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**DREAM’s projection of the Danish demand for dwellings**

*Background*

Heated dwellings are one of the main energy services demanded by households. The amount of energy required to meet this energy service demand depends on a number of factors, including the type and size of the dwellings (e.g. number of m2 in detached houses and multistorey buildings) and the technology and quality of these dwellings (e.g. heating sources, isolation standards, etc.).

In IntERACT the energy related technology and quality of dwellings is determined by the TIMES model, while the type and size of the dwellings is assumed to be exogenous to IntERACT. IntERACT thus requires a projection of the type and size of dwellings in Denmark for the period 2010-2050. To this end, IntERACT has commissioned a projection from DREAM of the Danish demand for dwellings based on their SMILE model.

*Methodology and assumptions*

DREAM’s SMILE model is a micro-simulation model of the demographic development in Denmark, including co-habitation patterns and moving patterns. [[1]](#footnote-1) The model details all individuals in the Danish population and the ensuing household structure. Simulation is performed year by year in the projection period and includes events such as births, deaths, changes in labour market status and educational status, the formation and break-up of couples, and moving between different kinds of housing. The probability of a given individual experiencing one or more events in a given year is based on data for the historic period 2010. These probabilities are held constant throughout the projection period.

The probability of moving to a given type of dwelling is divided into two steps:

1. Probability of moving: estimated on the basis of individual information regarding age, gender, family relations, education, ethnicity, labour market status, and characteristics of the dwelling being vacated.
2. Probability of choosing a given type of dwelling: estimated on the basis of geographic region, type of dwelling (owning/renting/etc.), category of dwelling (detached house/multi-storey/etc.), size of dwelling (m2 intervals), size of town (number of inhabitants), and construction year (?). Detailed dwelling characteristics in SMILE are listed in appendix A.

The SMILE model provides a projection of the demand for dwellings by forecasting the Danish household structure. However, it is important to note that SMILE only tracks the Danish households and not the physical stock of houses in Denmark. SMILE thus computes the potential housing demand by assuming that each household is assigned one dwelling with the demanded characteristics,[[2]](#footnote-2) but the supply side of the housing market is not modelled explicitly in SMILE. The justification for using the SMILE projection of housing demand as a proxy for the future dwelling structure is the notion that the supply of housing will adjust to demand in the longer run through construction of new dwellings or demolition of existing dwellings.

*Data technicalities:*

* Ex ante data cleaning: The historic data contains a number of dwellings with one or more unknown characteristics. There are also a small group of households, whose address cannot be identified (due to data errors or homelessness). The ex ante data cleaning entails replacing unknown dwelling characteristics with probable, known characteristics as well as assigning a dwelling to households with non-identifiable address. Base year data for the SMILE model will consequently deviate slightly from the historic, statistical data.
* Ex post randomization: Due to anonymity policies of Statistics Denmark, it is not allowed to transfer data sets from their servers containing data points with only 1 or 2 observations. As the SMILE model allows for a high level of disaggregation, there are a significant amount of data points with only 1 or 2 observations in the projection result files. In order to extract the results from the SMILE projection, these data points have consequently been modified – through a randomized process “1” has been changed to “0” (with the probability 2/3) or “3” (with the probability 1/3) and vice versa for “2”. In order to compensate for the potential inaccuracy in this procedure, five different randomization runs have been performed and we use the average of these five runs.

*Caveats:*

* Heating source: As SMILE does not model the housing stock, the parameter heating source is not part of the model, and data is only available for the historic base year 2010.
* Construction year: As SMILE does not model the housing stock, gross demolition and construction rates are not part of the model. The parameter construction year is thus only meaningful for the historic base year 2010.
* Dwelling size: As gross demolition and construction rates are not included in SMILE, and housing preferences are based on historic data, the projected dwelling area does not account for the tendency of newly constructed dwellings to be larger than the old dwellings they may be replacing. The projection may therefore tend to underestimate the future dwelling area. On the other hand, new buildings are generally more energy efficient than older buildings, so the consequences for the projected heating demand are unclear.
* Areas not accounted for: As SMILE focuses on households rather than physical houses, several types of dwelling areas are not included in the projections. The unaccounted areas, which may still be energy consuming, include empty houses, summerhouses which are not used for full-time residency, and common spaces in multi-storey buildings (??).
* General data issues: SMILE is based on data stocks taken in the beginning of a given year. Quality of certain data may vary (e.g. quality of BBR data on heating...)

*Appendix: Parameters and aggregation*

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| **Parameter** | **SMILE / Dst** | **Aggregation produced for TIMES** |
| Geographical region | Byen København | Byen København |
|  | Københavns Omegn | Københavns Omegn |
|  | Nordsjælland | Nordsjælland |
|  | Bornholm | Bornholm |
|  | Østsjælland | Østsjælland |
|  | Syd- og Vestsjælland | Syd- og Vestsjælland |
|  | Fyn | Fyn |
|  | Sydjylland | Sydjylland |
|  | Østjylland | Østjylland |
|  | Vestjylland | Vestjylland |
| Dwelling type | Ejerbolig | Ejer |
|  | Almen bolig | Lejer |
|  | Andelsbolig | Ejer |
|  | Udlejning offentlig | Lejer |
|  | Udlejning privat | Lejer |
|  | Uoplyst | Lejer |
| Dwelling category | Stuehus | Parcelhus mv. |
|  | Parcelhus | Parcelhus mv. |
|  | Række-, kæde- og dobbelthuse | Rækkehuse |
|  | Etagebolig | Etagebolig |
|  | Kollegium | Etagebolig |
|  | Anden helårsbeboelse | Parcelhus mv. |
|  | Erhvervsbolig | Parcelhus mv. |
|  | Døgninstitution | Parcelhus mv. |
|  | Fritidshus | Parcelhus mv. |
|  | Uoplyst | Parcelhus mv. |
| Dwelling size |  | 0-39 m2 |
|  |  | 40-59 m2 |
|  |  | 60-79 m2 |
|  |  | 80-99 m2 |
|  |  | 100-119 m2 |
|  |  | 119-159 m2 |
|  |  | 160-199 m2 |
|  |  | 200- m2 |
| Town size | Hovedstadsområdet | Hovedstadsområdet |
|  | By med min. 50.000 indbyg. | By med min. 50.000 indbyg. |
|  | By med 10.000-49.999 indbyg. | By med 10.000-49.999 indbyg. |
|  | By med 1.000-9.999 indbyg | By med 1.000-9.999 indbyg |
|  | By med mindre end 1000 indbyg. | By med mindre end 1000 indbyg. |
| Construction year |  | XX-1960 |
|  |  | 1961-1972 |
|  |  | 1973-1978 |
|  |  | 1979-1998 |
|  |  | 1999-YY |
| Heating source | Fjernvarme | Fjernvarme – central |
|  | Fjernvarme | Fjernvarme – decentral |
|  | Centralvarme med olie | Centralvarme med olie |
|  | Centralvarme med naturgas | Centralvarme med naturgas |
|  | Centralvarme, ikke olie og naturgas | Øvrige |
|  | Varmepumpe | El |
|  | Elvarme | El |
|  | Øvrige ovne | Øvrige |
|  | Uoplyst | Øvrige |
| Household members | 1 person | 1 person |
|  | 2 personer | 2 personer |
|  | 3 personer | 3 personer |
|  | 4 personer | 4 personer |
|  | 5 personer | 5 personer |
|  | 6 personer eller derover | 6 personer eller derover |
| Household income |  | XX-200.000 kr. |
|  |  | 200.000-300.000 kr. |
|  |  | 300.000-400.000 kr. |
|  |  | 400.000-500.000 kr. |
|  |  | 500.000-600.000 kr. |
|  |  | 600.000-700.000 kr. |
|  |  | 700.000-800.000 kr. |
|  |  | 800.000-YY kr. |

1. Cf. <http://www.dreammodel.dk/default_en.html> [↑](#footnote-ref-1)
2. The basic premise in SMILE is that one household is assigned one dwelling. It should be noted that one household can encompass more than one family. [↑](#footnote-ref-2)