the retrofit agenda: carbon, cost or quality?

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Welsh School of Architecture, May 2025

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

Context

In 2023, the Welsh housing stock consisted of 1.5 million homes. Over a quarter of all homes in Wales were built before 1919. Only 6% were built in the last ten years. (ONS, 2024)

Despite numerous energy efficiency initiatives, it is estimated that 45% of all households were in fuel poverty last year. (NEA 2023).

Housing produces 21% of Welsh carbon emissions (BEIS 2018). Less than 1% of homes have a source of renewable energy. (ONS, 2023)

The UK Committee for Climate Change has stated that Welsh Government should target a 95% reduction in carbon emissions by 2050 versus 1990 levels. (CCC 2019)

Homes of Today for Tomorrow was a series of four research projects funded by Welsh Government (2017-23) to better understand the challenge of successfully decarbonising the Welsh housing stock:

stage

2017-2018 — 1 — Understanding retrofit: a pan-Europe review of retrofit case studies and recent publications to learn from relevant good, best and emerging **retrofit practice**.

2018-2019 — 2 — Testing the Welsh housing stock: modelling the whole housing stock, to establish the scale of the **decarbonisation** challenge, and the importance of clean energy.

2020-2021 — 3 — Retrofit of social housing: exploring housing types within the Welsh social housing stock (as the sector most likely to decarbonise first) and the impact on **fuel bills**.

2022-2023 — 4 — ‘Hard to treat’ case studies: improving **quality** in ‘hard to treat’ properties as a stepping stone for understanding ways to encourage change in the private sector.

Stage 1_understanding best practice retrofit

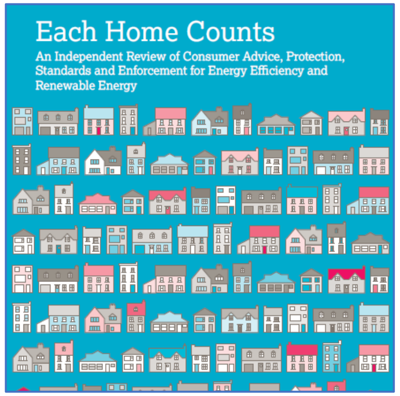
scoping review comprised of 50 case studies and 50 publications

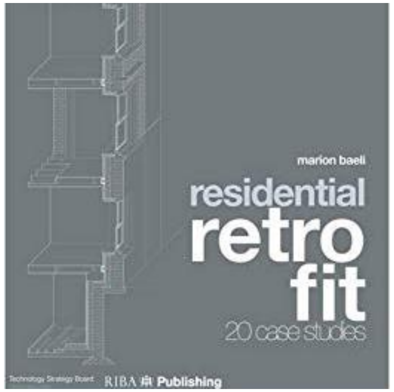


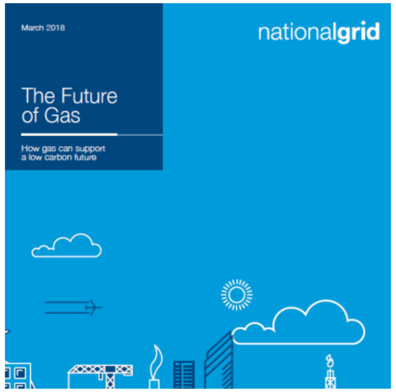










Stage 2_understanding the Welsh housing stock

Stage 2 used 14 case studies to understand the degree to which the nature and condition of the existing Welsh housing stock should inform a **decarbonisation** strategy, while giving due consideration to energy costs and affordability.

	HOUSE End terrace	HOUSE Mid terrace	HOUSE Semi-detached	HOUSE Detached	FLAT (Purpose built)	Total
pre 1919	3%	9%	4%	7%		23%
1919-1944			5%			5%
1945-1964			10%			10%
1965 - 1990	4%	6%	10%	9%	4%	33%
post 1990			5%	7%	1%	13%
Total	7%	15%	33%	23%	6%	84%

a representative taxonomy of 14 dwelling types

Stage 2_understanding the Welsh housing stock

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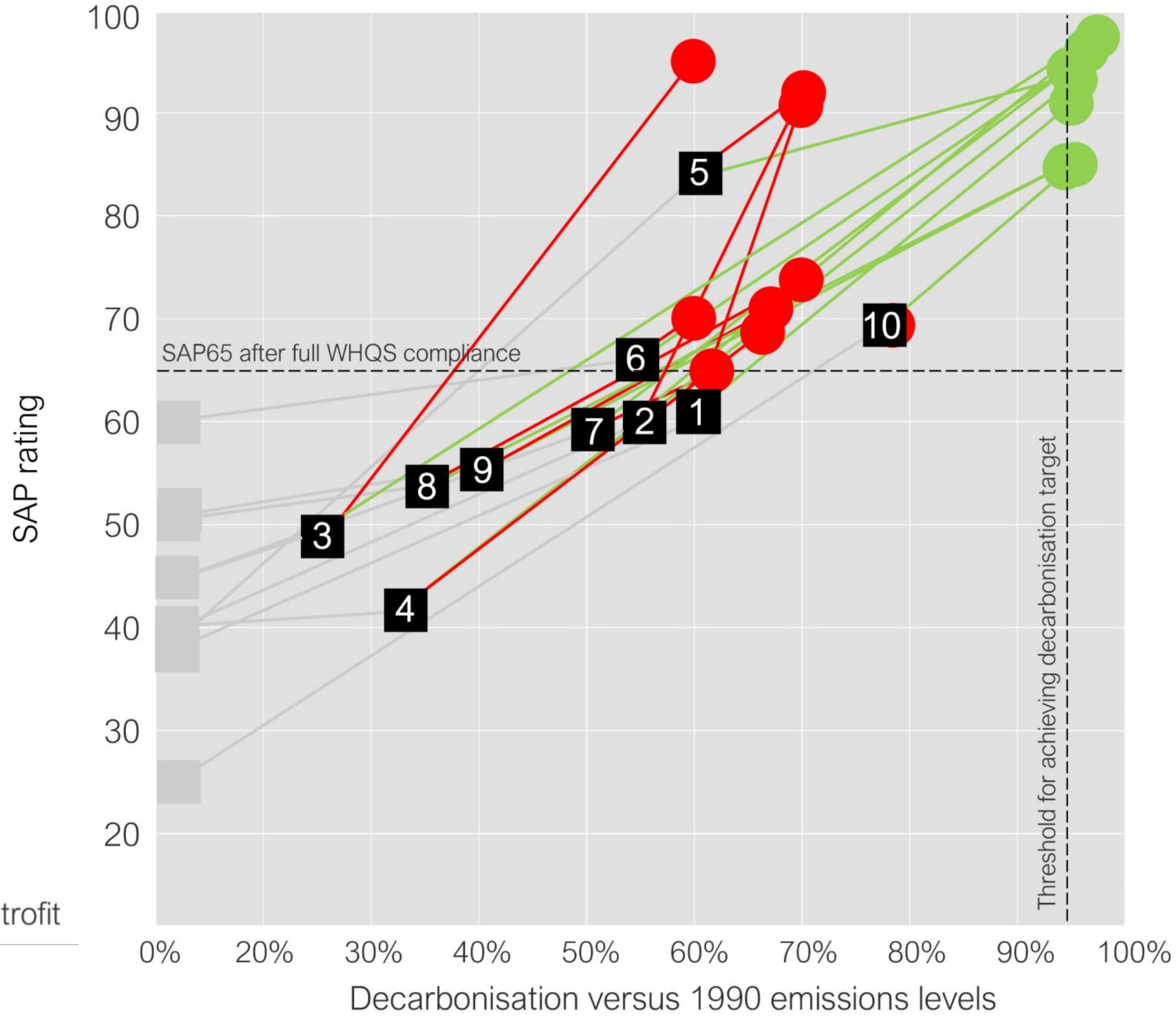
1965 - 1990						33%
post 1990						13%
Total	7%	15%	33%	23%	6%	84%

a representative taxonomy of 14 case studies

Stage 3_carbon versus cost

Stage 3 compared retrofit for decarbonisation with typical repairs, maintenance and improvement work, as planned by social housing landlords.

Ten case studies were reflect the range of house types evident in the social housing sector.



case study in 1990
case study as existing
case study after anticipated RMI
case study after decarbonisation retrofit

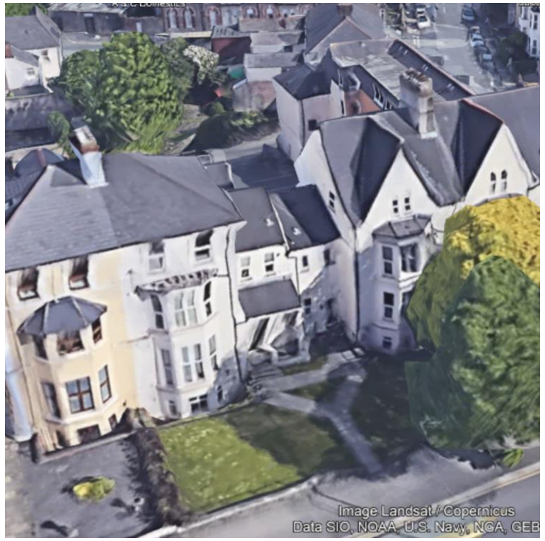
case study:	capital costs:
1	£22k £33k
2	£19k £31k
3	£18k £29k
4	£12k £31k
5	£10k £27k
6	£7k £26k
7	£8k £25k
8	£9k £20k
9	£8k £22k
10	£2k £19k

Stage 4_carbon, cost or quality?

case study 1:
a block of flats

case study 2:
a Victorian terrace

case study 3:
a post-war estate



case study 4:
a hard urban context

Context:

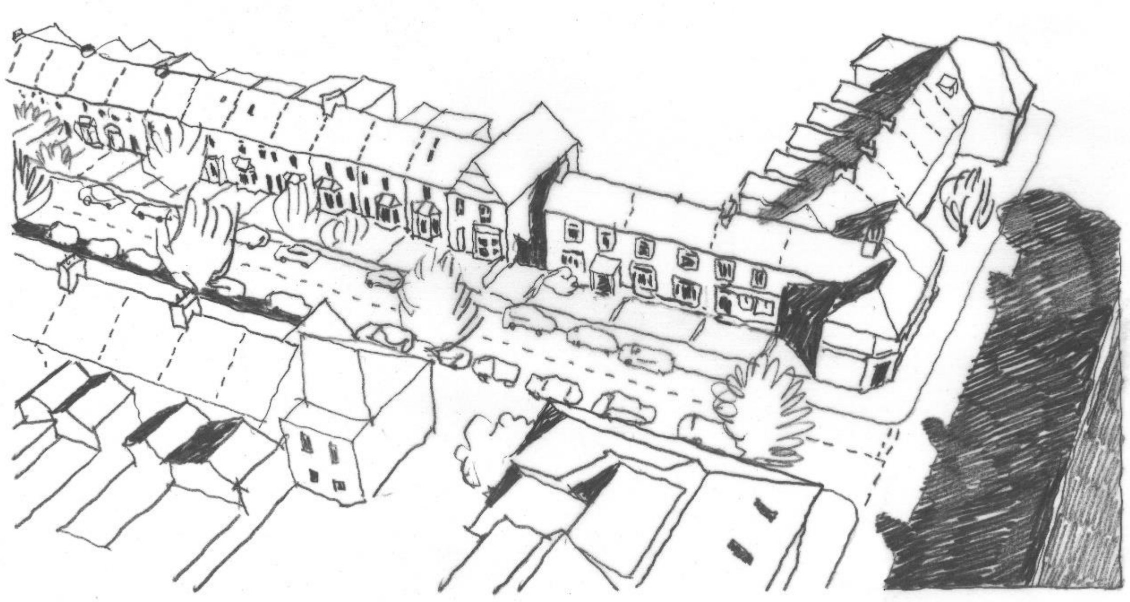
A pre-1919 mid-terrace dwelling owned by a private landlord in Roath, Cardiff.

A typical terraced Victorian house with traditional street frontage; street has consistent character and scale.

To the rear and internally homes have been adjusted, adapted and extended in different ways over the last century.

The variety evident along the street reveals scope for future changes, and opportunities to improve quality.

left: the case study in Roath, Cardiff
right: a breakdown of the Welsh housing stock
below: the existing street scene



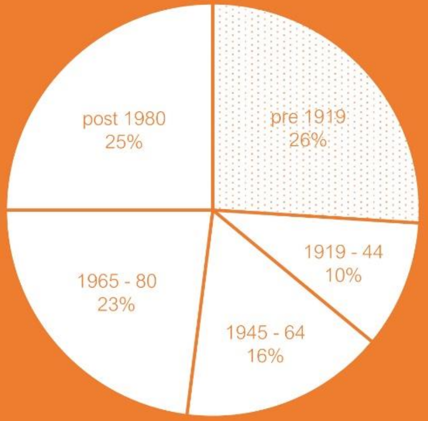


Figure 1: homes by age

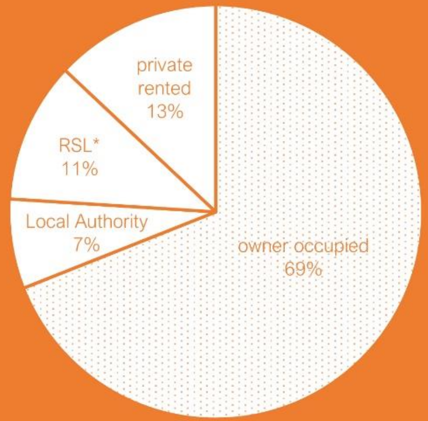


Figure 2: homes by tenure

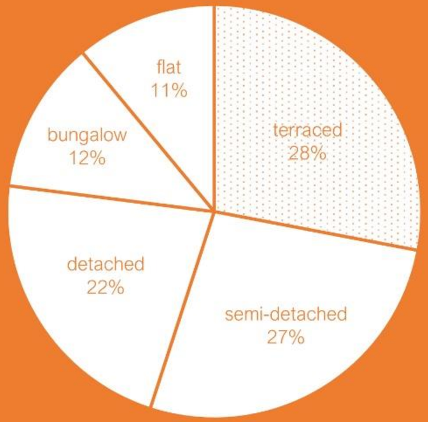
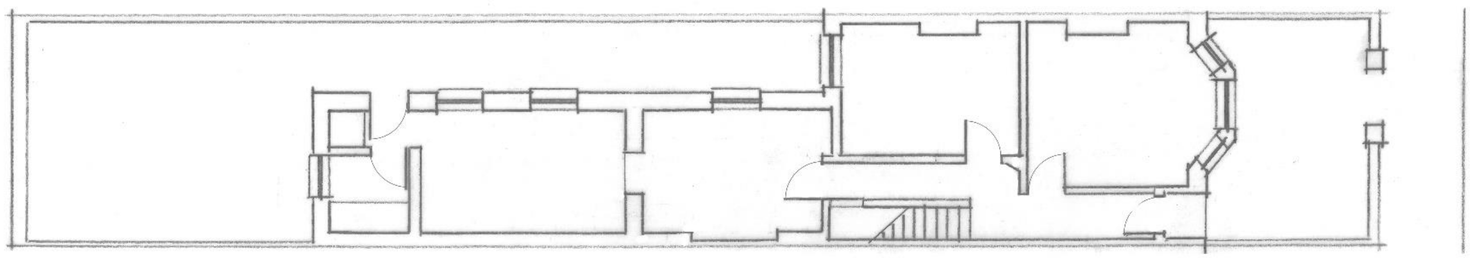
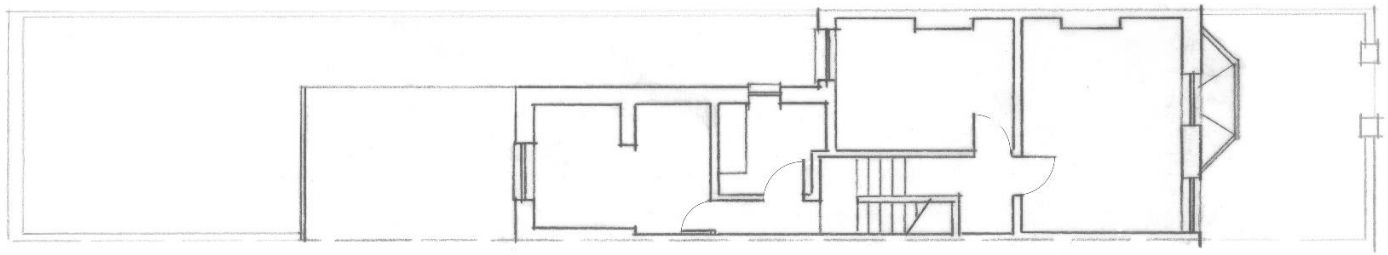


Figure 3: homes by type

as existing: a typical pre-1919 mid-terrace dwelling





Performance as existing:

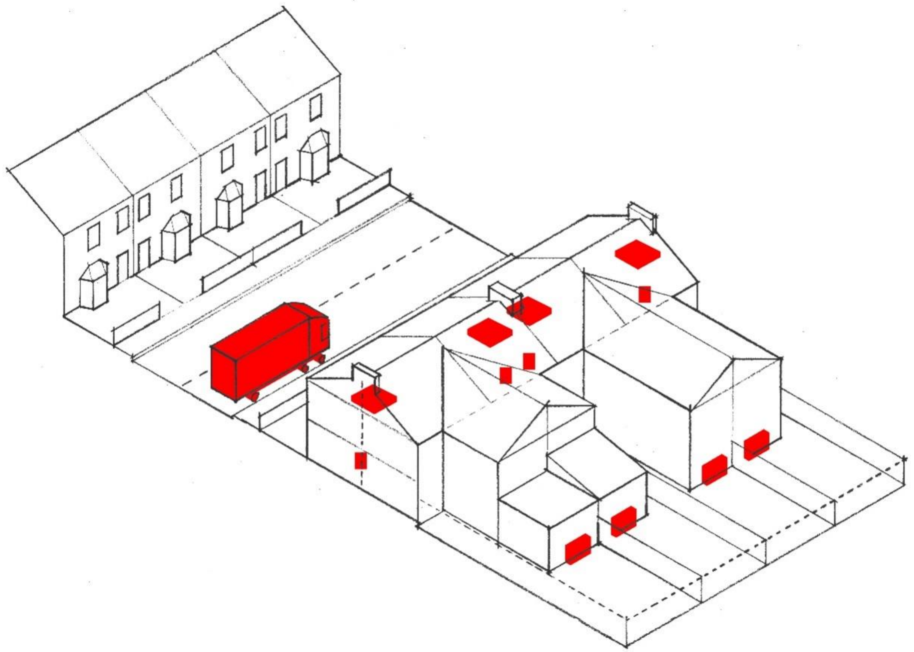
SAP rating 64 EPC band D

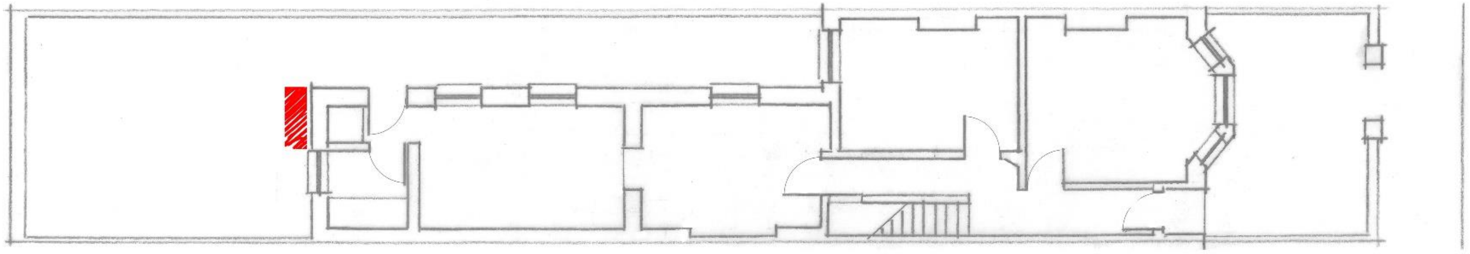
Predicted annual fuel bills: £3,218

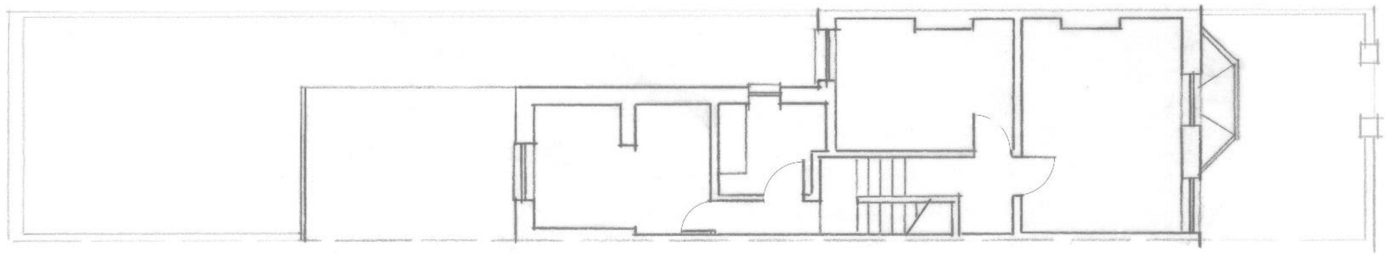
Embodied carbon, proposed work: nil

Carbon in use: 34% decarbonised vs.1990

scenario 1: light retrofit for decarbonisation







Results without renewables:

SAP rating 54 EPC band D

predicted annual fuel bills: £3,922

Embodied carbon of retrofit: 8524 $kgCO_2$

Carbon in use: 81% decarbonised vs.1990

Results with renewables:

SAP rating 65 EPC band D

predicted annual fuel bills: £3,026

Embodied carbon of retrofit: 18,580 $kgCO_2$

Carbon in use: 86% decarbonised vs.1990

scenario 2: deep retrofit for decarbonisation and affordable warmth

Results without renewables:

SAP rating 75 EPC band C

predicted annual fuel bills: £2,258

Embodied carbon of retrofit: 15,950 kgCO2

Carbon in use: 90% decarbonised vs.1990

Results with renewables:

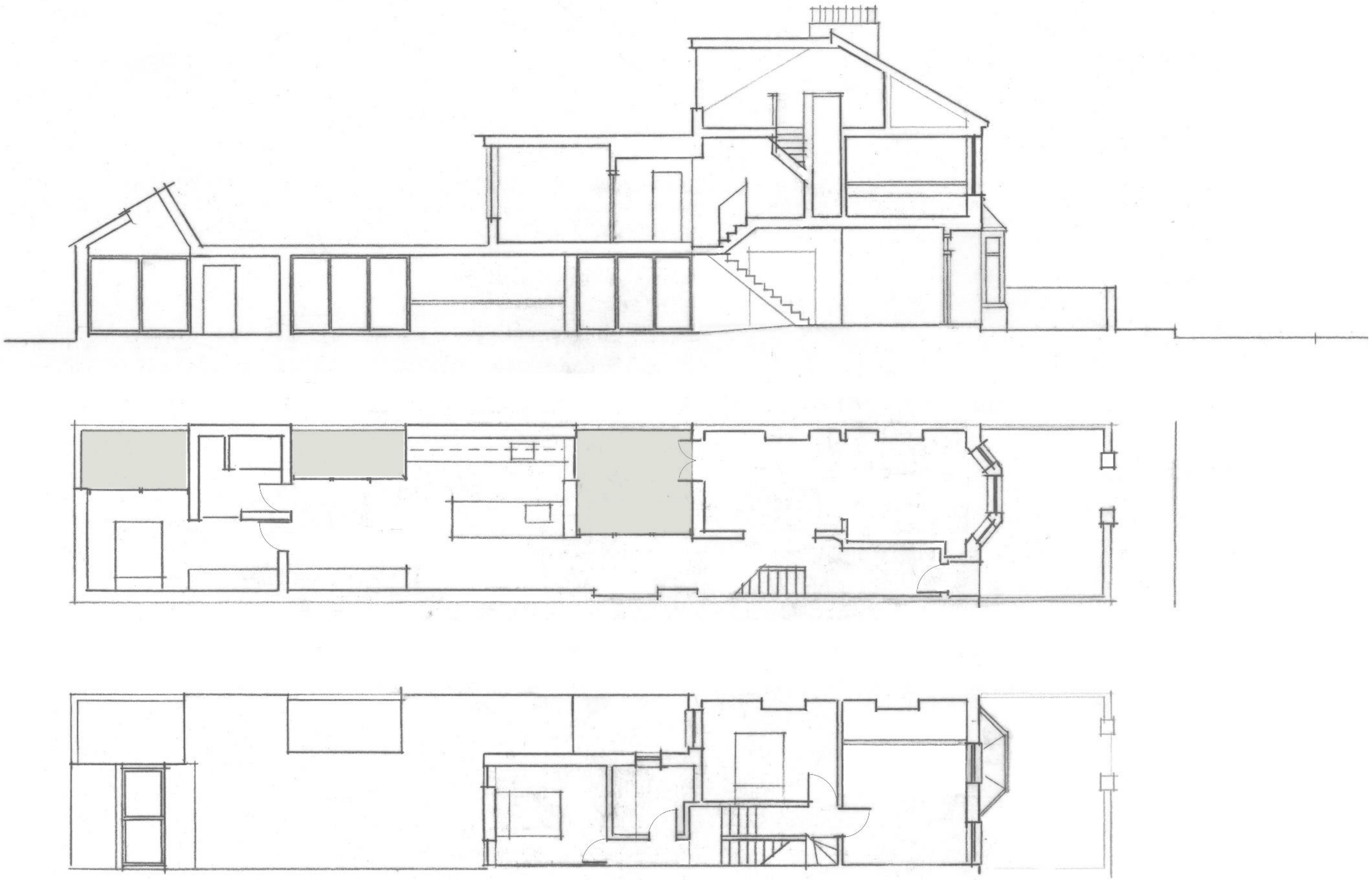
SAP rating 86 EPC band B

predicted annual fuel bills: £1,362

Embodied carbon of retrofit: 26,000 kgCO2

Carbon in use: 94% decarbonised vs.1990

scenario 3: adaptive retrofit for decarbonisation, affordable warmth and quality homes



Results without renewables:

SAP rating 78 EPC band C

predicted annual fuel bills: £2,680

Embodied carbon of retrofit: 19,545 $kgCO_2$

Carbon in use: 88% decarbonised vs.1990

Results with renewables:

SAP rating 90 EPC band B

predicted annual fuel bills: £1,336

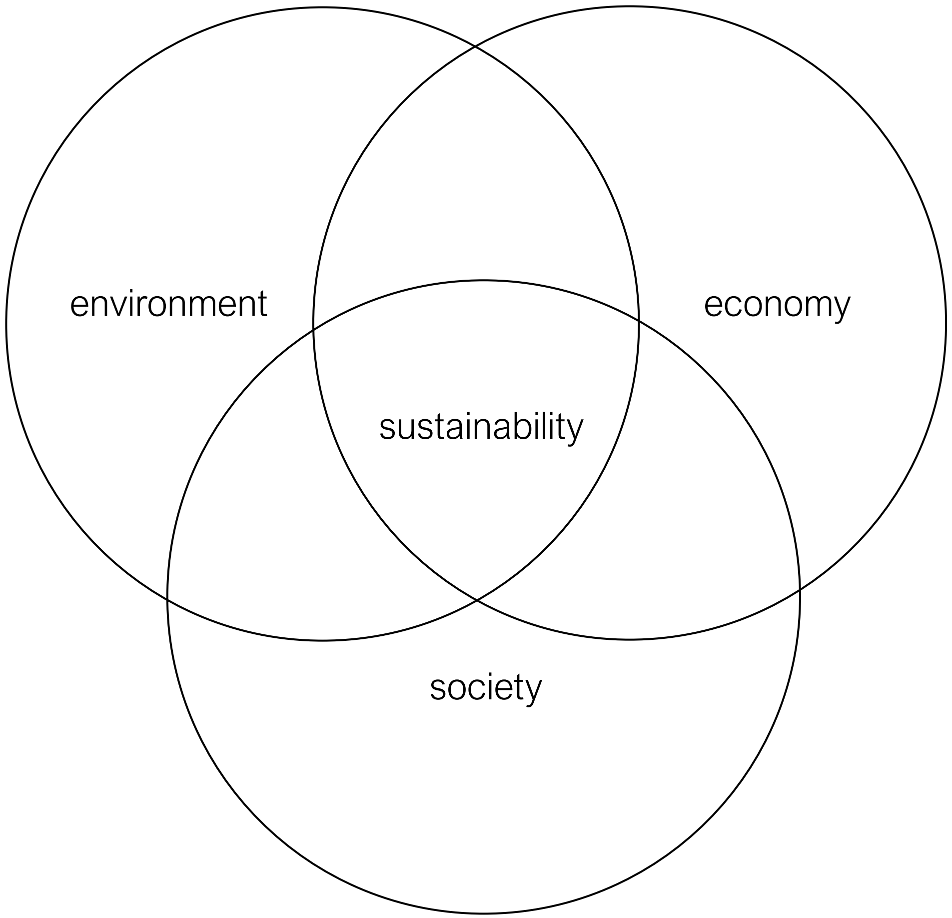
Embodied carbon of retrofit: 29,600 $kgCO_2$

Carbon in use: 95% decarbonised vs.1990

A retrofit agenda: carbon, cost or quality?

"The UK is heavily dependent on a handful of volume housebuilders motivated by short-term profitability. This model has served us badly. It has, of course, failed to create more than about half the new homes that the country needs. But more fundamentally, it has failed us in the quality of design and placemaking. As well as poor workmanship, abysmal space standards and an absence of investment in innovation and building skills, the major housebuilders have let us down by reneging on promises to include affordable homes."

Richard Best, Housing Design Handbook (2019)



Above: three pillars of sustainability - as defined by the Brundtland Report (1987), Agenda 21 (1992) and the 2002 World Summit

A retrofit agenda: carbon, cost or quality?

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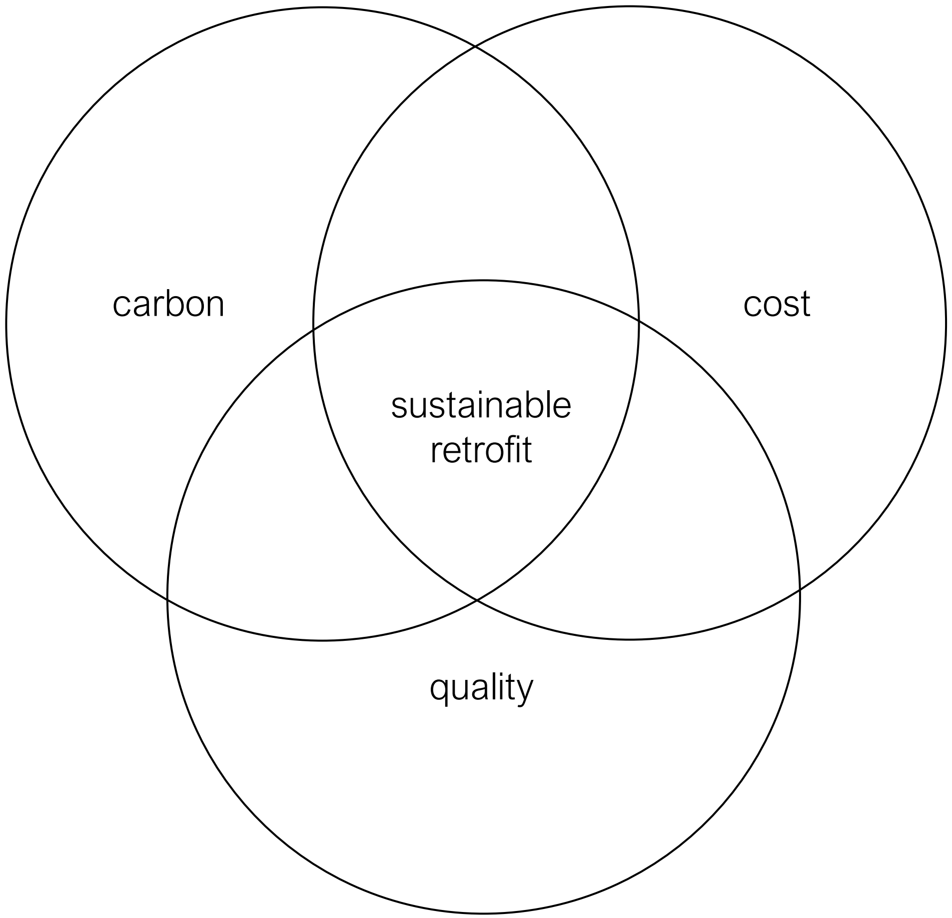


Above: three pillars for sustainable retrofit

Retrofit in practice and the RIBA plan of work

RIBA
Plan of Work
2020

Stage Boundaries:

Stages 0-4 will generally be undertaken one after the other.

Stages 4 and 5 will overlap in the **Project Programme** for most projects.

Stage 5 commences when the contractor takes possession of the site and finishes at **Practical Completion**.

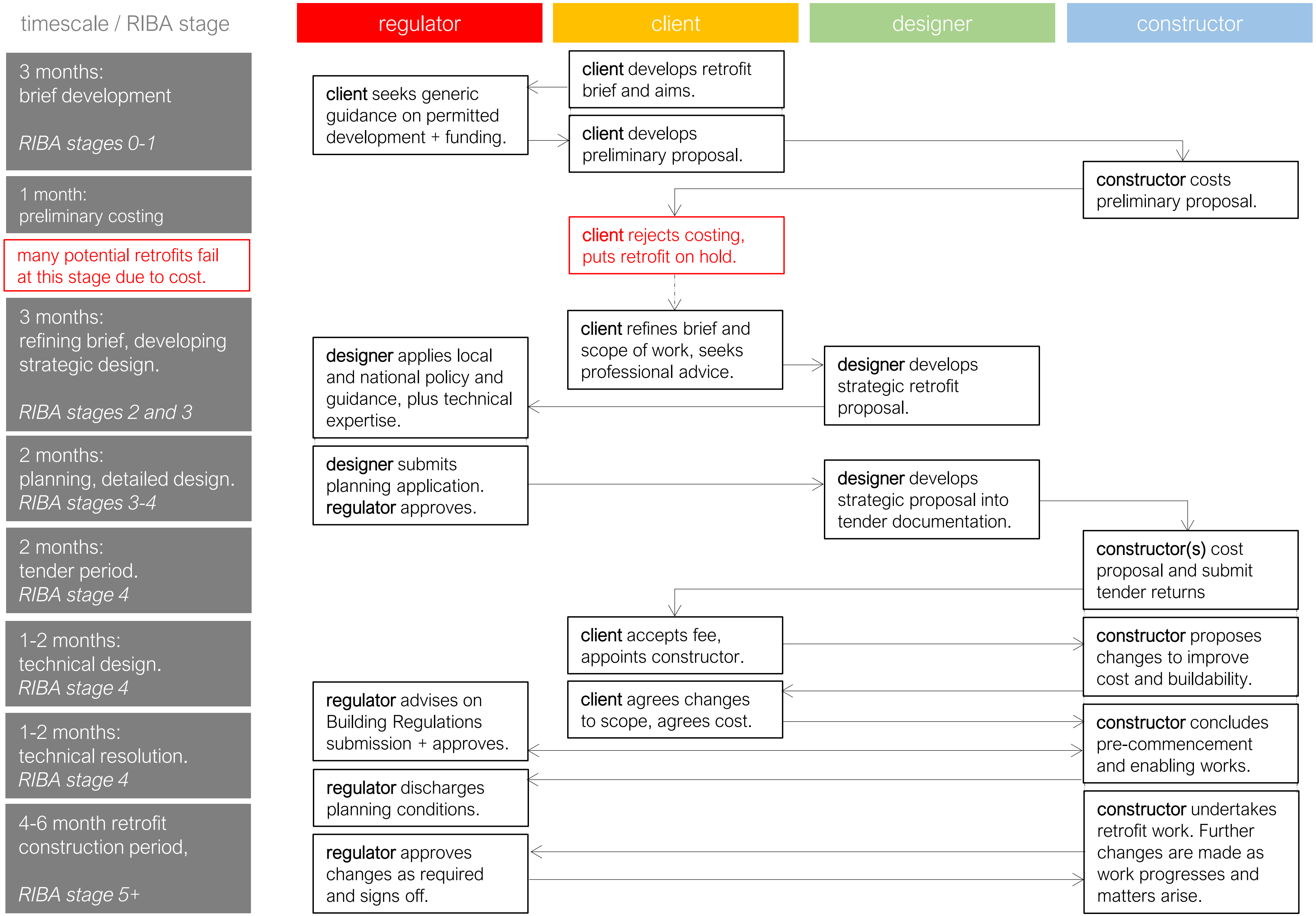
Stage 6 starts with the handover of the building to the client immediately after **Practical Completion** and finishes at the end of the **Defects Liability Period**.

Stage 7 starts concurrently with Stage 6 and lasts for the life of the building.

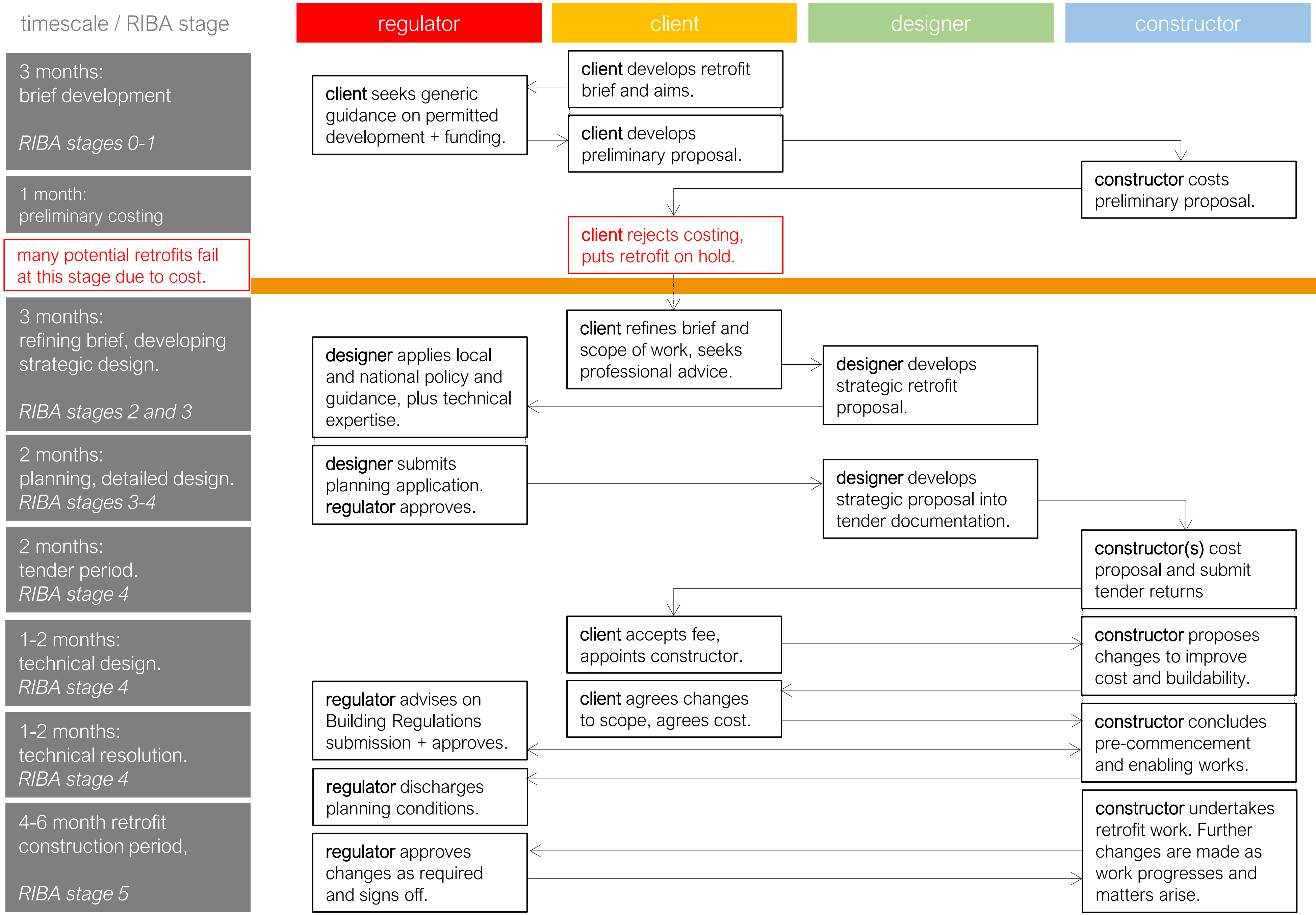
Planning Note:
Planning Applications are generally submitted

The RIBA Plan of Work organises the process of briefing, designing, delivering, maintaining, operating and using a building into eight stages. It is a framework for all disciplines on construction projects and should be used solely as guidance for the preparation of detailed professional services and building contracts.

	0 Strategic Definition	1 Preparation and Briefing	2 Concept Design	3 Spatial Coordination	4 Technical Design	5 Manufacturing and Construction	6 Handover	7 Use
		← Projects span from Stage 1 to Stage 6; the outcome of Stage 0 may be the decision to initiate a project and Stage 7 covers the ongoing use of the building. →						
Stage Outcome at the end of the stage	The best means of achieving the **Client Requirements** confirmed If the outcome determines that a building is the best means of achieving the **Client Requirements**, the client proceeds to Stage 1	**Project Brief** approved by the client and confirmed that it can be accommodated on the site	**Architectural Concept** approved by the client and aligned to the **Project Brief** The brief remains "live" during Stage 2 and is derogated in response to the **Architectural Concept**	Architectural and engineering information **Spatially Coordinated**	All design information required to manufacture and construct the project completed Stage 4 will overlap with Stage 5 on most projects	Manufacturing, construction and **Commissioning** completed There is no design work in Stage 5 other than responding to **Site Queries**	Building handed over, **Aftercare** initiated and **Building Contract** concluded	Building used, operated and maintained efficiently Stage 7 starts concurrently with Stage 6 and lasts for the life of the building
Core Tasks during the stage **Project Strategies** might include: – **Conservation** (if applicable) – **Cost** – **Fire Safety** – **Health and Safety** – **Inclusive Design** – **Planning** – **Plan for Use** – **Procurement** – **Sustainability** See *RIBA Plan of Work 2020 Overview* for detailed guidance on **Project Strategies**	Prepare **Client Requirements** Develop **Business Case** for feasible options including review of **Project Risks** and **Project Budget** Ratify option that best delivers **Client Requirements** Review **Feedback** from previous projects Undertake **Site Appraisals**	Prepare **Project Brief** including **Project Outcomes** and **Sustainability Outcomes**, **Quality Aspirations** and **Spatial Requirements** Undertake **Feasibility Studies** Agree **Project Budget** Source **Site Information** including **Site Surveys** Prepare **Project Programme** Prepare **Project Execution Plan**	Prepare **Architectural Concept** incorporating **Strategic Engineering** requirements and aligned to **Cost Plan**, **Project Strategies** and **Outline Specification** Agree **Project Brief Derogations** Undertake **Design Reviews** with client and **Project Stakeholders** Prepare stage **Design Programme**	Undertake **Design Studies**, **Engineering Analysis** and **Cost Exercises** to test **Architectural Concept** resulting in **Spatially Coordinated** design aligned to updated **Cost Plan**, **Project Strategies** and **Outline Specification** Initiate **Change Control Procedures** Prepare stage **Design Programme**	Develop architectural and engineering technical design Prepare and coordinate design team **Building Systems** information Prepare and integrate specialist subcontractor **Building Systems** information Prepare stage **Design Programme** Specialist subcontractor designs are prepared and reviewed during Stage 4	Finalise **Site Logistics** Manufacture **Building Systems** and construct building Monitor progress against **Construction Programme** Inspect **Construction Quality** Resolve **Site Queries** as required Undertake **Commissioning** of building Prepare **Building Manual**	Hand over building in line with **Plan for Use Strategy** Undertake review of **Project Performance** Undertake seasonal **Commissioning** Rectify defects Complete initial **Aftercare** tasks including light touch **Post Occupancy Evaluation**	Implement **Facilities Management** and **Asset Management** Undertake **Post Occupancy Evaluation** of building performance in use Verify **Project Outcomes** including **Sustainability Outcomes** Adaptation of a building (at the end of its useful life) triggers a new Stage 0
	No design team required for Stages 0 and 1. Client advisers may be appointed to the client team to provide strategic advice and design thinking before Stage 2 commences.					Building handover tasks bridge Stages 5 and 6 as set out in the **Plan for Use Strategy**		

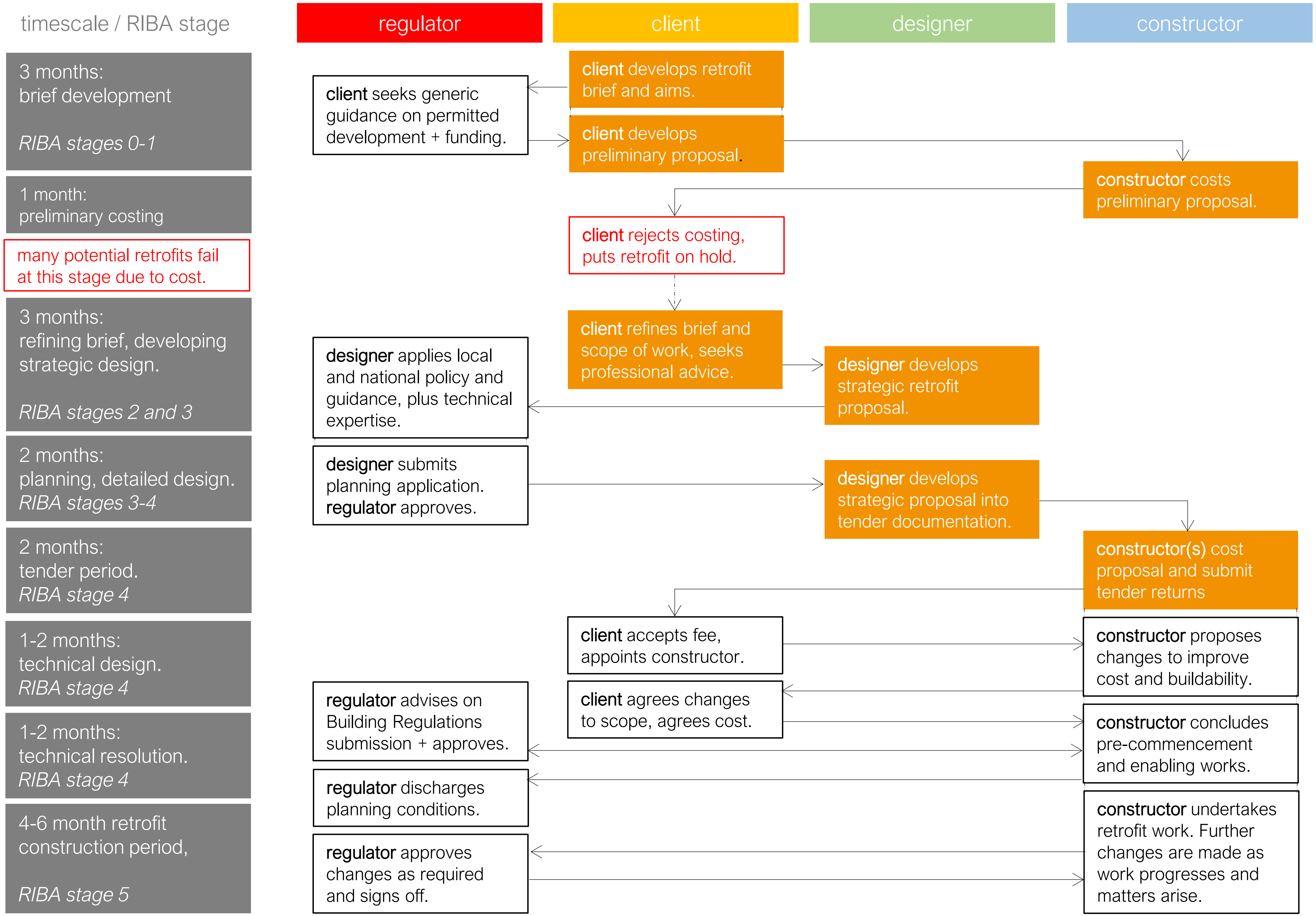


timescale / RIBA stage
regulator
client
designer
constructor
3 months:
brief development
RIBA stages 0-1
client develops retrofit brief and aims.
client seeks generic guidance on permitted development + funding.
client develops preliminary proposal.
1 month:
preliminary costing
constructor costs preliminary proposal.
many potential retrofits fail at this stage due to cost.
client rejects costing, puts retrofit on hold.
3 months:
refining brief, developing strategic design.
RIBA stages 2 and 3
client refines brief and scope of work, seeks professional advice.
designer develops strategic retrofit proposal.
designer applies local and national policy and guidance, plus technical expertise.
2 months:
planning, detailed design.
RIBA stages 3-4
designer submits planning application. regulator approves.
designer develops strategic proposal into tender documentation.
2 months:
tender period.
RIBA stage 4
constructor(s) cost proposal and submit tender returns
1-2 months:
technical design.
RIBA stage 4
client accepts fee, appoints constructor.
constructor proposes changes to improve cost and buildability.
1-2 months:
technical resolution.
RIBA stage 4
regulator advises on Building Regulations submission + approves.
client agrees changes to scope, agrees cost.
constructor concludes pre-commencement and enabling works.
regulator discharges planning conditions.
4-6 month retrofit construction period,
RIBA stage 5+
regulator approves changes as required and signs off.
constructor undertakes retrofit work. Further changes are made as work progresses and matters arise.



early failure

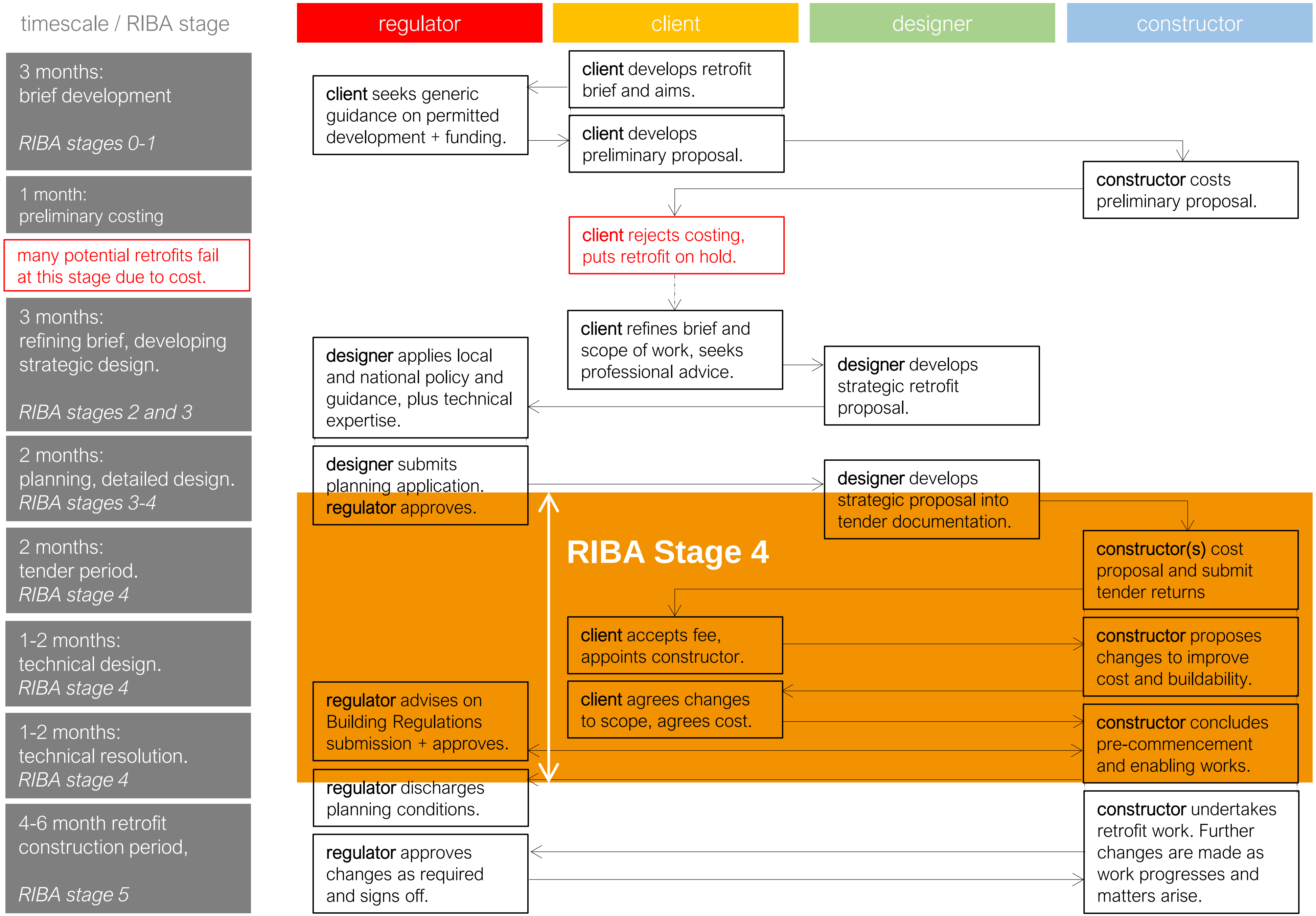
Many possible retrofit projects fail at this point. A lack of good quality information and high levels of risk lead to poor decision making.



abortive work

Key stakeholders are brought in at very different times, and each has different expertise.

As a result, the scope of work is revised many times, leading to extensive abortive work and a prolonged programme.



late technical design

(compressed into RIBA plan of work Stage 4)

For retrofit to succeed, decision-making must be informed by sound technical understanding from the outset.

timescale / RIBA stage

regulator | client | designer | constructor

3 months:
brief development

RIBA stages 0-1

client develops retrofit brief and aims.

client seeks generic guidance on permitted development + funding.

client develops preliminary proposal.

1 month:
preliminary costing

constructor costs preliminary proposal.

many potential retrofits fail at this stage due to cost.

client rejects costing, puts retrofit on hold.

3 months:
refining brief, developing strategic design.

RIBA stages 2 and 3

client refines brief and scope of work, seeks professional advice.

designer develops strategic retrofit proposal.

designer applies local and national policy and guidance, plus technical expertise.

2 months:
planning, detailed design.
RIBA stages 3-4

designer submits planning application. **regulator** approves.

designer develops strategic proposal into tender documentation.

2 months:
tender period.
RIBA stage 4

constructor(s) cost proposal and submit tender returns

1-2 months:
technical design.
RIBA stage 4

client accepts fee, appoints constructor.

constructor proposes changes to improve cost and buildability.

client agrees changes to scope, agrees cost.

1-2 months:
technical resolution.
RIBA stage 4

regulator advises on Building Regulations submission + approves.

constructor concludes pre-commencement and enabling works.

regulator discharges planning conditions.

4-6 month retrofit construction period,

RIBA stage 5

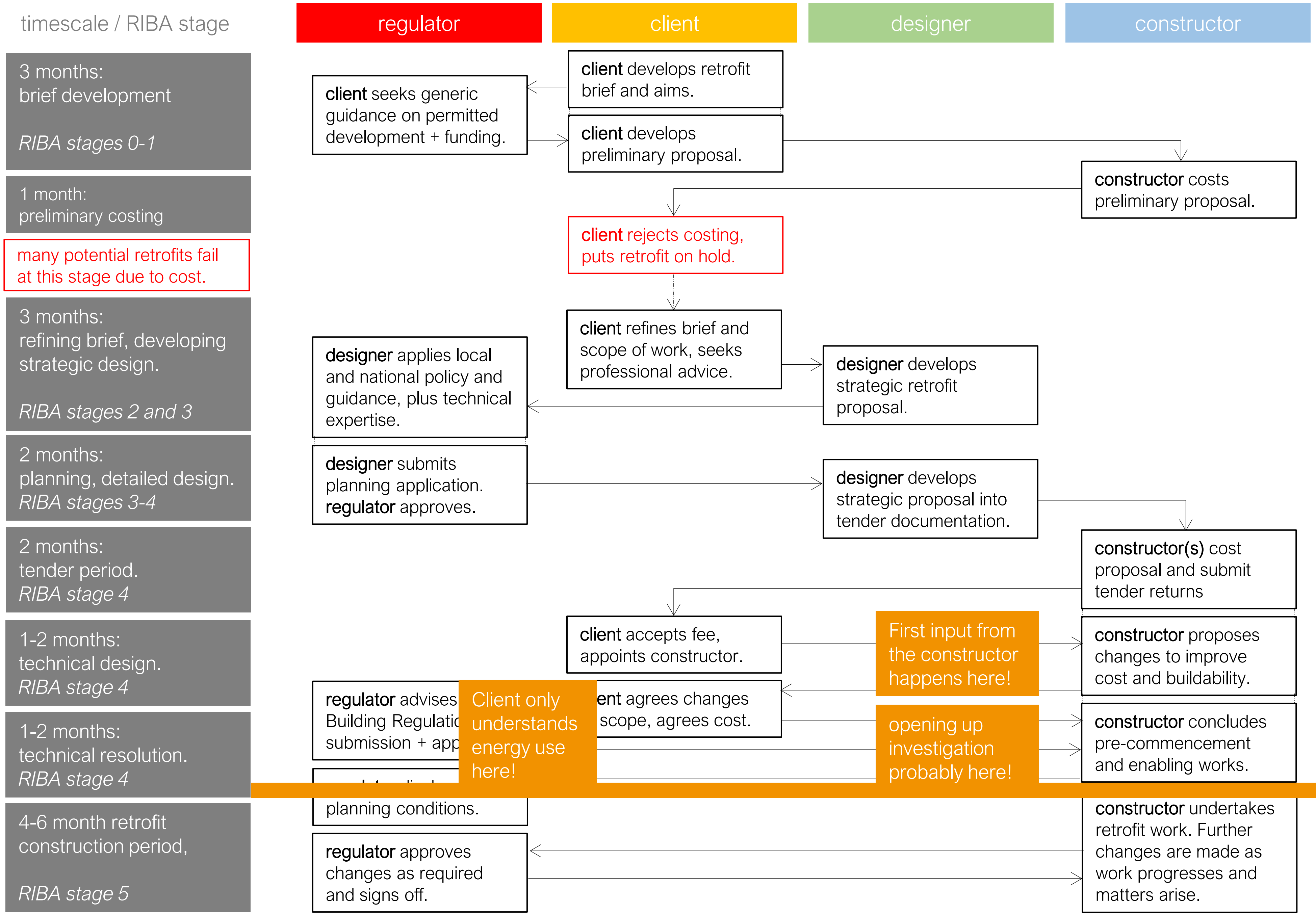
regulator approves changes as required and signs off.

constructor undertakes retrofit work. Further changes are made as work progresses and matters arise.

missing link

The designer provides an important link between client and constructor, and understands key project aims, but may have no input as technical design develops.

lack of coherent holistic vision



slow progress

The RIBA Plan of Work describes practice as a linear process, with key milestones in a particular order.

This creates a slow front end and increases cost, with many opportunities for delays and / or failure.

12-15 months to this point

a different agenda:
collaborative holistic retrofit

Retrofit and governance

Governance could create a context for more, better retrofit. Centrally provided guidance for homeowners and landlords would increase the amount and quality of retrofit, particularly in an economic climate where fewer people are moving home. Advice should come from a reputable public body without commercial bias. It should outline a streamlined retrofit process, and describe benefits and challenges clearly.

The planning process presents a major obstacle for retrofit, particularly if the aim is to increase property value. Permitted development rights enable some work, but currently it is difficult to obtain meaningful advice on planning matters, partly because every retrofit is different. Local Authorities could reduce risk and uncertainty by providing affordable, accessible project-specific advice. But this would require considerable investment.

Understanding the impact of retrofit on fuel bills is essential. Presently, energy modelling tends to happen too late. A coordinated energy efficiency advisory service, aligned with funding for energy efficiency measures, could pump-prime retrofit. This service could deliver best practice advice through exemplar case studies and useful, project-specific guidance at the right points in the retrofit process. This would increase confidence in retrofit, diminishing risk and reducing the likelihood of project failure.

Finally, central government, Local Authorities or professional accreditation bodies could make retrofit more attractive and cost-effective by incentivising collaboration between retrofit designers and constructors. If these services were offered in a joined up way, either through a one-stop-shop or a partnering approach, there would be less abortive work, shorter retrofit timelines, and better decision making throughout.

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