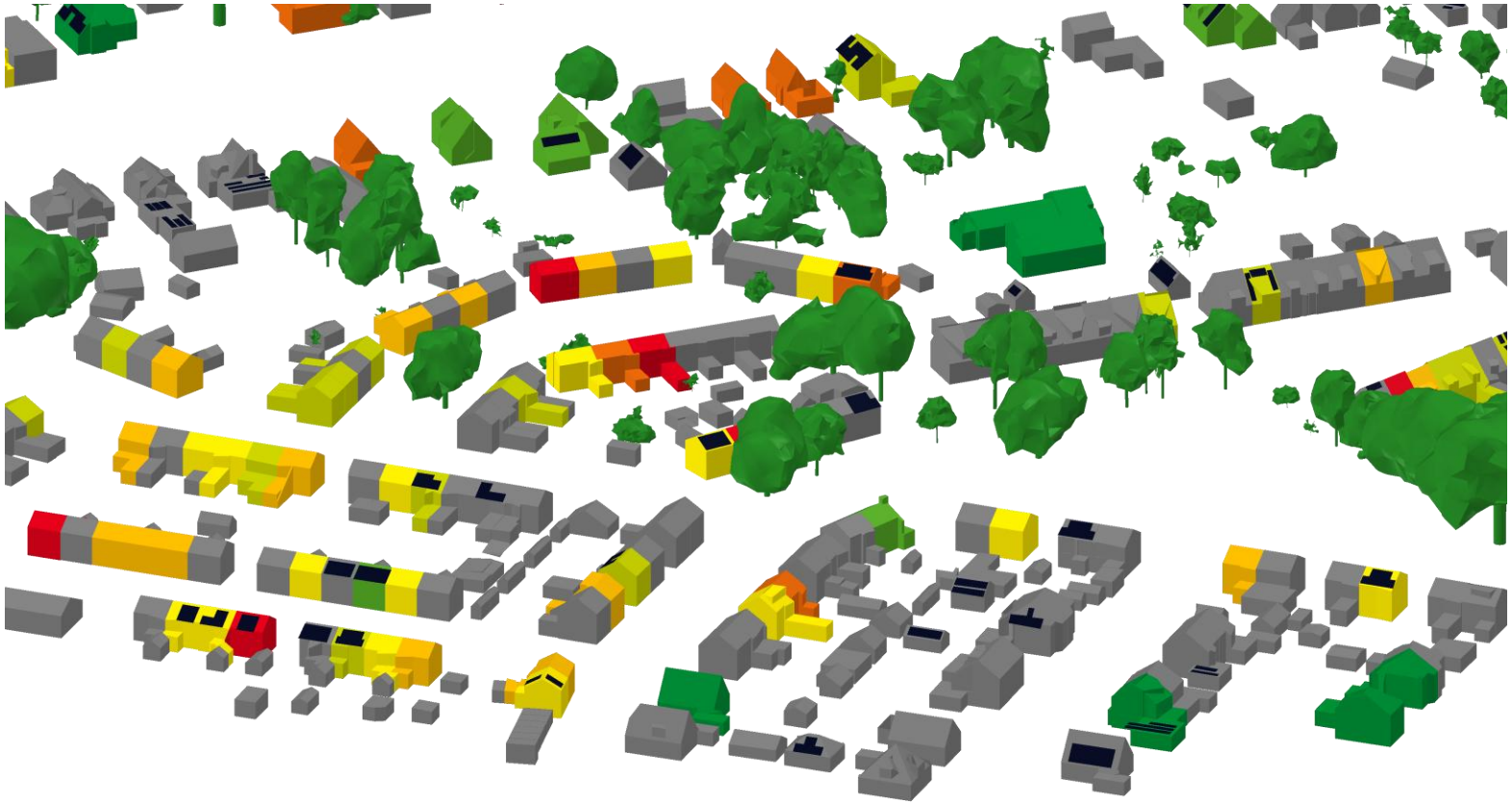
A building and its EPC

Name	Value	Description
`bldg:Building`		from BAG *pand*
├─ `nrg3:identifier`	0114100000280857	BAG pand code space
├─ `bldg:yearOfConstruction`	1926	BAG
├─ `bldg:address → core:Address`		Hoofdkanaal WZ 38, 7881AB Emmer-Compascuum
└─ `nrg3:BuildingUnit`		from BAG *verblijfsobject*
├─ `nrg3:identifier`	0114010000280857	BAG vbo code space
├─ `nrg3:address`	xlink	references the Address above
└─ `nrg3:EnergyPerformanceCertificate`		from EP-Online
├─ `nrg3:label`	G	
├─ `nrg3:type`	totalEnergyDemand	
└─ `nrg3:status`	actual	

One building linked from its BAG identity to its EP-Online certificate. The link is built into the model, not a manual spreadsheet lookup each time. Own work.

NEIGHBOURHOOD SCALE · OPEN DATA

Small area model, built from open sources

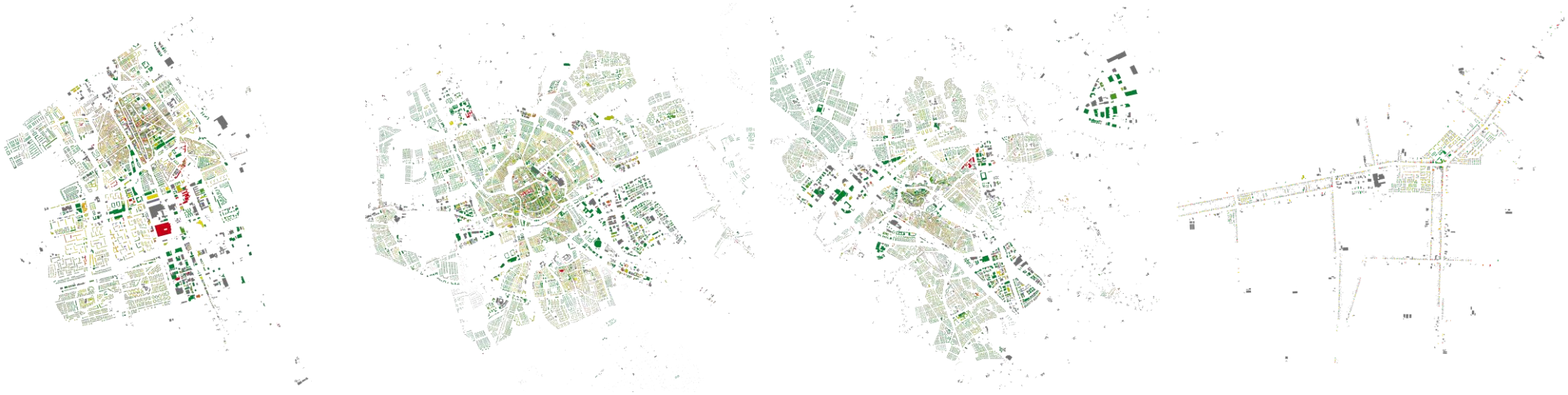


Emmer-Compascuum from BAG, 3DBAG, EP-Online, the solar-panel dataset, BGT, and CBS, in the KITModelViewer. Own work.

BAG, Basisregistratie Adressen en Gebouwen · BGT, Basisregistratie Grootschalige Topografie · CBS, Centraal Bureau voor de Statistiek

CITY SCALE · FOUR MUNICIPALITIES

Scaling up to four municipalities

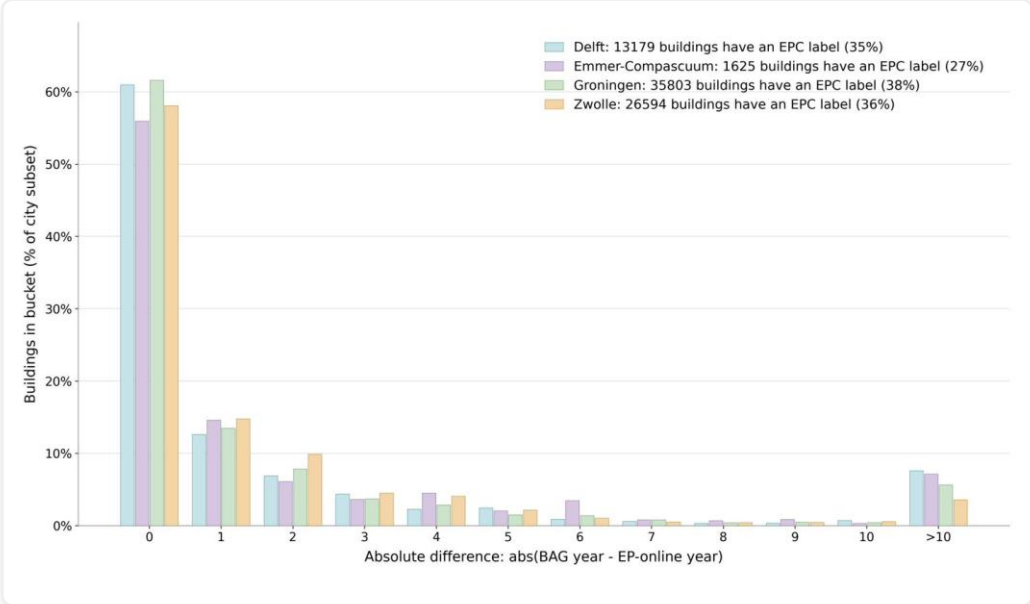


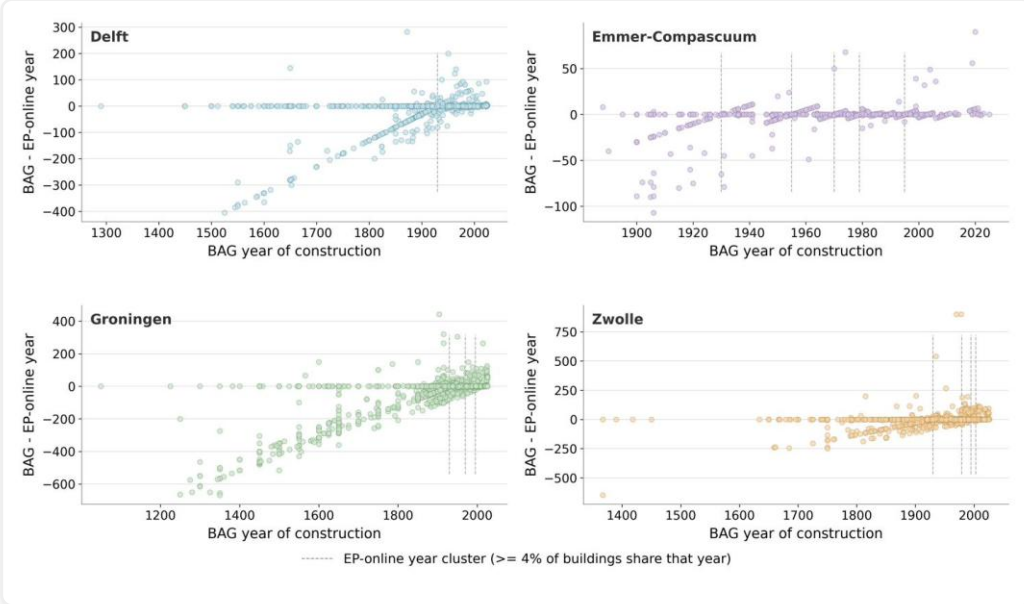
Delft | Groningen | Zwolle | Emmer-Compascuum

The same pipeline run on four areas, the municipalities of Delft, Groningen and Zwolle plus the Emmer-Compascuum settlement (up to ~94,000 buildings), each coloured by its energy label. Own work.

RESULTS, DATA QUALITY

Integration reveals data quality issues

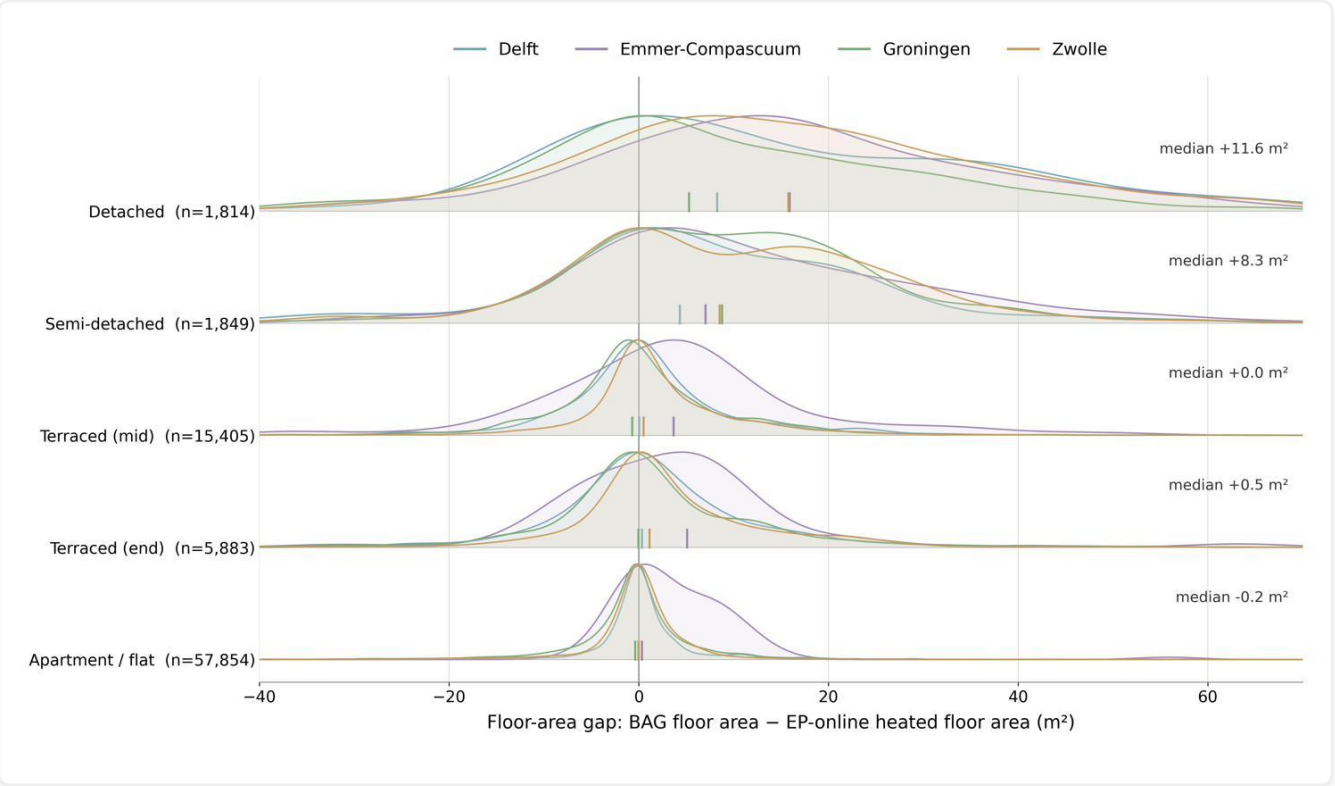




~2 in 5 buildings: two national registers disagree on the construction year. The model doesn't hide the conflict, it makes it **systematically visible, and therefore fixable.**

RESULTS, DATA QUALITY (CONTINUED)

Structured discrepancies in floor area



Floor-area gap between the two registers, by building type

Not random noise, a pattern.

- Apartments & terraced homes: the two areas agree (~0 m²).
- Detached homes: the gap grows to ~12 m².
- Likely cause: registers count "heated" vs "usable" space differently, and big homes have more unheated attic & garage.

IMPLICATIONS

Conclusion

CityGML 2.0 + Energy ADE 3.0 (beta 8) is a meaningful, strong starting point

The gaps are localised, not structural, and the model holds on real Dutch data at both scales

The one substantial gap is Module 13, the renovation roadmap (73%)

Practitioners (and open data) weight and use fields differently. The model lets almost every field be optional, which fits that divergence well

IMPLICATIONS

Implications for policy, practice, and the Energy ADE

Policy

EPBD IV requires passports but leaves the data model open. Here is a tested, open, vendor-neutral candidate.

The Dutch national data facility

The exact registers a national service must join, with their reconciliation problems named in advance.

Owners, advisors, vendors

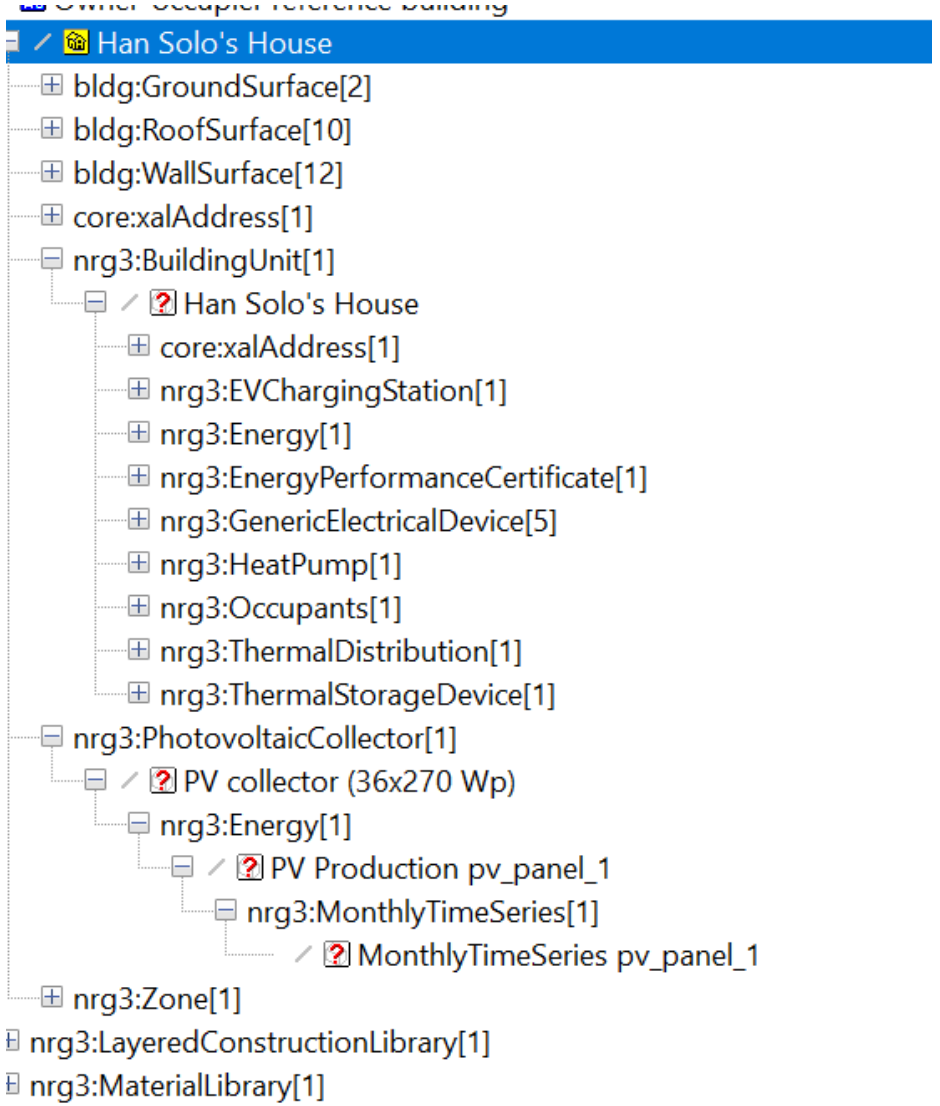
Less manual re-entry between tools; lower cost; fewer errors as data flows between systems.

The Energy ADE itself

Concrete, localised extension proposals, feeding directly into the work of this workshop.

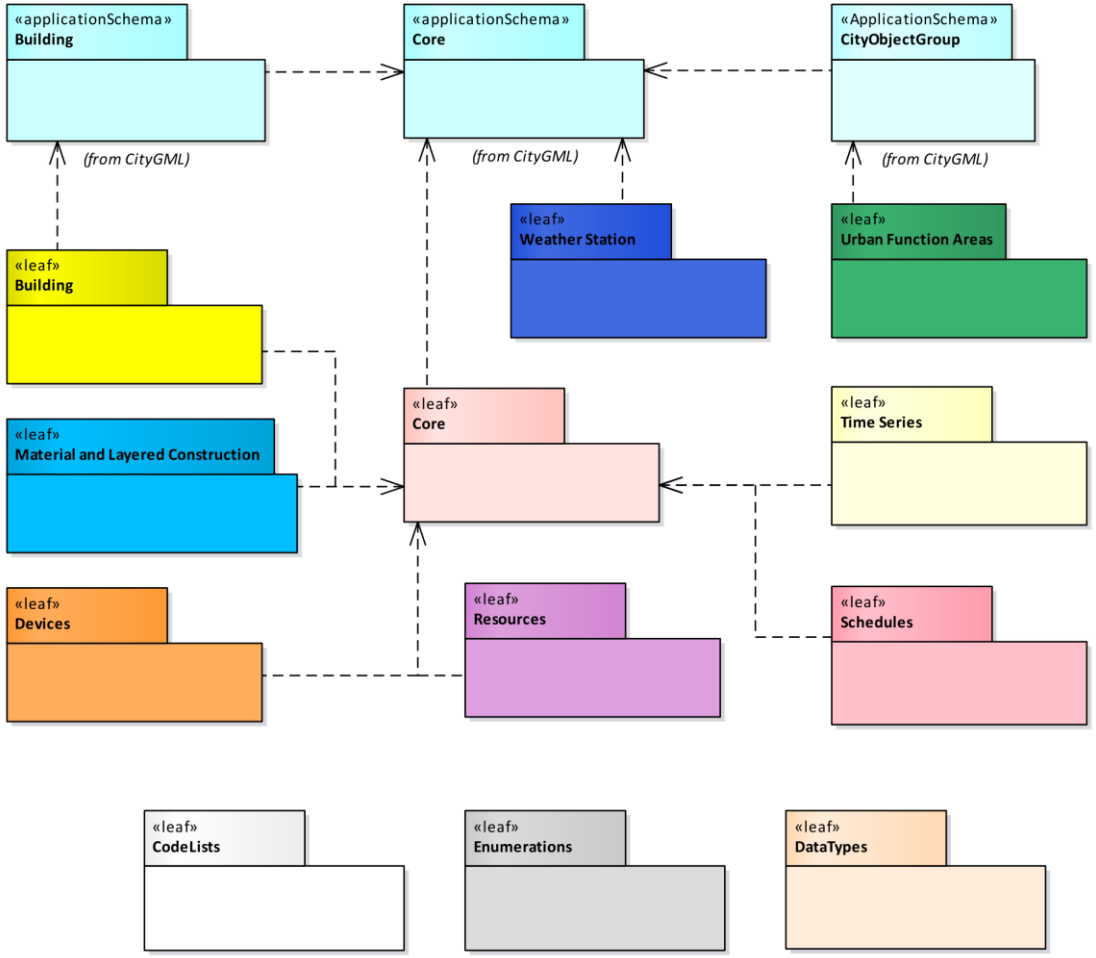
Thank you

Questions are very welcome



nrg3:type	grossFloorArea (grossFloorArea)	codeSpace = http://3dcities.bk.t..
nrg3:QualifiedArea	119.6 [m²]	
nrg3:bdgHeight		
nrg3:description	Building height measured from ...	
nrg3:source	3D model (LOD3 STEP geometry)	
nrg3:type	The elevation has been captured...	codeSpace = http://3dcities.bk.t..
nrg3:QualifiedHeight	8.75 [m]	
GML Attributes		
bldg:class	1000	codeSpace = http://www.sig3d....
bldg:function	1000	codeSpace = http://www.sig3d....
bldg:roofType	1130	codeSpace = https://www.sig3d..
bldg:usage	1000	codeSpace = http://www.sig3d....
gml:id	id_building_1	
gml:name	Han Solo's House	
nrg3:bdgType	singleFamilyHouse (singleFamily...	codeSpace = http://3dcities.bk.t..
nrg3:identifier	0000000000000001	codeSpace = http://bag.basisre...
bldg:yearOfConstruction	2020	
core:creationDate	2026-04-04	
bldg:storeysAboveGrou...	3	
bldg:storeysBelowGround	0	
nrg3:bdgNumberOfBuil...	1	

The Energy ADE 3.0 modules



Package overview of CityGML 2.0 + Energy ADE 3.0 (beta 8). Reproduced from the Energy ADE 3.0 (beta 8) UML documentation.