

Market Potential and Life Cycle Analysis of Massive Wood Buildings

***Output Report from EU-funded project
“Sustainable Energy Systems in Advanced Cities”
(SESAC)
(Work Package 16.2)***

***Prospects for timber frame in multi-storey
house-building in England, France, Germany,
Ireland, the Netherlands & Sweden***

***By
Ragnar Jonsson***



Background

The construction sector uses

≈ 40 % of total energy consumption &
≈ 30 % of CO₂ emissions

Use of Wood >>>> many advantages:

Production phase (extraction, production and transport to site): uses less energy
& negative CO₂ emissions (**carbon sink effect of forests**)

In-use phase: wood's natural thermal efficiency =>
timber systems more cost-effective than other materials in
energy-efficient construction

End-of-life phase (recycling, recovery & disposal): wood-based panels manufactured
from by-products, sawdust & chips, as well as from recovered wood,
& wood, used as a substitute for fossil fuels => renewable, **carbon
dioxide neutral, energy source.**





Determinants

Overall house-building levels

- **Economic development:** Economic growth increases demand for housing
- **Demographics:** a) **Population increases** => housing demand increases
b) **number of households** even more decisive than population size for housing demand
c) **Age structure**; ageing population => i) housing demand decreases; ii) industrialisation in the construction industry: increased demand for factory made construction components (shrinking workforce)

Timber frame (TF) market share

- **Attitudes:** (mainly architects, developers and construction firms)
- **Building regulations & other policy instruments**

Real GDP growth (%). Observations and forecasts.

Five year averages

	<u>1993-1997</u>	<u>1998-2002</u>	<u>2003-2007</u>	<u>2008-2012</u>	<u>2013-2017</u>	<u>2018-2022</u>
France	1.4	2.7	2.0	0.4	2.2	1.9
Germany	1.3	1.7	1.5	-0.4	1.9	1.7
UK	3.1	2.9	2.8	0.3	2.6	2.4
Ireland	7.6	8.1	5.2	-2.0	4.0	3.9
Netherlands	2.7	2.9	2.3	0.1	2.5	2.4
Sweden	2.2	3.3	3.2	0.3	2.5	2.6

Sources: *UN National Accounts Main Aggregates Database* (1988-1997), *eurostat* (1998-2009) & *Economist Intelligence Unit* (2010-2022). Forecasts for 2008-2012 from *IMF*.

Population projections (millions)

	<u>2005</u>	<u>2010</u>	<u>2015</u>	<u>2020</u>	<u>2025</u>
France	60.2	61.5	62.6	63.6	64.4
Germany	82.6	82.8	82.9	82.7	82.1
UK	59.9	60.9	61.9	62.9	63.8
Ireland	4.1	4.3	4.6	4.8	4.9
NL	16.3	16.7	17.0	17.2	17.4
Sweden	9.0	9.2	9.4	9.6	9.8

Distribution of household size (%)

	1 person			2 persons			3 persons			4 persons			≥5 persons		
	1981	2003	2004	1981	2003	2004	1981	2003	2004	1981	2003	2004	1981	2003	2004
France	24.0	30.0	32.5	29.0	33.0	32.3	18.0	15.0	na	16.0	14.0	na	12.0	8.0	7.1
Germany	31.0	37.0	37.0	29.0	34.0	34.0	17.0	14.0	14.0	14.0	11.0	11.0	9.0	4.0	4.0
UK	22.0	31.0	29.0	31.0	34.0	35.0	17.0	16.0	16.0	18.0	13.0	13.0	11.0	6.0	7.0
Ireland	17.0	22.0	na	20.0	26.0	na	15.0	18.0	na	15.0	17.0	na	32.0	18.0	na
NL	21.0	34.0	34.0	29.0	33.0	33.0	16.0	13.0	13.0	21.0	14.0	14.0	13.0	6.0	6.0
Sweden	33.0	47.0	46.0	31.0	28.0	28.0	15.0	11.0	10.0	15.0	10.0	11.0	6.0	4.0	5.0

Sources: *National Statistical Institutes* Note: *na = not available*

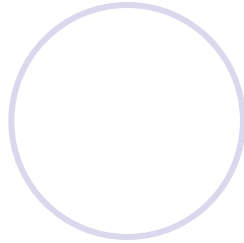
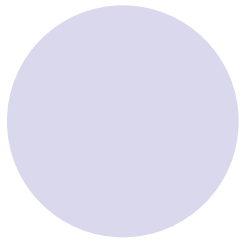
Prevalent trend: smaller, more numerous households

Old-age dependency ratio (%)

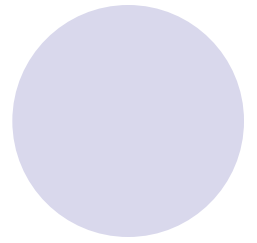
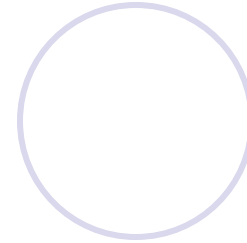
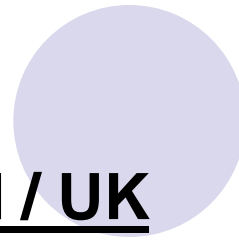
	<u>2008</u>	<u>2010</u>	<u>2020</u>	<u>2030</u>
France	25.3	25.8	32.8	39.0
Germany	30.3	31.2	35.3	46.2
UK	24.3	24.7	28.6	33.2
Ireland	16.3	16.7	20.2	24.6
NL	21.8	22.8	30.7	40.0
Sweden	26.7	27.8	33.7	37.4

Sources: *Eurostat, EUROPOP2008 convergence scenario*

Note: *Population aged 65 years or over divided by the working age population (15 -64 years old)*



England / UK



Attitudes:

Households prioritise **pragmatic issues** when choosing home, i.e., **location, affordability safety, comfort** (see.e.g., NHBCFoundation, 2007)

High confidence for TF method in the construction industry in Scotland, which is malso more adapted to TF than in England & Wales

In **England, concerns regarding quality of TF**, e.g., shrinks more than allowed for

Policy instruments:

UK / England

Building regulations:

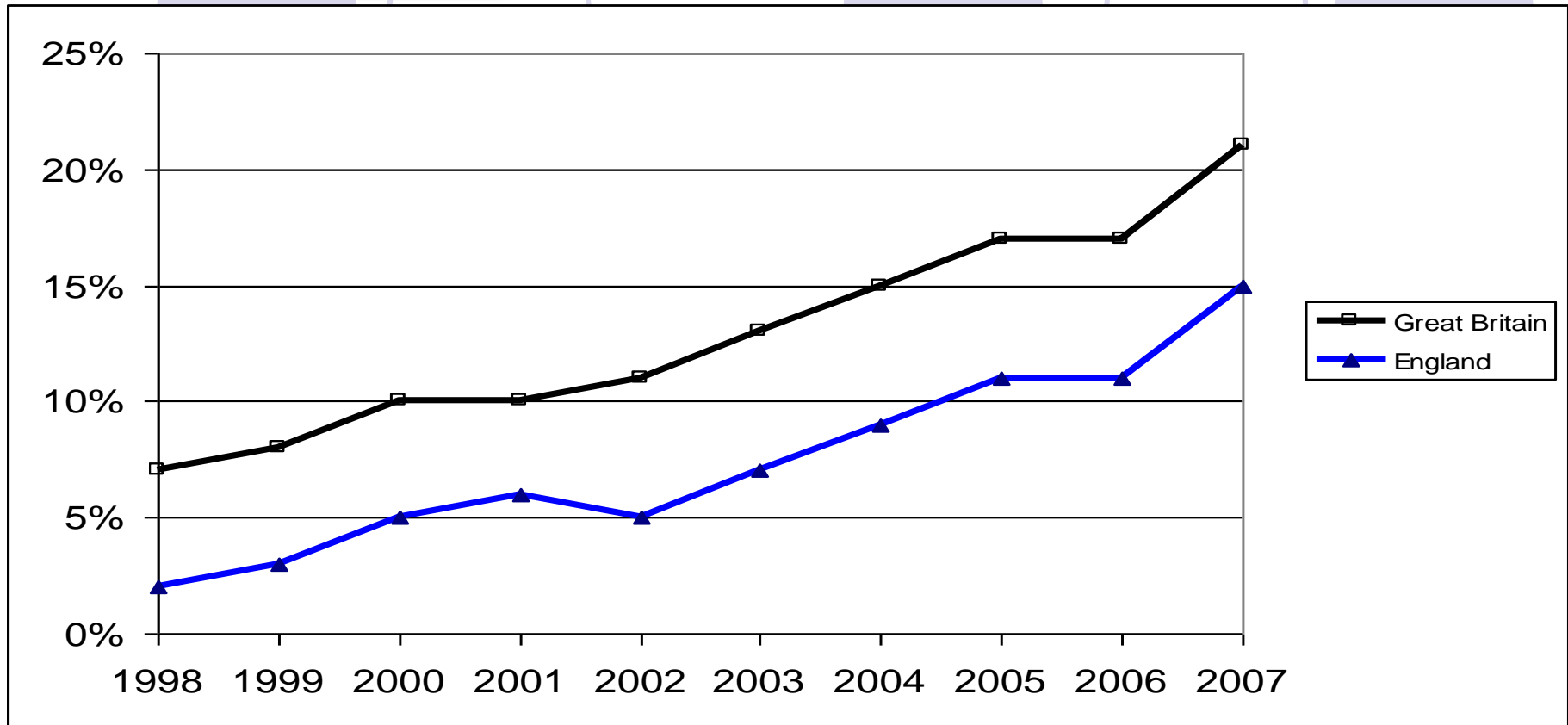
> > > 1991: more than three storeys with TF required special waivers.

1991 > > > : up to eight storeys with TF allowed in England & Wales

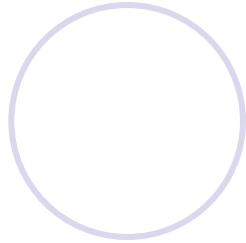
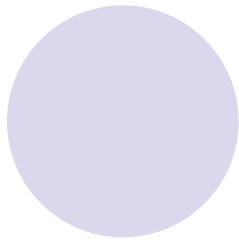
(HMSO, 1990-1995).

- **The Code for Sustainable Homes**; a national standard on energy use & CO₂ emissions from homes, environmental impact of construction materials & site waste management.
- **The National Affordable Housing Programme (NAHP)**: a target to increase output of affordable housing (a combination of social housing for rent & subsidised housing for part ownership). Government funding conditional on committing ≥ 25% of the development budget to **MMC, Modern Methods of Construction**
- **The Wood for good** campaign, started in 2000, supported by the Forestry commission & the British forest industry association Confor. Purpose: increasing the knowledge about & positive attitudes toward wood as a construction material

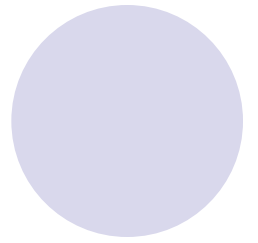
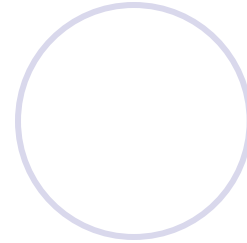
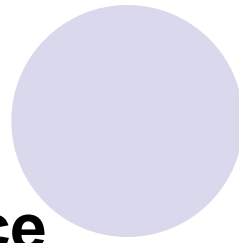
UK / England – Market share of Timber Frame



A market share for TF in England of 25-30% within ten years should be possible. Single-family houses will continue to make up the majority, but flats could climb up to \approx 40% of TF housing starts



France



Attitudes:

A survey indicated that **78% of the French are willing to pay more for a construction representing sustainable development** (CNDB, 2006).

However, despite a generally positive attitude toward wood, **TF lack in cultural references** (Ibid)

Wood is quite simply not associated with French building traditions, based around stone and brickwork (Bumanis, 2005).



France

Policy instruments:

Bois – Construction - Environnement, initiated in 1996 with the participation of the French government & major professional organisation: an effort to fight the greenhouse effect by furthering the use of wood in construction by, e.g., encouraging cooperation between different actors in the construction sector; increasing education & research within the field of timber construction

In 2001, **agreement between the state & the French construction industry** to increase the share of wood in construction by 25% within five years

In 2004 **the campaign - *Le bois, c'est essentiel* - a partnership between the Swedish Forest Industries Federation and the French organisation CNDB** (Comité National pour le Développement du Bois) promoting the use of wood in construction, was initiated

France - Current state & trends

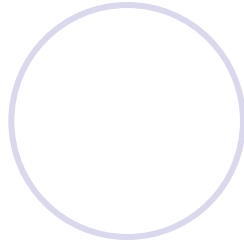
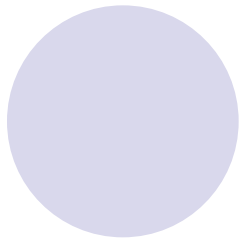
There are **no time series** for the timber frame (TF) share of **housing starts** & **no data at all** with regard to the share of **TF in multi-storey housing**.

In 2005, TF accounted for only 4% of single-family dwelling start,

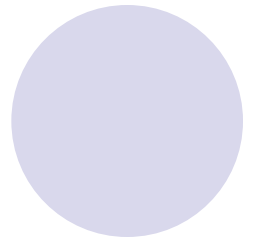
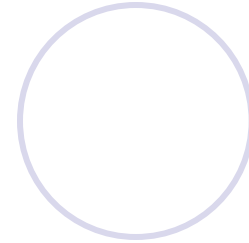
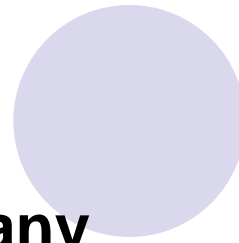
For multi-family dwelling starts the TF share was only 1% (CNDB, 2006).

Overcoming the main obstacle for TF, **cultural barriers**, is a lengthy process.

Up to 2020 a TF market share > 5 - 7.5% as regards single-family dwelling starts & > 2 - 2.5% as regards multi-family dwellings is **unlikely**



Germany



Attitudes:

In a survey **50% of respondents saw wood as a construction material** for the future, compared with 27% , 13% & 6% as regards brick, concrete & steel respectively (Sommar, 2007).

Large regional differences: TF already well established in Southern Germany (Köster & Wehner, 2008)

Policy instruments:

Germany

Change in **building regulations** in 2002 (Musterbauordnung MBO 2002), **allowing the construction of TF houses of up to five storeys.**

Charta für Holz: declaration adopted in 2004, in agreement between the federal government & German forest industry associations.

Aim: to increase the consumption of wood by 20% in the next ten years by stimulating demand, improving wood supply & promote innovation.

Energy-efficient & sustainable building construction will remain the main agenda items, due to the required reduction of greenhouse gases.

According to experts, **TF share in one- and two family housing will increase from 14% to 30%, & in multi-family housing from 2% to 10%, between 2006 and 2030.**

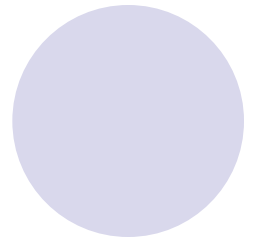
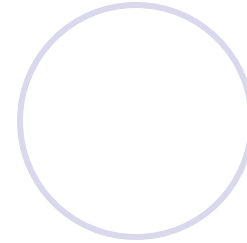
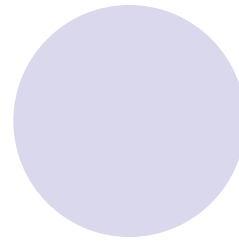
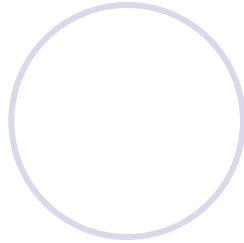
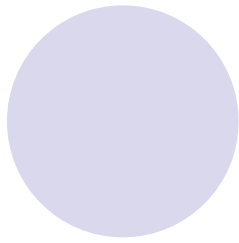
Germany - Current state & trends

Market share of Timber Frame in housing completions

	One- and two family houses	Multi-family houses	All dwellings
2002	13.4%	2.2%	12.7%
2003	12.9%	2.3%	12.2%
2004	12.7%	2.3%	12.1%
2005	13.8%	1.9%	13.1%
2006	14.2%	2.5%	13.5%

Note: In 2000, TF share in residential construction was only 2.7% (Köster & Wehner, 2008)

Sources: *Holzabsatzfonds*

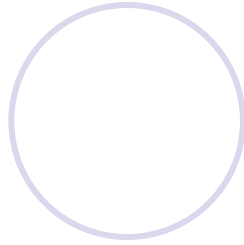
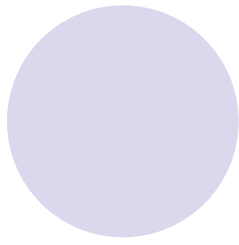


Ireland

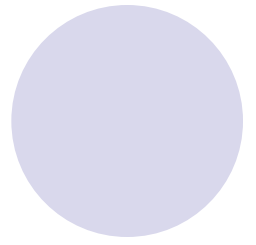
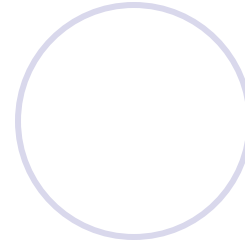
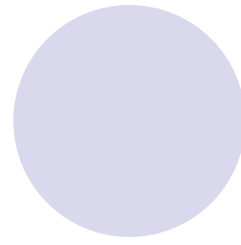
Attitudes:

Increased knowledge of & confidence in TF construction among designers, specifiers, builders and consumers (ITFMA).

> > > > TF is the fastest growing method of construction.



Ireland



Policy instruments:

Building regulations permit the use of TF in residential construction \leq 4 storeys (Cullen, 2003),

Changes in the building regulations from July 2008: to provide for

- a 40 % improvement in energy efficiency &
- a 40% reduction in CO2 emissions in new dwellings

Low carbon homes programme; a grant scheme: financial support for the construction of energy efficient, low carbon housing schemes

Ireland - Current state & trends

TF accounted for only 5 % of new dwellings constructed in 1992. By the end of 2006, that market share had risen to 30 % (ITFMA, 2008).

Private housing accounts for over 90 % of the TF output (Cullen, 2003).

About 80 % of the dwellings completed in Ireland are single-family (source: DEHLG).

Market share in overall residential construction of **≈ 50 % for TF** by the next decade is attainable, mainly single-family housing



The Netherlands

Attitudes:

Adoption of TF by Dutch construction industry is slow,

Explanation:-TF sector has focused too much on *form*

(technical features) **& too little on *function*** (social effects)

-TF industry has kept to its own network of converted enthusiasts (TF producers & constructors & architects, missing out on construction firms, contractors & structural engineers)



The Netherlands

Policy instruments:

1995-1999 Government program promoting TF construction on sustainability grounds.

Target: 20 % increase of wood in construction.

Outcome: 16 % increase (Sommar, 2007)

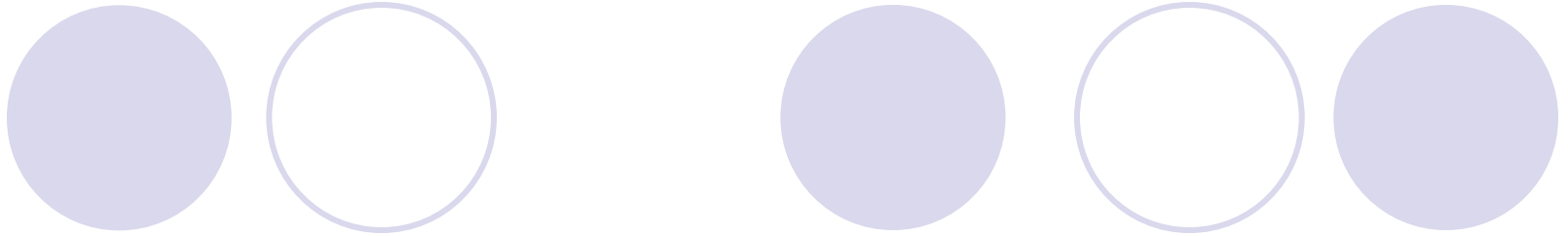
The Netherlands - Current state & trends

There are **no comprehensive data** as to the market share of **TF**

Around 100,000 TF dwellings have been constructed **since the introduction of the construction method** about 35 years ago (Centrum Hout, 2008).

TF market share in residential, commercial and industrial construction was only 3 % in 1998, up from 2 % in 1996 (Hügli Pollock, 1999).

The strongest driver for TF is environmental concerns; Netherlands being one of the nations with the greatest incentives for curbing global warming.

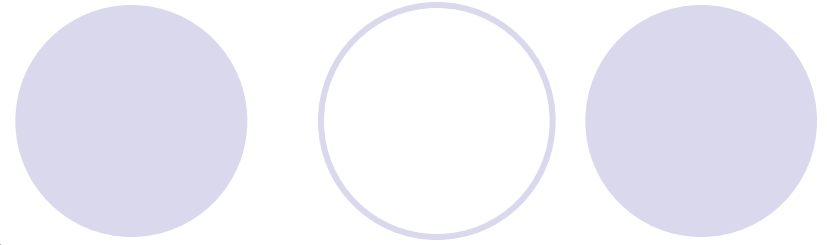
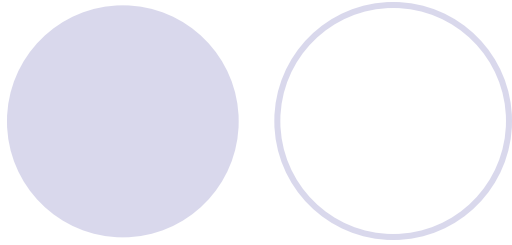


Sweden

Attitudes:

Positive attitude toward wood in general & as a construction material for single-family houses, but the fact that

wood was banned from being used in buildings with more than 3 storeys for 120 years means that there is scepticism toward TF in multi-storey house-building



Sweden

Policy instruments:

2004 **Government committee, *Nationella träbyggnadsstrategin***: promoting TF construction by:

- (i) supporting information to architects & construction engineers**
- (ii) furthering education & research within the field of TF construction**



Sweden - Current state & trends

TF dominates in single-family housing in Sweden, with a market share of $\approx 80-90$ % (von Platen, 2004)

There is no comprehensive statistics as to the share of TF in multi-storey residential construction in Sweden.

- **The share of TF in multi-family house-building ≈ 30 %,**
- **The share of TF in multi-storey ($>$ two storeys) house-building ≈ 10 %**

- **the target of 30 % of multi-storey houses constructed should be TF within ten years will most likely be reached, the majority in the segment ≤ 4 storeys**

Conclusions & outlook

Data as to the share of TF in house building in general & multi-storey house-building in particular **insufficient** in all the countries in question.

The countries are **in different evolutionary stages** as regards the share of timber frame in house-building in general:

France & the Netherlands are in **the introductory phase**, whereas **England & Ireland** have **experienced tremendous growth** in the share of timber frame houses the last 10 years.

In **Germany** there are significant regional differences, **the southern parts** of Germany **account for most of the growth** in TF construction.

In **Sweden**, the **TF share of single-family house building** has always been **very high**, whereas, **before 1994, timber load-bearing structures were allowed only in the construction of buildings up to two storeys**



Conclusions & outlook

For TF to become more than a niche method requires that the main material specifiers; architects, developers and construction engineers, regard timber frame as a real alternative when deciding on structural material. This, apparently, takes a while to accomplish.

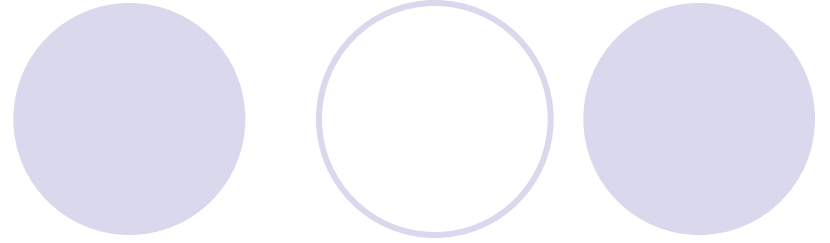
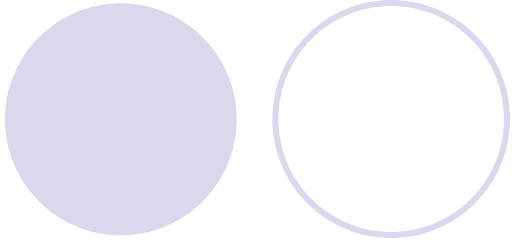
In countries, where timber frame has been used frequently in single-family house building, like (in declining order) Sweden, Ireland, England & southern Germany, TF should gain market shares in multi-storey house building quicker than in France & the Netherlands; the two latter lack in wood construction tradition.



Conclusions & outlook

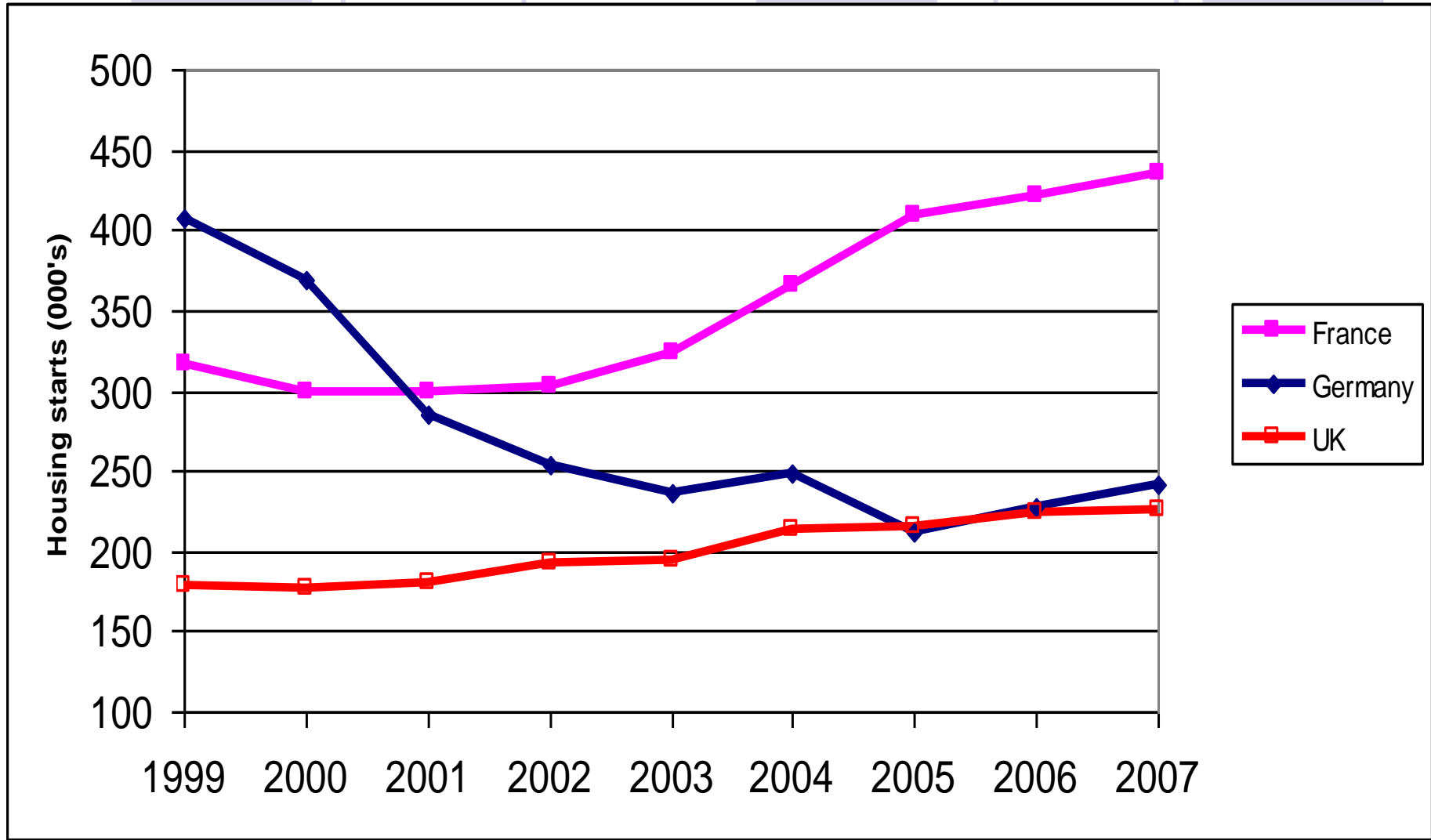
The future success of TF construction is contingent upon:

- **Ample communication & feedback from different TF construction projects
=> enhances learning**
- **Rationalisation of the on-site process, away from the craft-based approach toward multi-tasking**
- **Developing industrial standards & norms as regards timber frame construction**
- **Greater involvement of construction firms in the timber frame network**



END

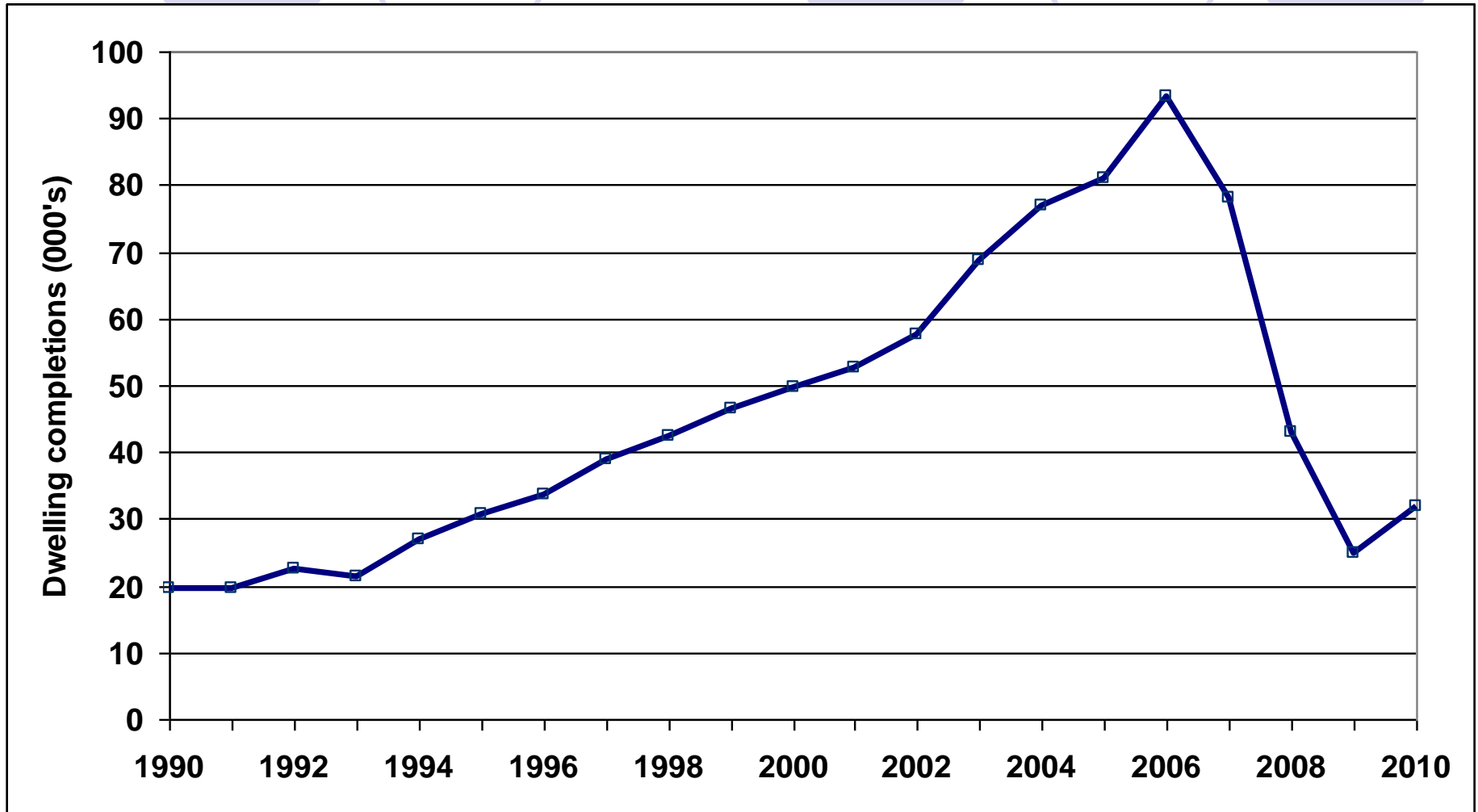
UK / England - Current state & trends



Housing starts in France, Germany and the UK Sources: Euroconstruct, &, for France, Insee

Ireland - Current state & trends

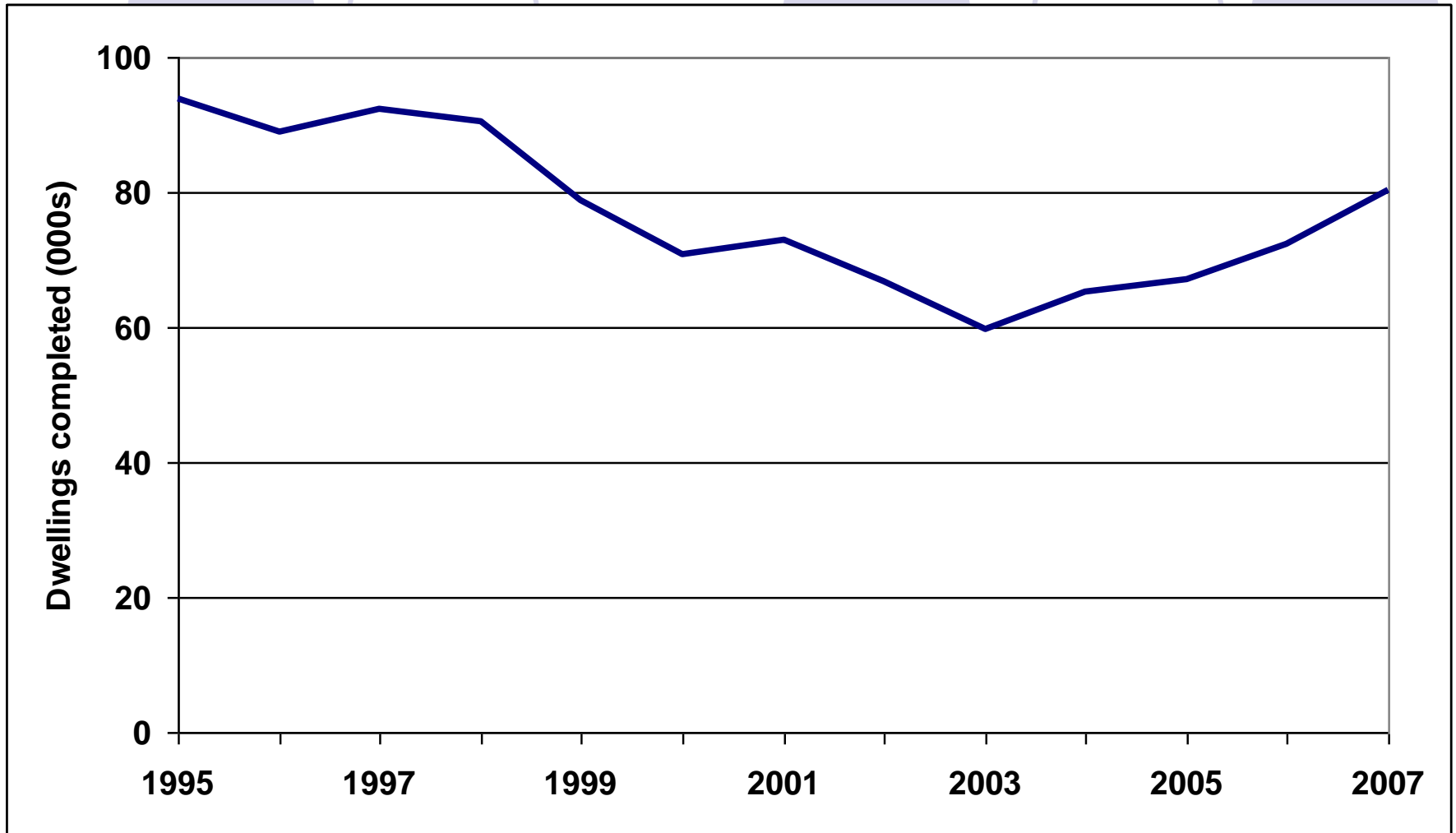
house-building: Dwellings completed in Ireland (thousands)



Sources: *DEHLG and DKM Economic Consultants Ltd.*

Note: 2008 estimate, 2009 & 2010 forecasts

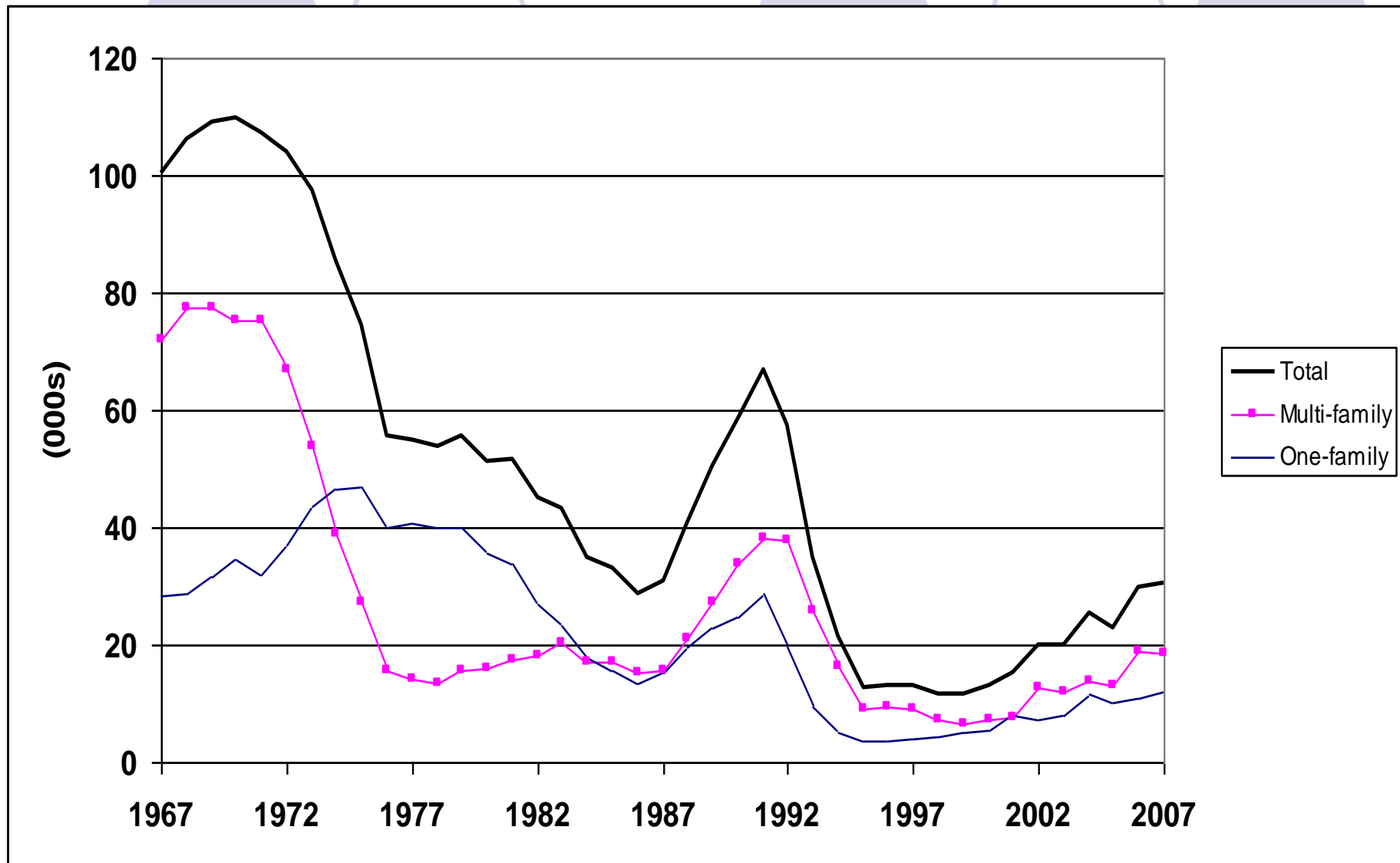
The Netherlands - Current state & trends



House-building: **dwellings completed** in the Netherlands (thousands)

Sources: *Statistics Netherlands (cbs)*.

Sweden - Current state & trends



house-building: **dwellings completed** in Sweden, by type of building (000s)

Sources: *Statistics Sweden (SCB)*