Employment Impacts of a Large-Scale Deep Building Energy Retrofit Programme in Hungary

CENTER FOR CLIMATE CHANGE AND SUSTAINABLE ENERGY POLICY

CENTRAL EUROPEAN UNIVERSITY

Presentation of results

June 08, 2010

Summary: Key findings

- Energy use and CO2 emissions reduction
  - Up to **85%** of Hungarian **heating energy use and the corresponding CO2 emissions can be avoided** by a consistent and wide-spread deep retrofit programme
  - **A suboptimal scenario** (saving only 40% of energy use) **locks in 45%** of 2010 building **heating-related emissions** at the end of the programme
  - This makes medium-term national emission reduction targets (75 – 85%) very difficult and expensive to achieve
- Energy security enhancement
  - A deep retrofit programme can reduce Hungary's natural gas import dependence significantly (in % of 2006-2008 average NG imports):
    - Up to 39% of annual import needs by 2030
    - Up to **59% of the January import needs** (the most critical month for energy security)
  - A suboptimal retrofit programme would lack the same strength
    - Only 10% of natural gas imports saved in 2030
    - Peak (January) savings reduced to 18%

European Climate Foundation

3CSEP

Summary: Key findings (2)

- Employment benefits
  - Up to 131,000 net jobs created by 2020, including the losses in the energy supply sector
    - This value is 184,000 in 2015
    - 38% of this value: indirect and induced effects in other sectors than construction
  - Suboptimal scenario: 43,000 jobs
- Deep renovation activities are much more labour intensive than other economic recovery activities
  - e.g. 5 times more jobs are created than with the same investments in road construction
- The corresponding investment needs are also higher
  - For the most ambitious programme (5.7% floor area/yr):
    - 4.5 Bln EUR/year initially, and 2.8 Bln EUR/year towards the end; vs. 2 bln/year for a gradual program (2.3% floor area renovated/year), declining to 1 bln/year
    - Cumulative undiscounted investments: 59 Bln EUR, vs. 44 in a more gradual program
    - Cumulative undiscounted savings: 97 Bln EUR by 2050

European Climate Foundation

3CSEP

Summary: Recommendations

- Recommendation: deep renovation programme with more gradual implementation
  - App. 8 million sqm per year, 2.3% of the floor area, 100,000 dwellings-equivalent
  - 52,000 jobs created by 2020
  - Initial costs peak at 2 Bln EUR per year, and are reduced to less than 1 Bln EUR in the final phases of the programme
    - Take advantage of the initial learning period
- App. 1 billion Euros public funds per year could potentially be made available
  - Partly from EU funding
  - Partly from redirecting current energy subsidies
- Pay-as-you-save schemes and other innovative financing schemes also relieve the financing burden
- More gradual implementation means less shock for the labour market
- For all scenarios:
  - Employment created is long-term
  - New jobs will be distributed across the country
- Public administration should be heavily involved
  - To the achievement of deep savings through deep renovations
  - To reduce the risks of supply bottlenecks

European Climate Foundation

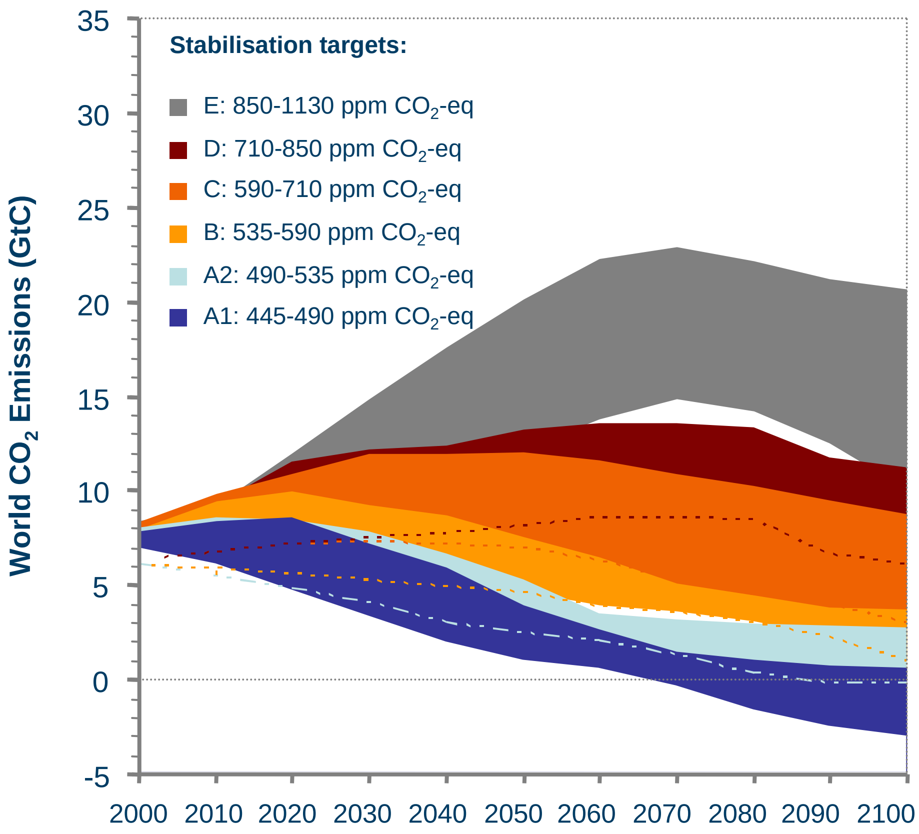
3CSEP

The climate change challenge

In order to limit the impacts of CC, GHG emissions have to be reduced significantly

- Stabilizing global mean temperature requires a stabilization of GHG concentrations in the atmosphere -> GHG emissions would need to peak and decline thereafter (SPM 18 WG III)
- The lower the target stabilisation level limit, the earlier global emissions have to peak.
- Limiting increase to 3.2 – 4℃ requires emissions to peak within the next 55 years.
- Limiting increase to 2.8 – 3.2℃ requires global emissions to peak within 25 years.
- Limiting global mean temperature increases to 2 – 2.4℃ above pre-industrial levels requires global emissions to peak within 15 years and then fall to about **50 to 85%** of current levels by 2050.

Based on SPM 7, WG III. Emission pathways to mitigation scenarios

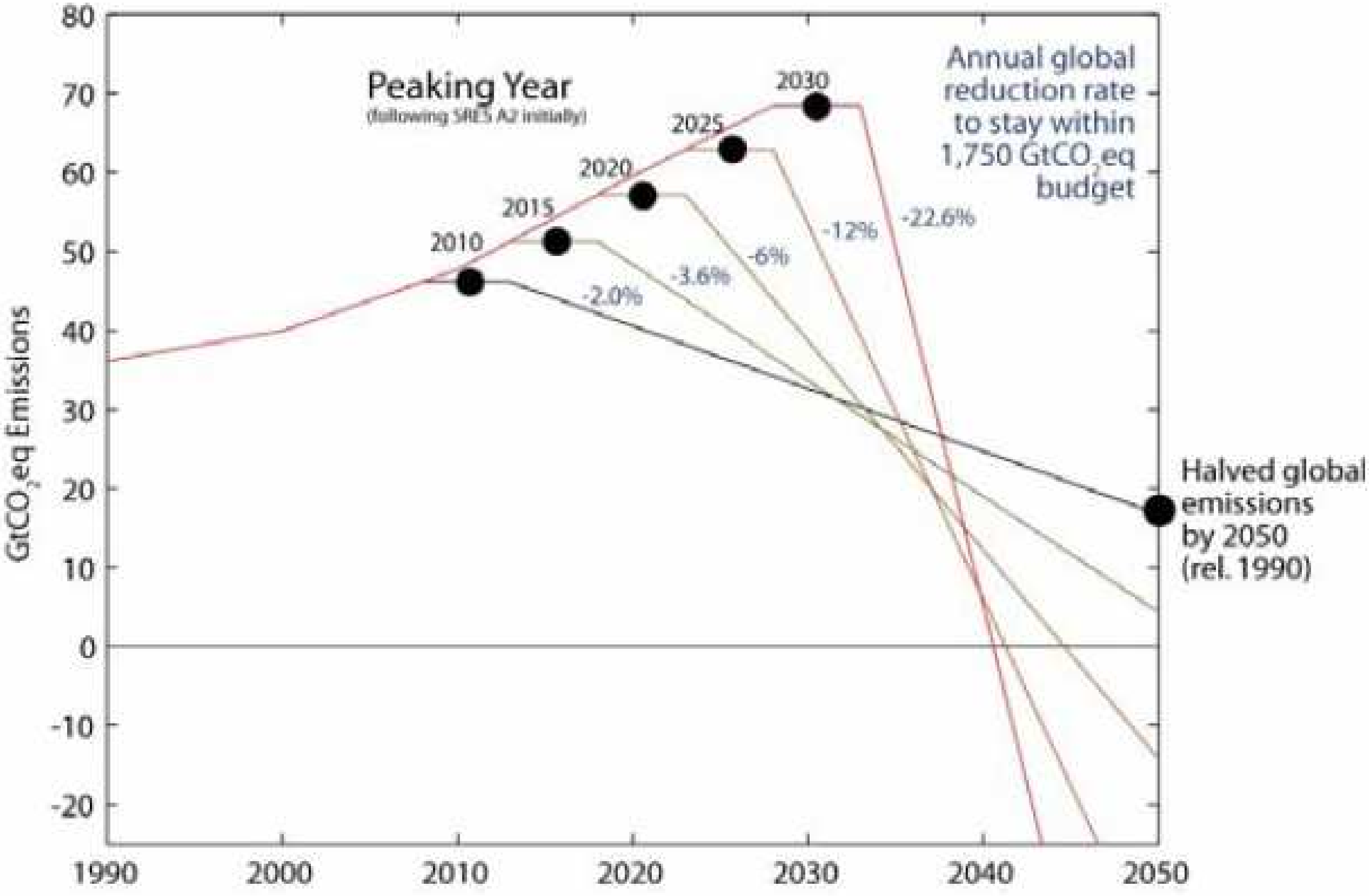


Multigas and CO_2 only studies combined

European Climate Foundation

3CSEP

The later emissions peak, the more ambitious reductions needed



Source: *Meinshausen et al 2009*

Climate Foundation

3CSEP

EE as an economic/social agenda: employment and other economic benefits

- A wide range of co-benefits of energy-efficient buildings:
  - labor **productivity** rises by app. 6–16%;
  - students' test scores shows ~20–26% faster learning
  - Influenza and cold rates can decrease by as much as 20%, resulting in a USD10 bln/yr savings in US alone
    - better indoor environments related with building EE save annually in the US $6 -14 bill.(reduced respiratory disease); $1 - 4 bill. (reduced allergies and asthma); $10 - 30 bill. (reduced sick building syndrome); and $20 - 160 bill. (direct improvements in worker performance unrelated to health)
- Employment: (local) job creation: Danish trade union study finds twice higher employment intensity than for other mitigation options
- This research studies the employment impacts of a wide-scale energy-efficient renovation programme in Hungary

European Climate Foundation

3CSEP

Background

- Climate and energy challenges in Hungary
  - GHG emissions are below Kyoto targets
  - But: very high energy dependency
    - Especially from Russian gas
  - Fuel poverty
    - Over 80% of Hungarian households live in fuel poverty, according to the UK definition
    - A widespread, deep renovation program could eliminate,, or at least alleviate this problem

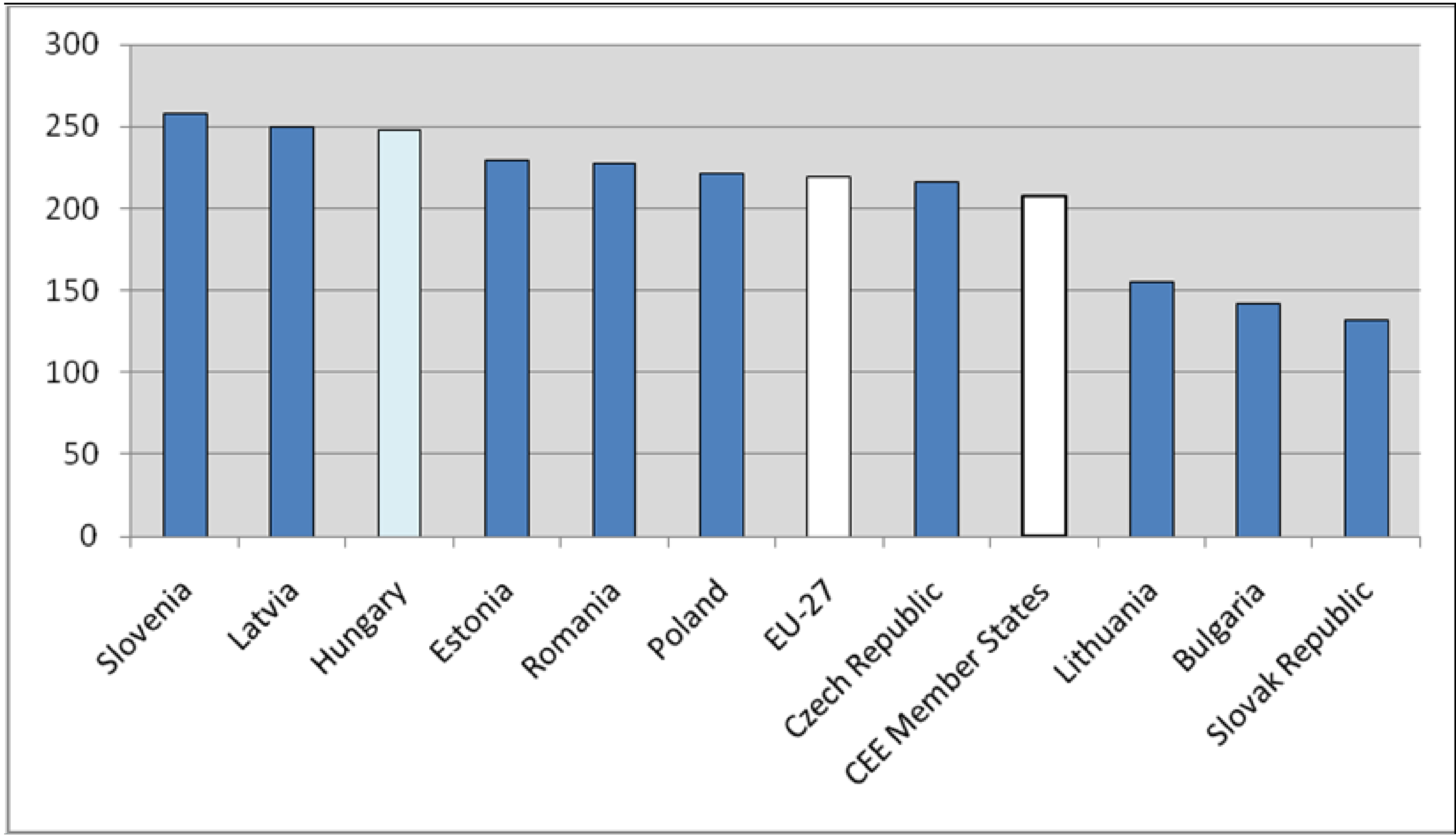
European Climate Foundation

3CSEP

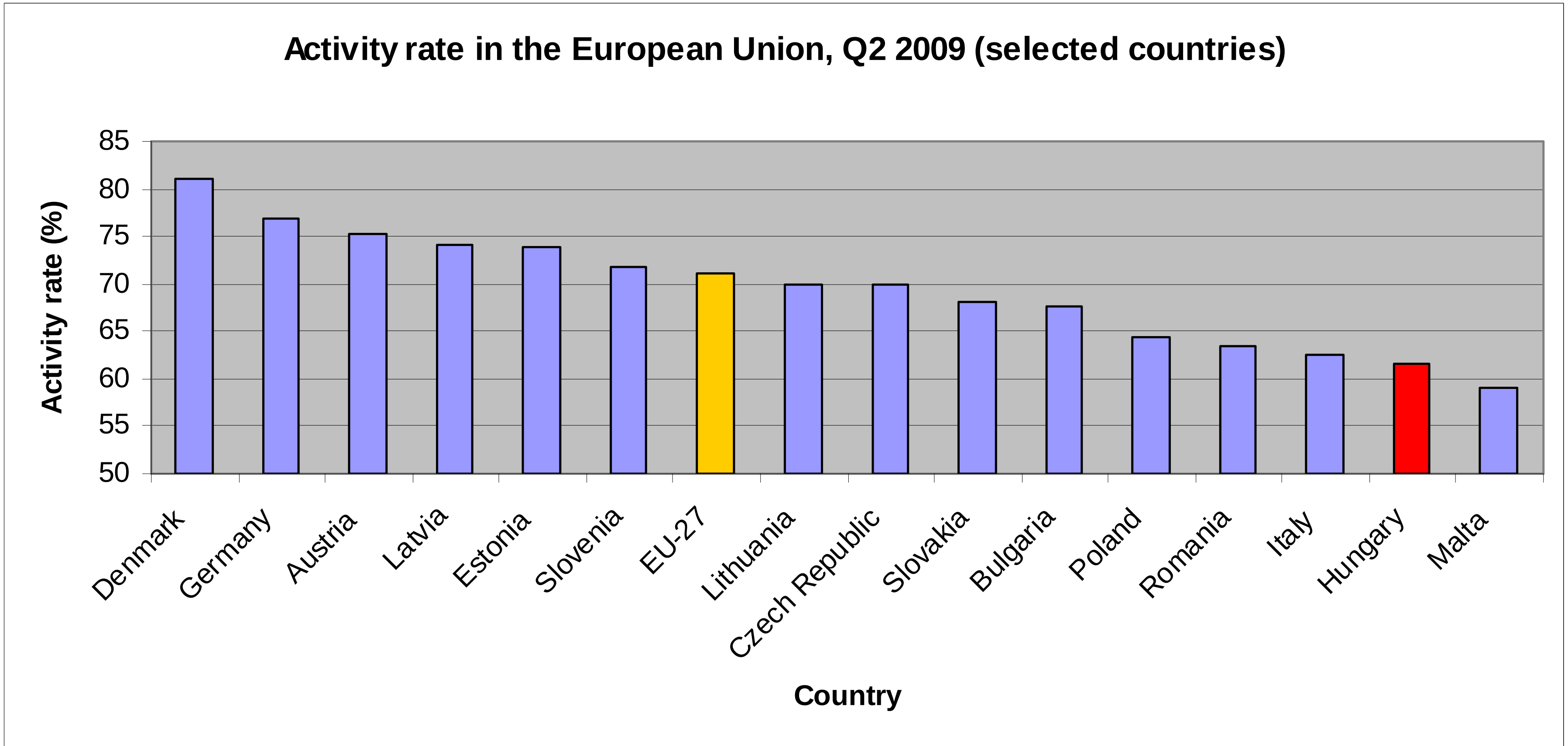
Background

- Inefficiency of Hungarian buildings
  - Largest potential for energy consumption reduction among end-use sectors
  - Contribute 50% of energy-related emissions in Hungary
  - Only Slovenia and Latvia are less energy-efficient in residential heating

Households' specific energy consumption (kWh/m2a) scaled to EU average climate. Hungary vs. CEE Member States. Average 2000-2007
Source: own elaboration based on data retrieved from the ODYSSEE database



Background: Hungary has the EU's 2nd lowest employment and activity rate



Source:
Eurostat

European Climate Foundation

3CSEP

The project in a nutshell

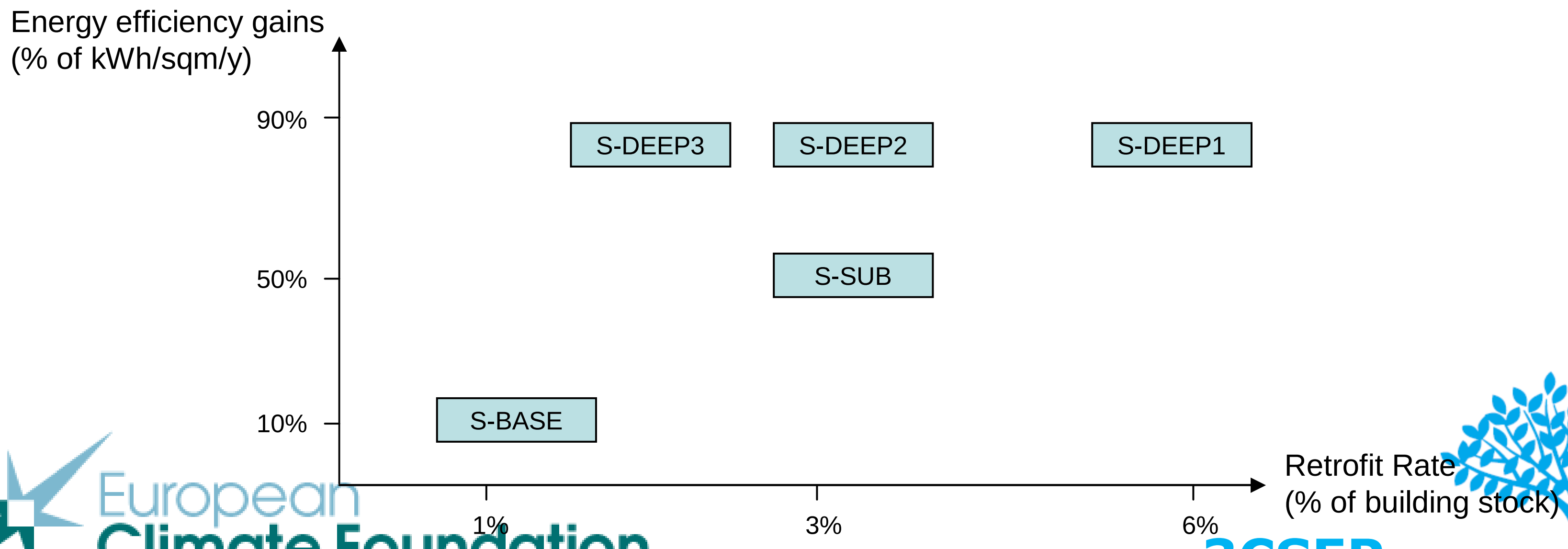
- **Objective**: to gauge the net employment impacts of a large-scale deep building energy-efficiency renovation programme in Hungary
- **Scope of the research**:
  - Type of buildings: residential and public buildings (no industrial or commercial)
  - Type of renovation: reduce demand for heating (no appliances)
  - Employment effects: direct, indirect and induced
- **Scenarios**: *S-BASE, S-SUB, S-DEEP1, S-DEEP2, S-DEEP3*
- **Expected results**:
  - Non-employment results: investments involved, reduction in energy consumption and CO_2 emissions, energy cost savings
  - Net impacts on Hungarian labour market
- **Two phases**:
  - Preliminary results: 22 March 2010
  - Final report: by 31 May 2010 (revised results)

European Climate Foundation

3CSEP

Scenarios considered

Name	Scenario	Retrofit rate	Type of retrofits	Forecasted completion
S-BASE	Baseline scenario: no intervention	1.3% of the total building stock (around 4.5 million square metres a year, equivalent to 55,000 dwellings)	"Business as usual" retrofits	N/A
S-DEEP1	Deep retrofit with fast implementation rate	Around 20 million square metres (equivalent to 5.7% of floor area, 250,000 dwellings) per year	Deep retrofits	17-18 years
S-DEEP2	Deep retrofit with medium implementation rate	Around 12 million square metres (equivalent to 3.4% of floor area, 150,000 dwellings) per year	Deep retrofits	26-28 years
S-DEEP3	Deep retrofit with slow implementation rate	Around 8 million square metres (equivalent to 2.3% of floor area, 100,000 dwellings) per year	Deep retrofits	39-41 years
S-SUB	Suboptimal retrofit with medium implementation rate	Around 12 million square metres (equivalent to 3.4% of floor area, 150,000 dwellings) per year	Suboptimal retrofits	26-28 years



European Climate Foundation

3CSEP

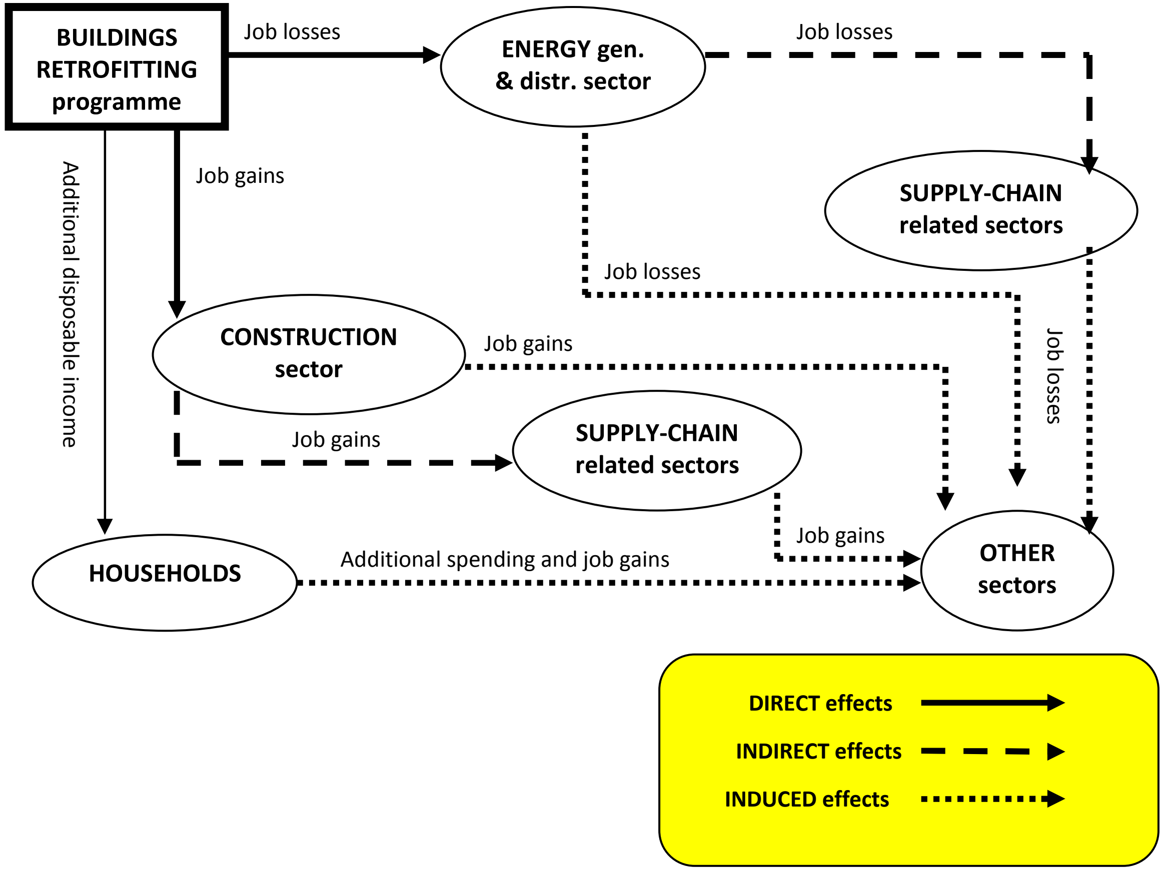
Employment Effects: Overview

- Direct impacts
  - Positive on the construction industry
  - Negative on the energy industry
- Indirect impacts
  - Upstream in the supply chain
- Induced impacts
  - Caused by the increased disposable income:
    - From new jobs (directly and indirectly generated)
    - From energy savings
- Qualitative analysis
  - Types of employment generated and skill levels
  - Geographical distribution
  - Durability of the jobs (short/long-term)
  - Supply of labour

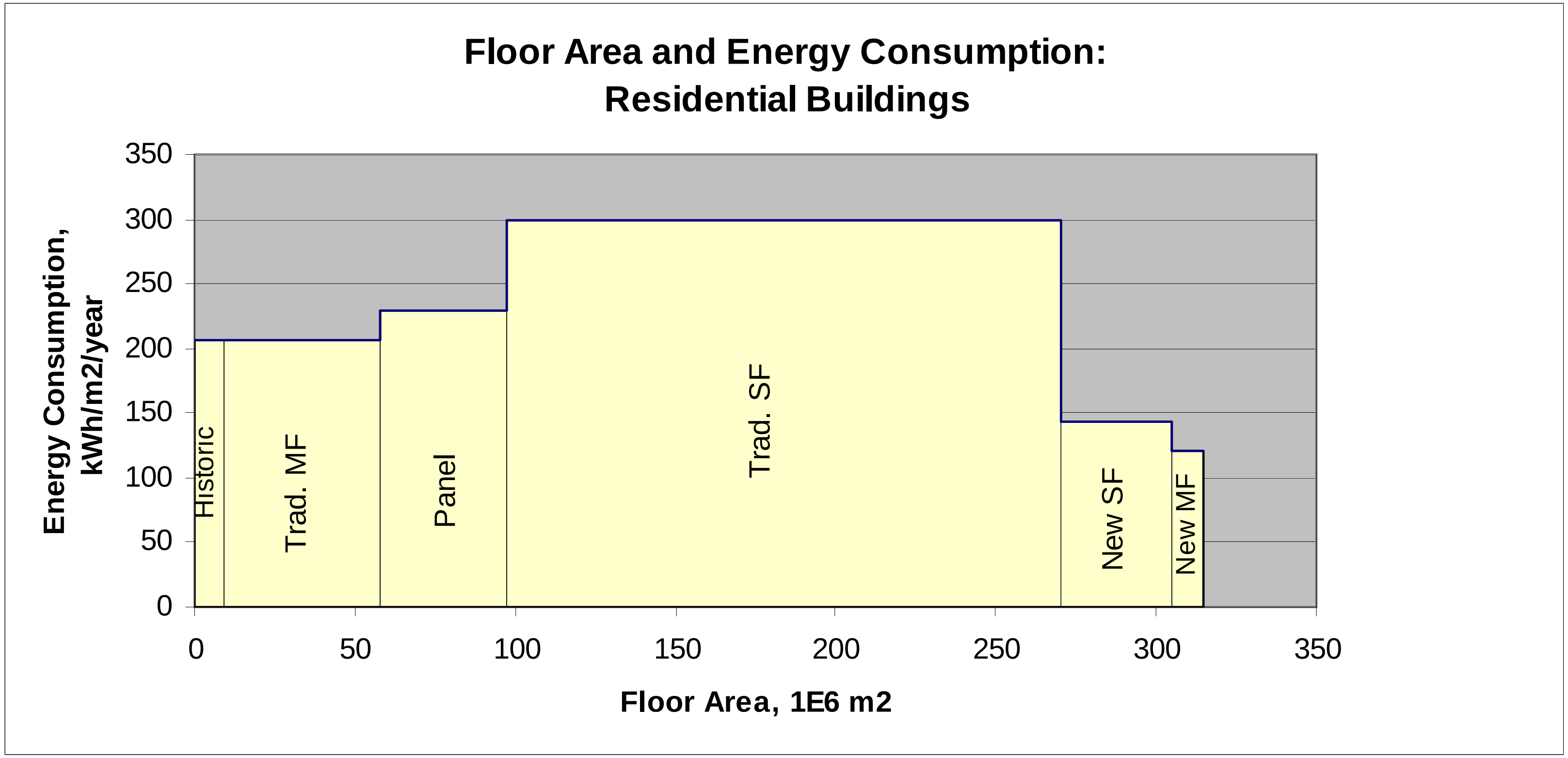
European Climate Foundation

3CSEP

Employment Effects: Overview



Residential Building Stock
Current Characteristics

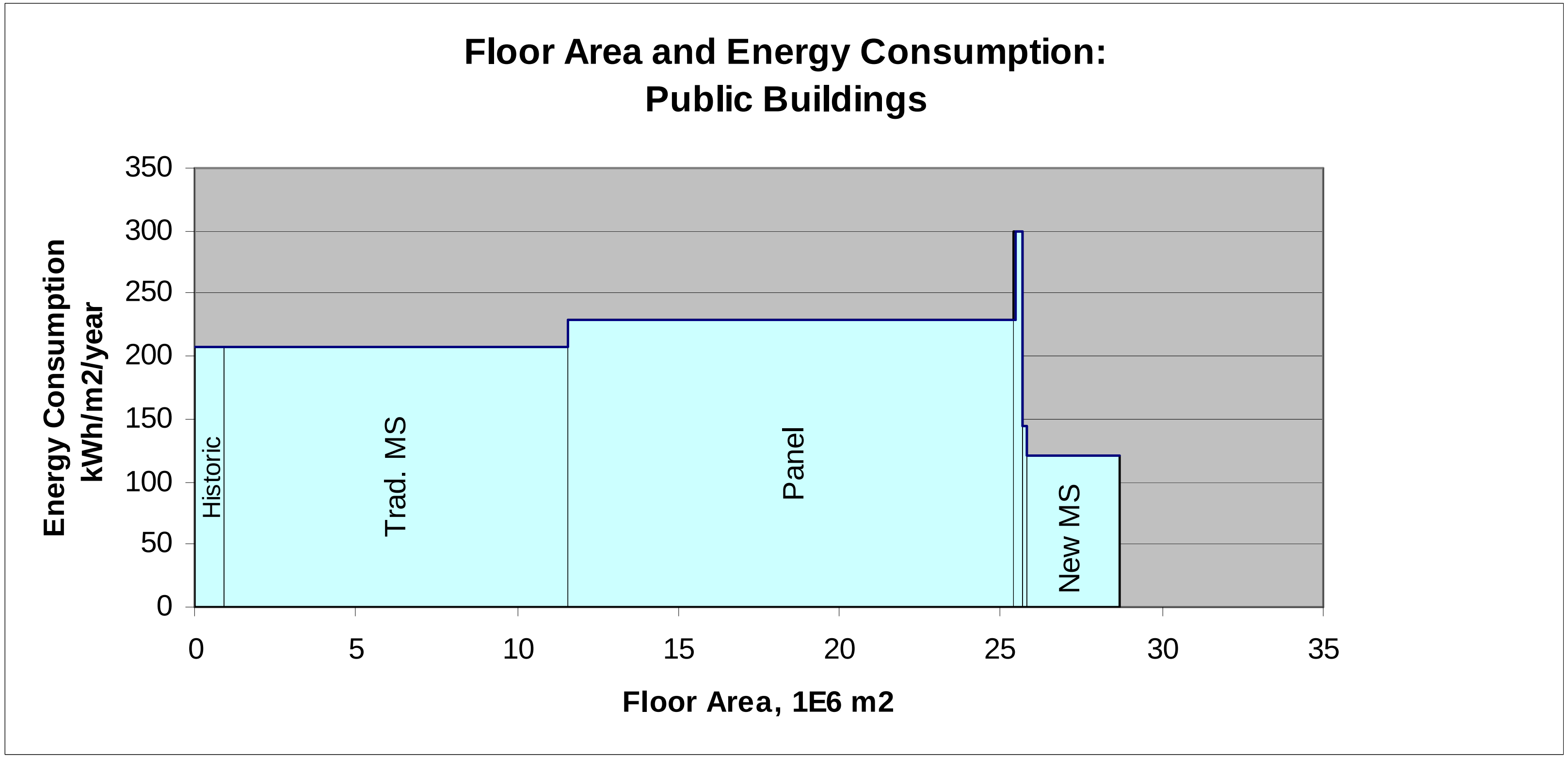


Total Heating Energy Consumption: 58 TWh/year

European Climate Foundation

3CSEP

Public Building Stock
Current Characteristics

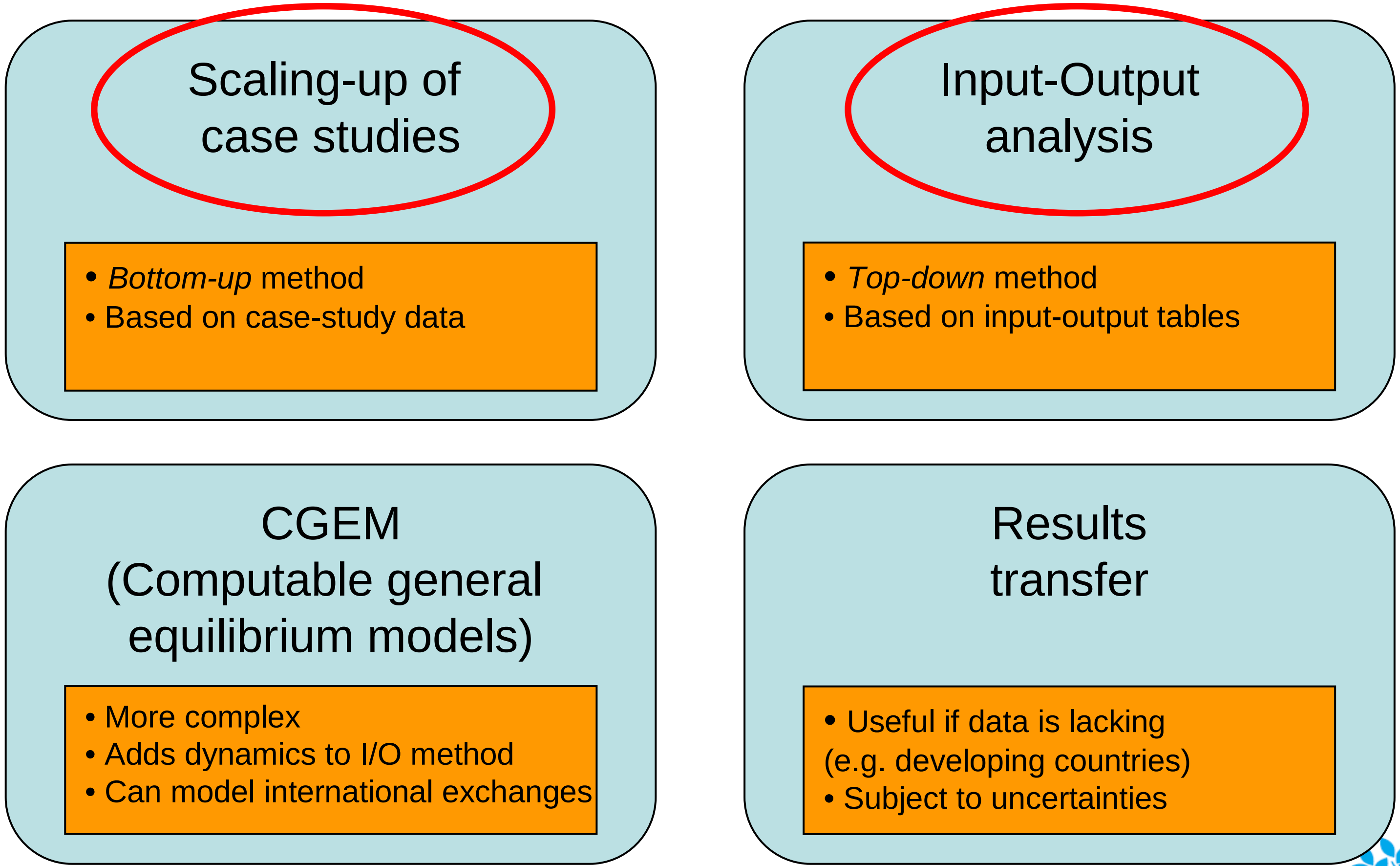


Total Heating Energy Consumption: 5 TWh/year

European Climate Foundation

3CSEP

Employment effects: available methodologies

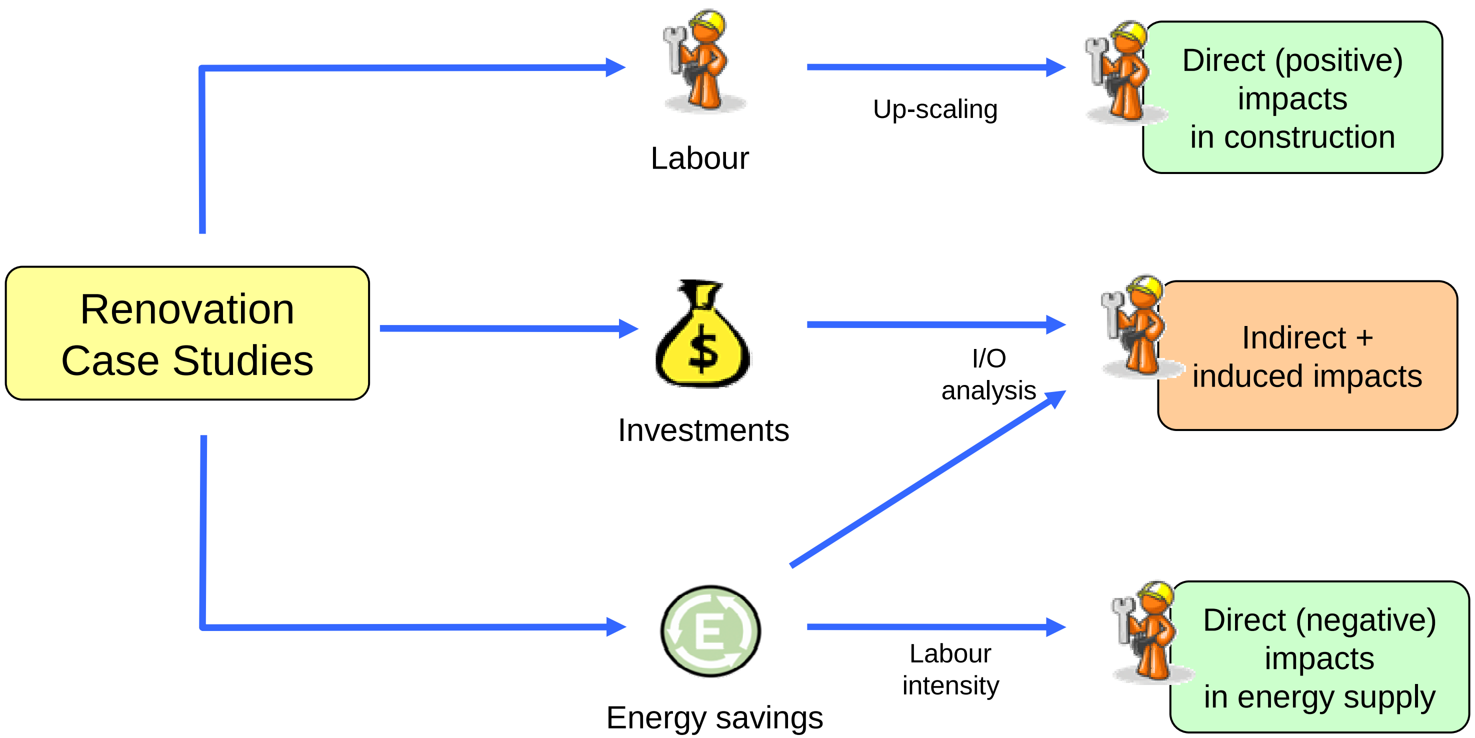


European Climate Foundation

3CSEP

Methodology used

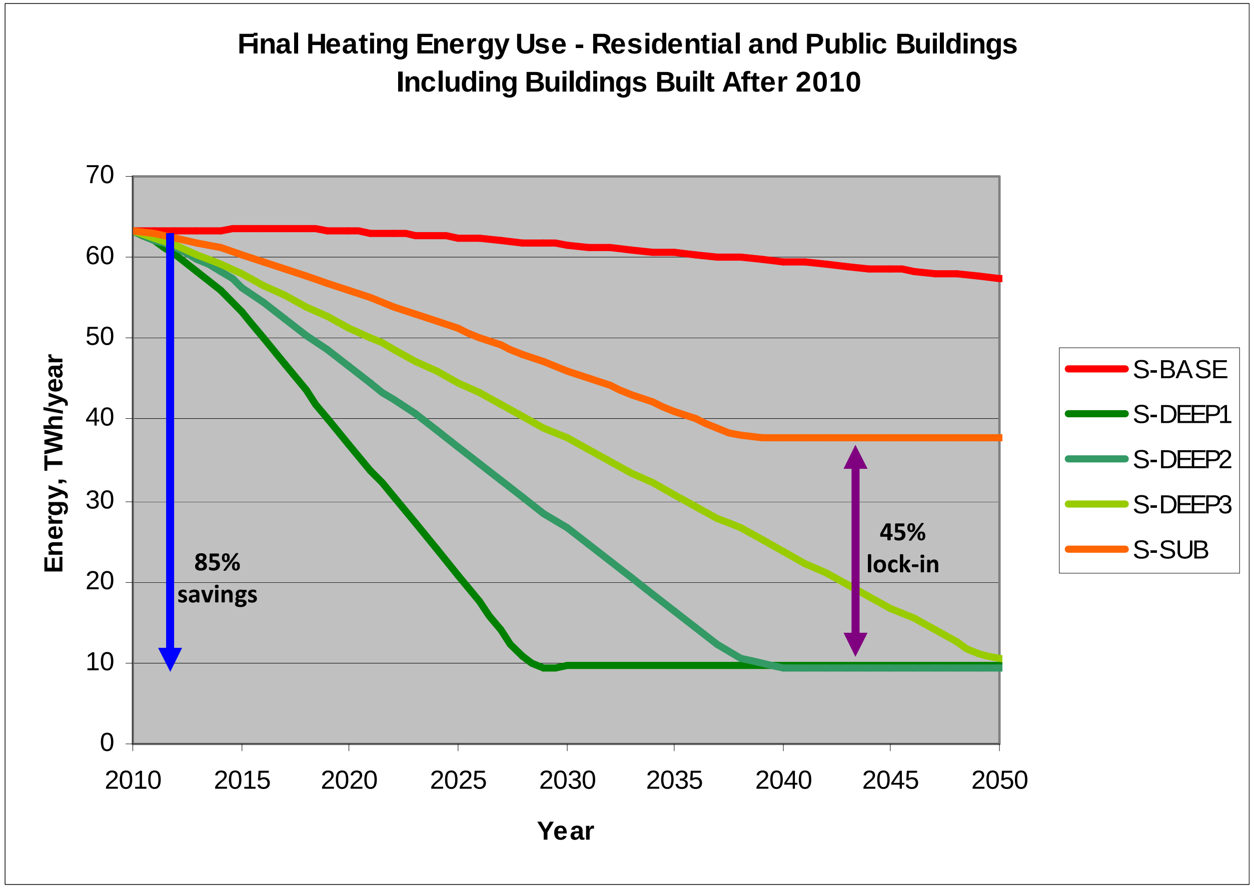
- Mixed: Up-scaling + Input-Output analysis



European Climate Foundation

3CSEP

Scenario results: Final energy use until 2050

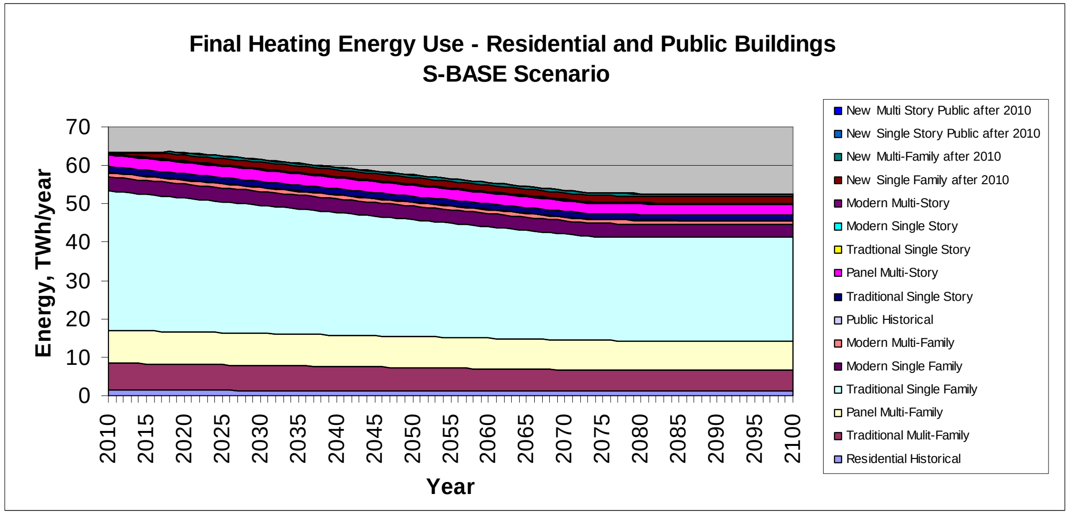


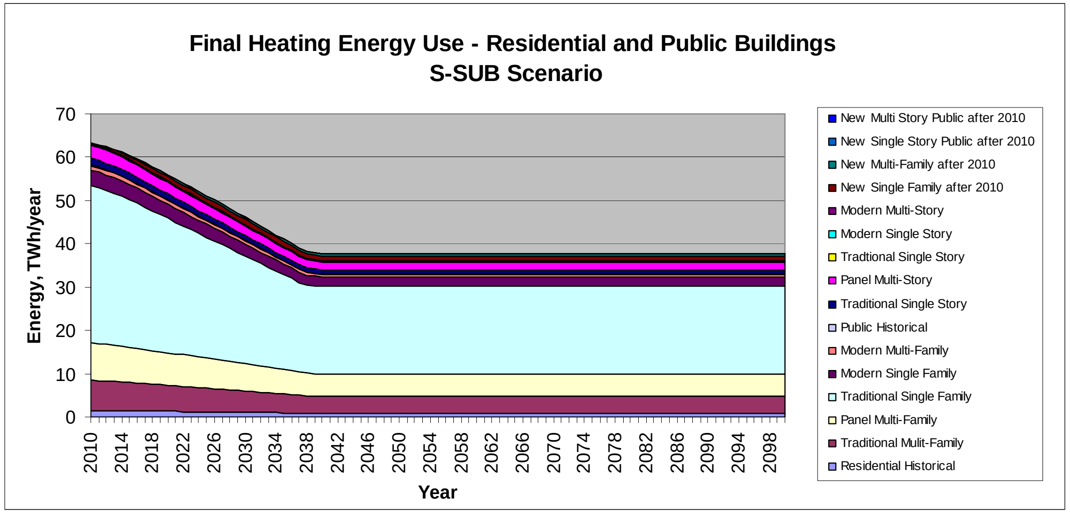
- 85% of energy is saved in deep scenarios
- 45% of the savings remain locked-in by the suboptimal scenario

European Climate Foundation

3CSEP

Scenario results: Energy savings by building category

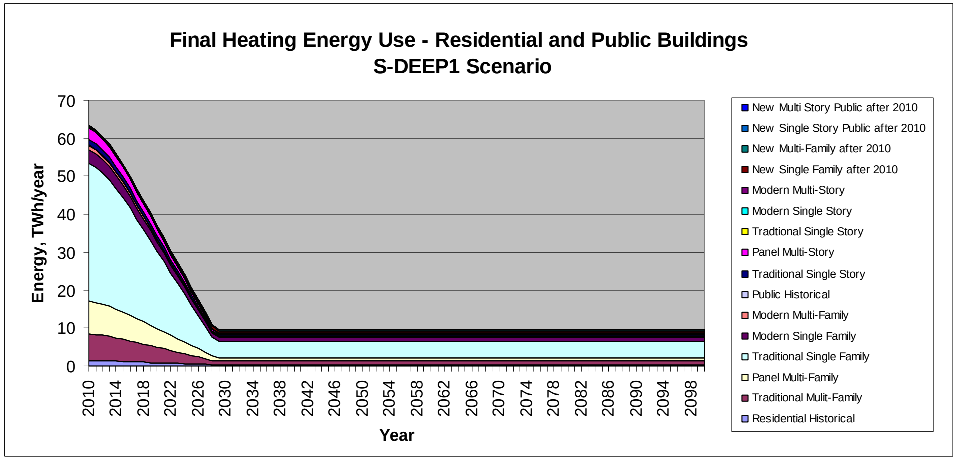


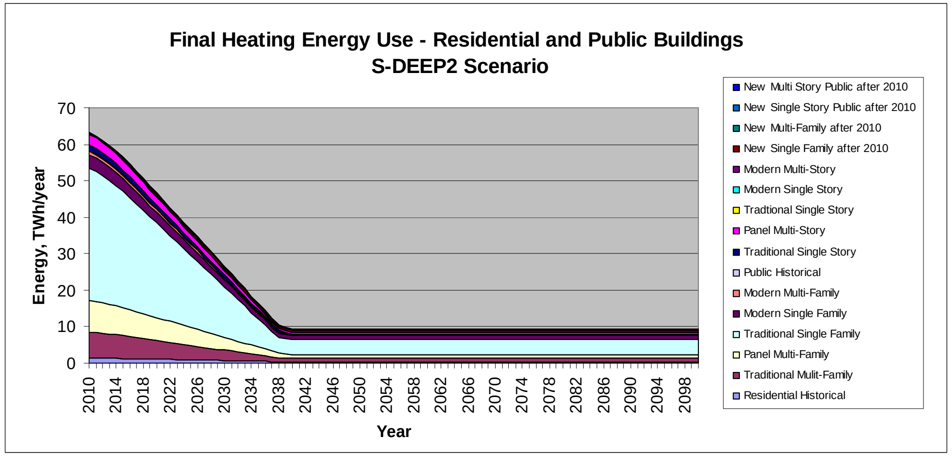


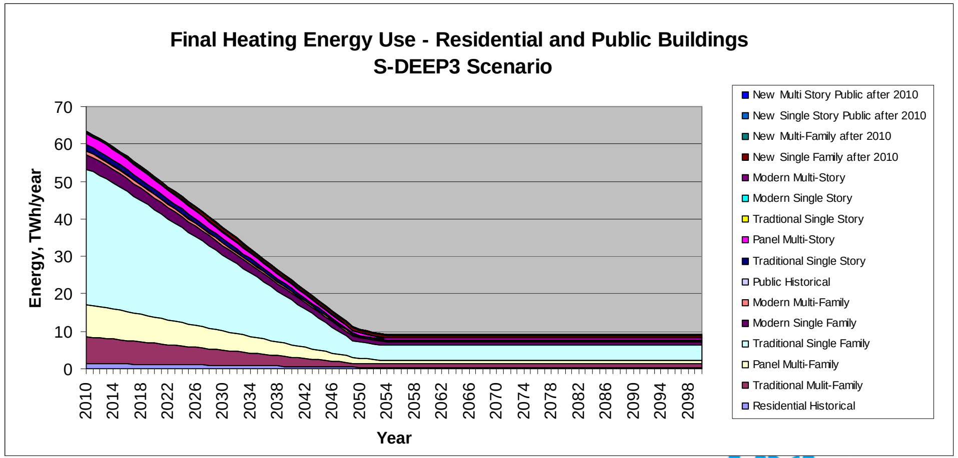
European Climate Foundation

3CSEP

Scenario results: Energy savings by building category





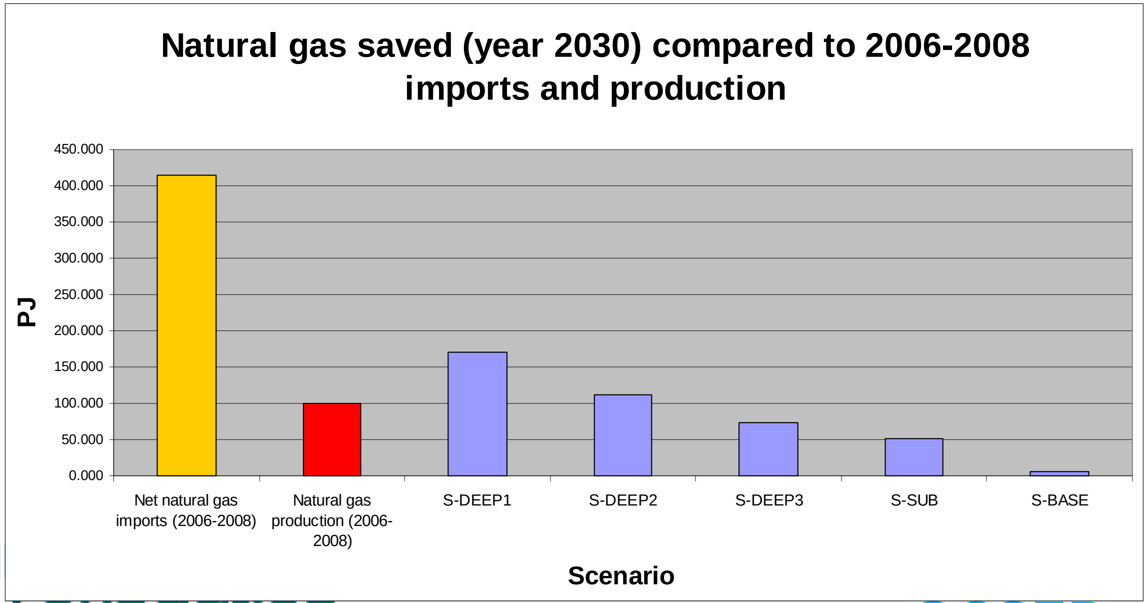


European Climate Foundation

3CSEP

Energy Security Benefits

- Reduced import of Natural Gas
  - At the end of their implementation, the deep renovation scenarios can save up to 39% of the current natural gas imports
  - The natural gas saved in 2030 is the same order of magnitude as Hungary's NG production (2008 levels)

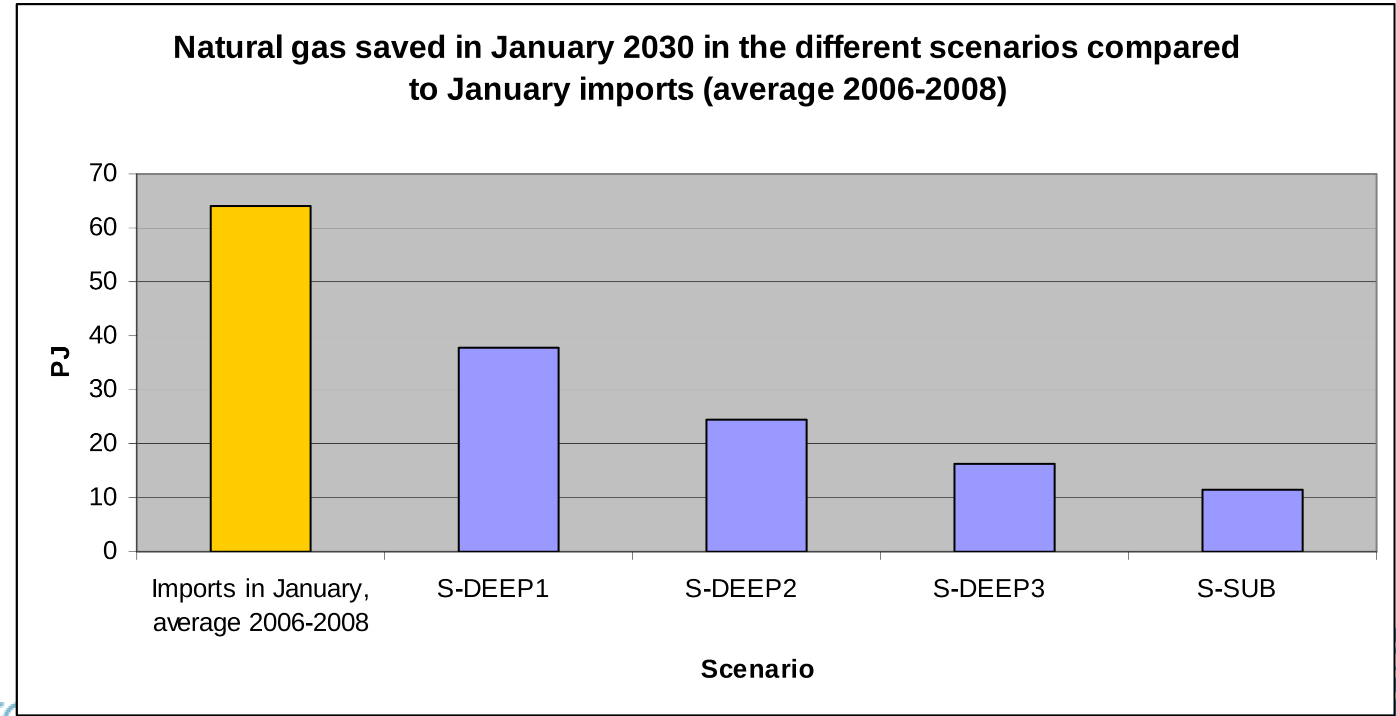


European Climate Foundation

3CSEP

Energy Security Benefits (2)

- In January (peak month for imports) the energy savings achieved by 2030 would be equivalent to between 59% (*S-DEEP1* scenario), 26% (*S-DEEP3* scenario) and 18% (*S-SUB* scenario) of the natural gas imports recorded for that month



European Climate Foundation

3CSEP

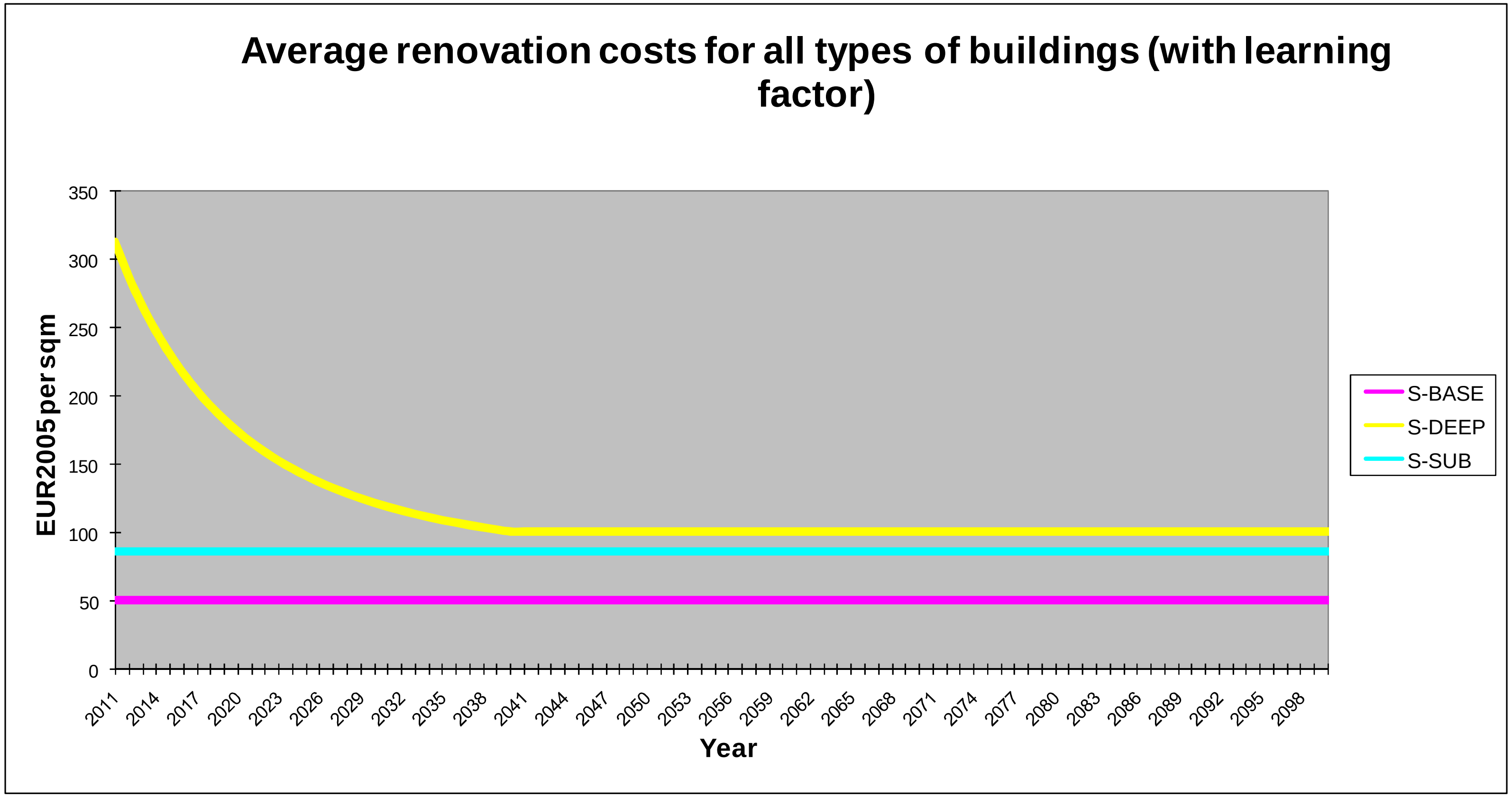
Scenario results: renovation costs

- Investments for renovations
  - Use of best practices to estimate the cost per sqm in every scenario, for every building type
  - SOLANOVA case study (Dunaujvaros):
    - Pilot project for deep renovation in a panel building
    - The only deep renovation project available in Hungary
    - 90% energy savings
    - 42 dwellings, 2300 sqm
    - Cost: 250€ per sqm
  - Examples abroad: Mostly in Austria and Germany
  - Transfer of results to Hungary

European Climate Foundation

3CSEP

Evolution of investments per sqm, with learning factor

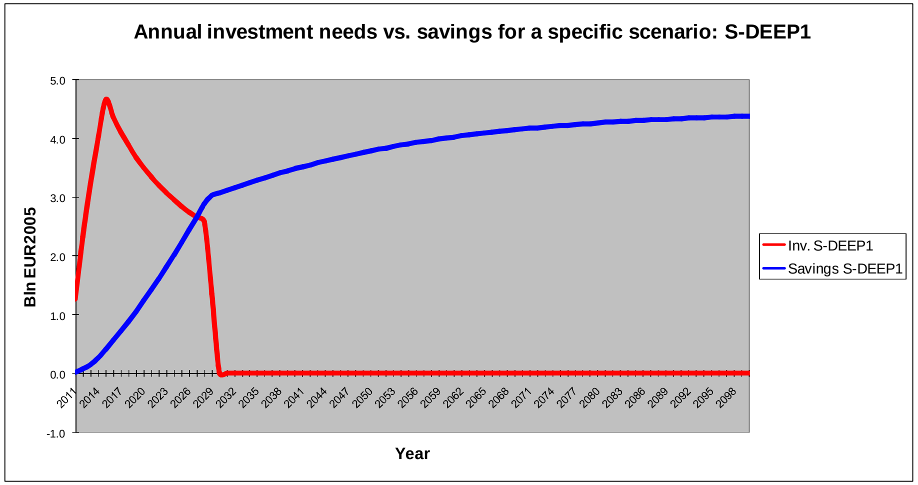


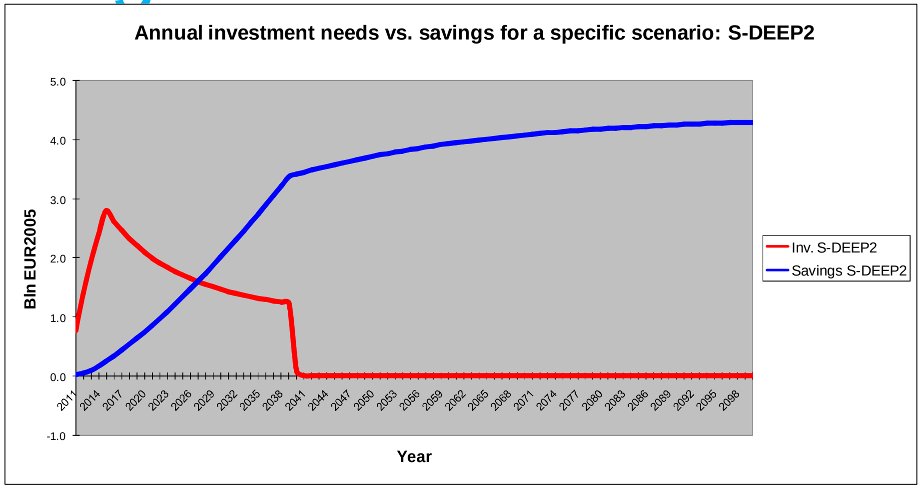
- Baseline and suboptimal costs remain fixed (mature technology)
- Deep renovation costs decrease until they reach double baseline renovation costs

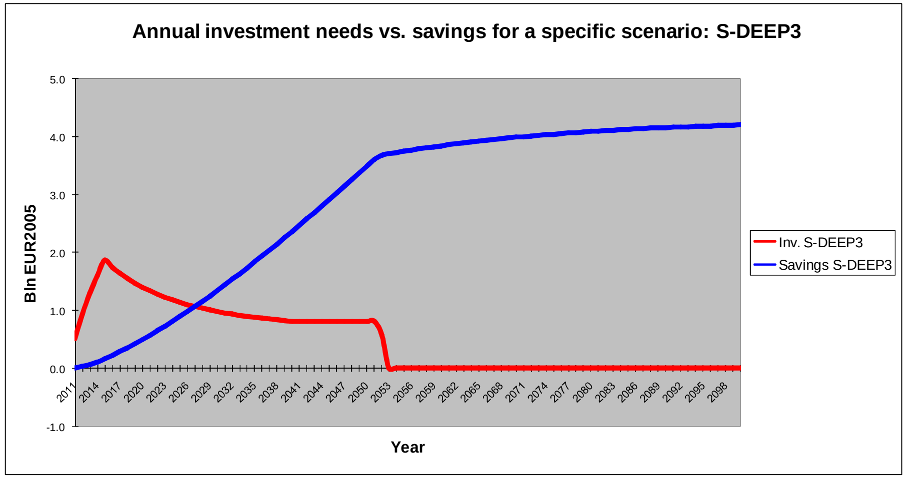
European Climate Foundation

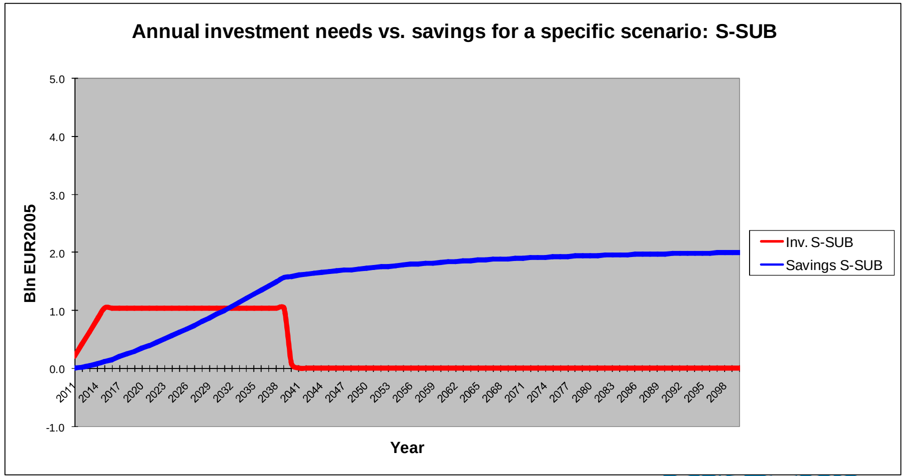
3CSEP

Scenario results: annual investment needs vs. savings









- Annual savings become higher than the investment needs in 20 years

European Climate Foundation

3CSEP

Cumulative (undiscounted) investments and savings

- Total investments needed to refurbish the whole building stock:
  - S-DEEP1: 60 Bln EUR
  - S-DEEP2: 50 Bln EUR
  - S-DEEP3: 44 Bln EUR
  - S-SUB: 28 Bln EUR
- Cumulative savings eventually outstrip the investment needs

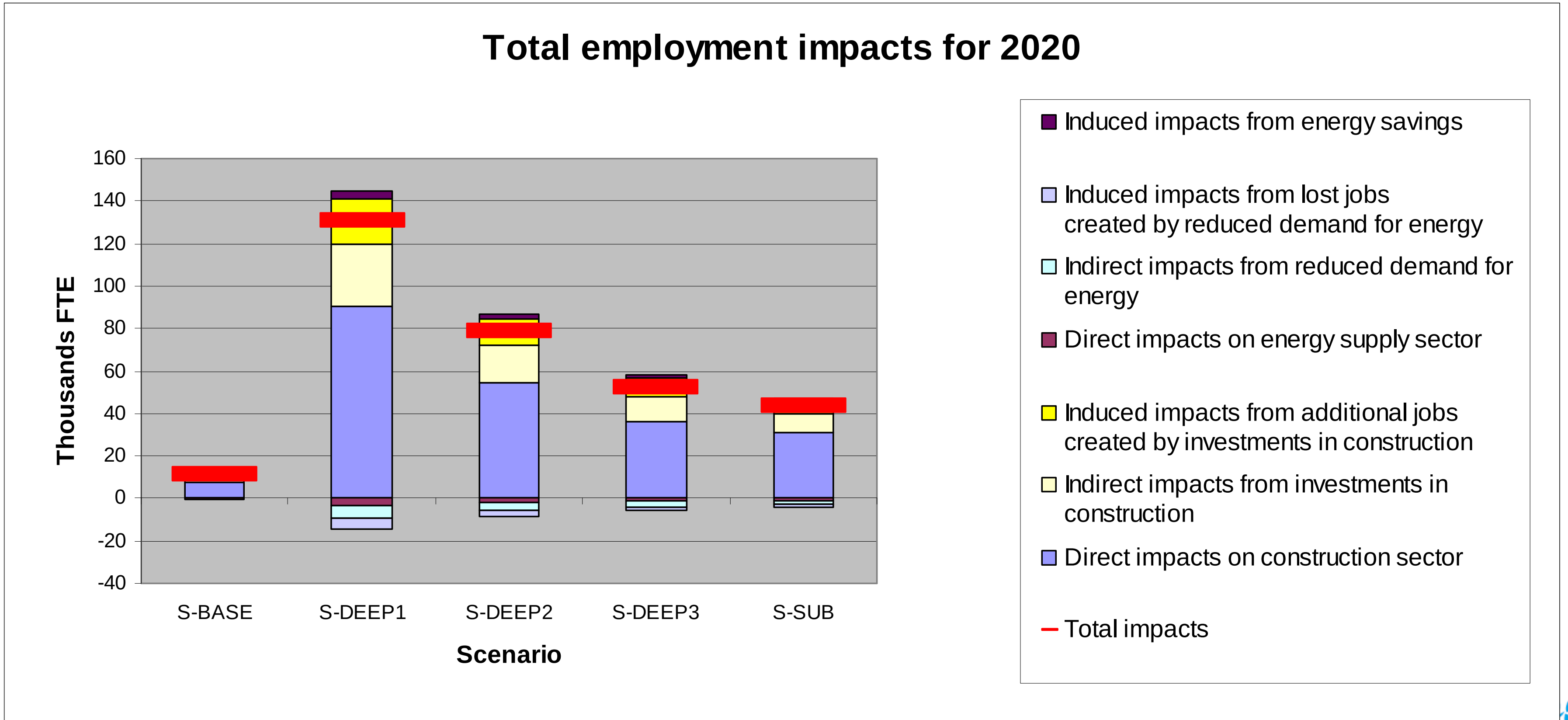
Cumulative investments vs. cumulative savings (Billion Euros)	2025	2050	2075
S-DEEP1			
Cumulative investments	50.47	59.83	59.83
Cumulative savings	14.13	97.00	197.73
S-DEEP2			
Cumulative investments	30.29	50.05	50.05
Cumulative savings	8.48	80.56	179.39
S-DEEP3			
Cumulative investments	20.20	42.20	43.58
Cumulative savings	5.65	59.56	156.06
S-SUB			
Cumulative investments	13.53	28.17	28.17
Cumulative savings	3.94	37.43	83.34

European Climate Foundation

3CSEP

Total net employment impacts: snapshot in 2020

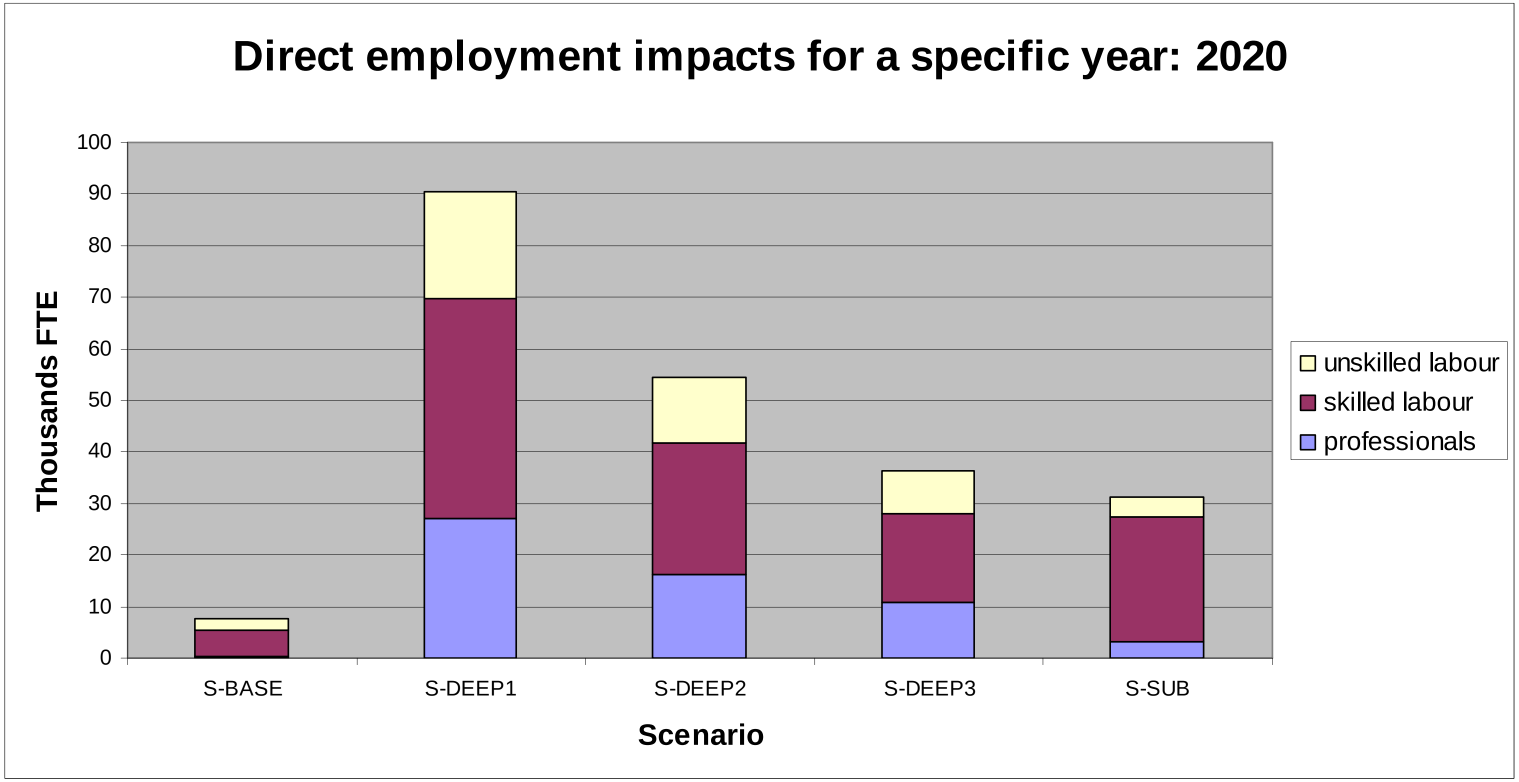
- Direct effects
  - Calculated with bottom-up method
  - Shown in the previous slides
- Indirect + induced effects
  - Application of I/O tables
  - Indirect + induced impacts have the same order of magnitude as the direct impacts



European Climate Foundation

3CSEP

Direct employment impacts in construction per skill: snapshot in 2020

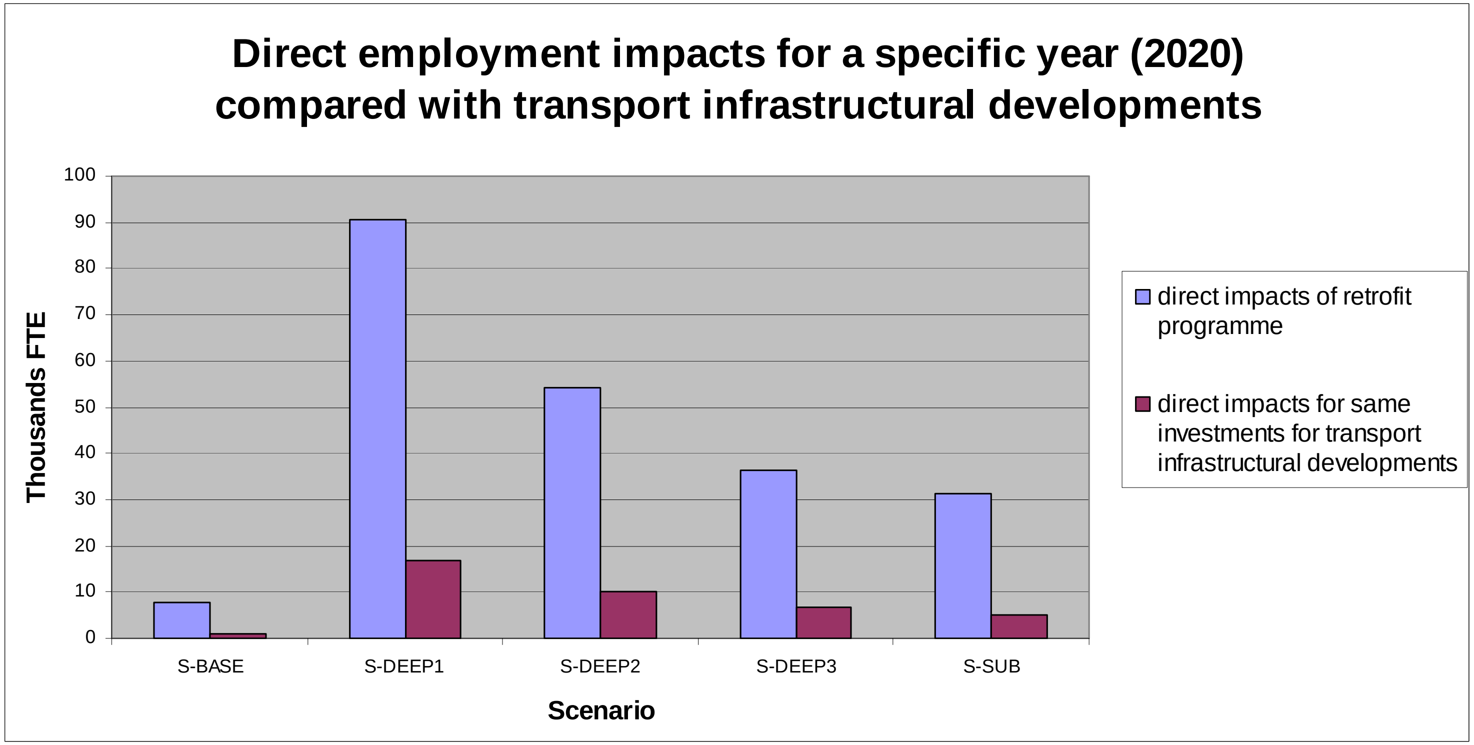


- The effects on professional labour are highest in the deep renovation scenarios

European Climate Foundation

3CSEP

Direct employment impacts: comparison with other investments

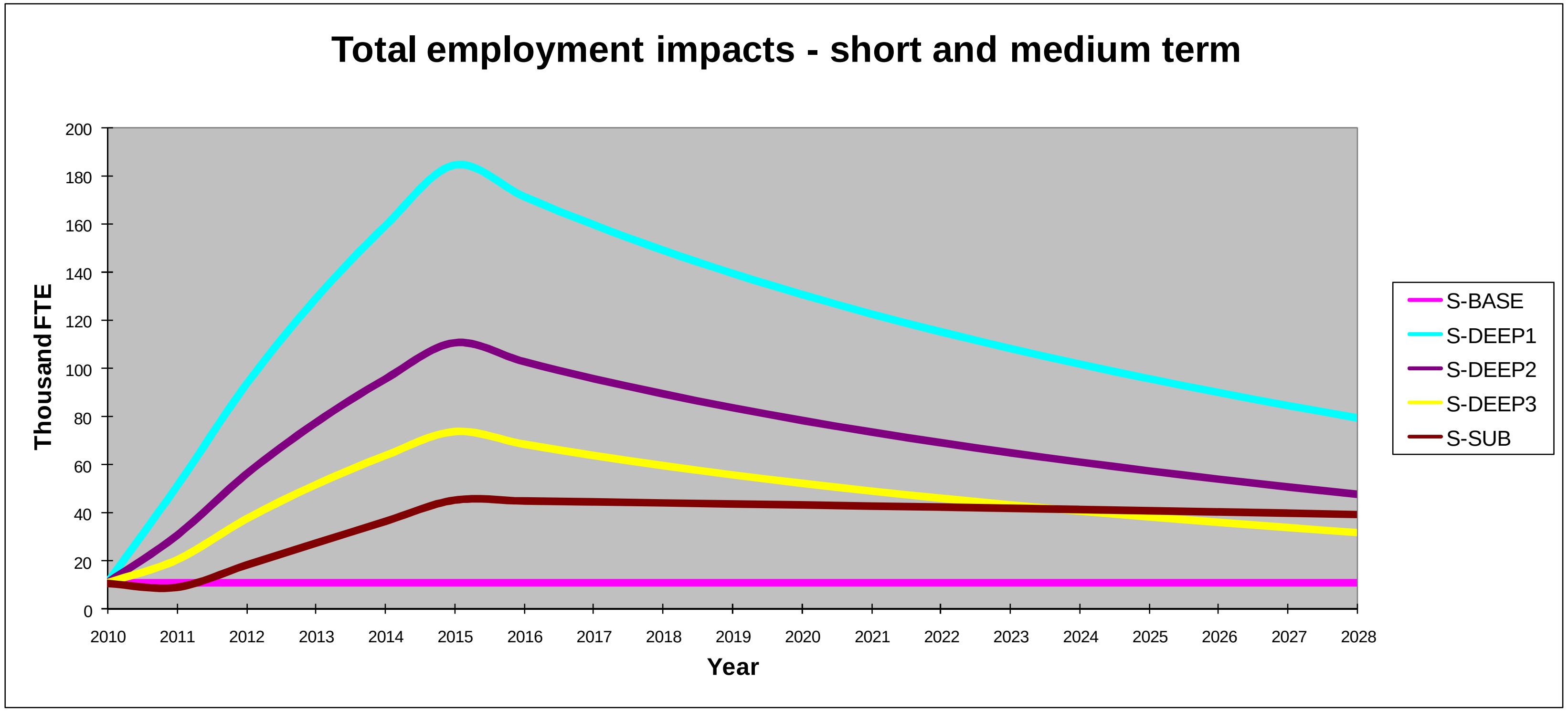


- Labour intensity in renovations is much higher than labour intensity in many other sectors
- E.g. many more jobs would be created with these programmes than if the money was spent in building highways

European Climate Foundation

3CSEP

Net employment impacts in construction: medium-term view

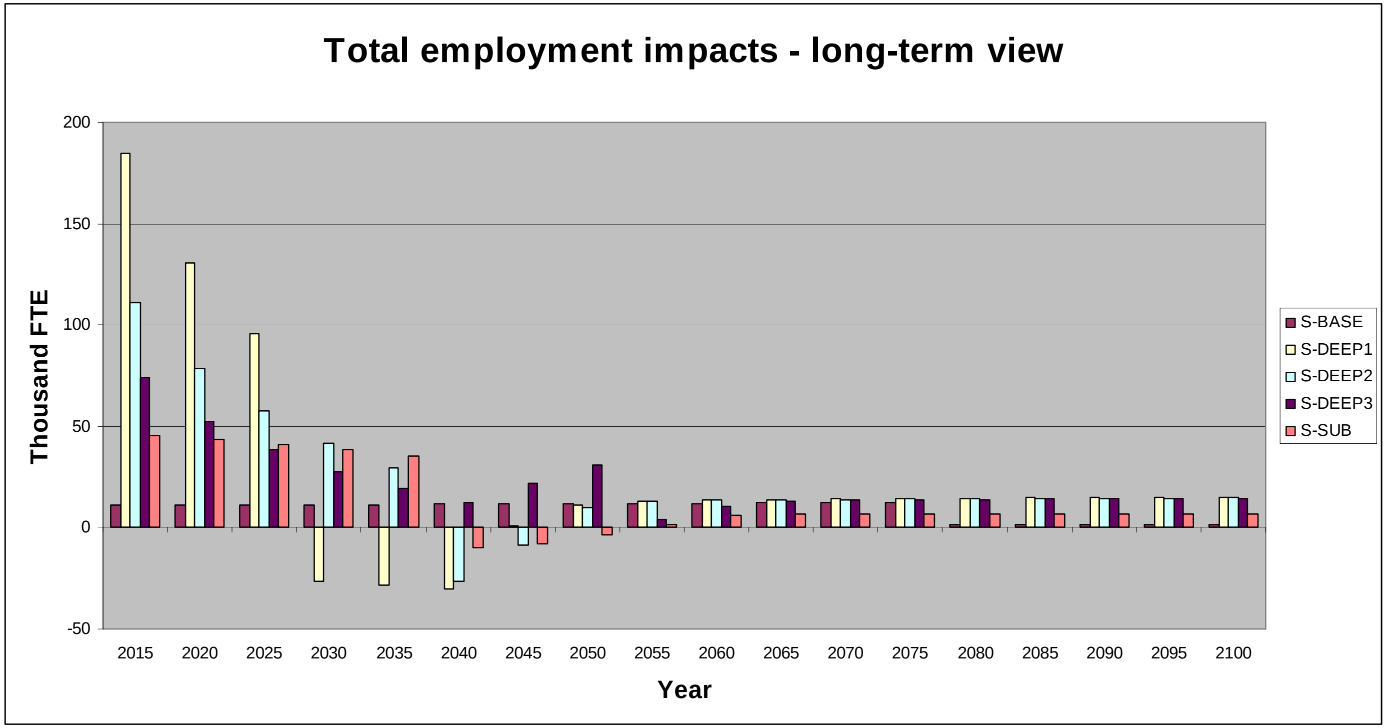


- The initial increase shows the ramp-up period
- The subsequent decrease is due to the learning factor
  - Productivity increases
  - Therefore costs and labour intensities decrease
  - There is practically no learning factor in S-BASE and S-SUB: the technologies are mature

European Climate Foundation

3CSEP

Total employment impacts: long-term view



- After the end of the renovation programme, in certain scenarios there are negative impacts coming from the reduction of demand in energy
  - However, realistically these negative impacts will be dampened or even cancelled
    - By additional energy consumption in other sectors
    - Reductions in energy sector cannot be linear (see qualitative discussion)
- In later years, the effects of increased consumption can be seen
  - They kick off later on because the energy savings are first used to repay the loan for the initial renovation investment
- Results for such a long term are extremely uncertain

European Climate Foundation

3CSEP

Further issues

- Distributed geographic effects
  - The buildings are renovated throughout the country
  - Work is mainly done by small-medium enterprises
  - Induced consumption is also distributed
- Durability of effects
  - Such a programme lasts 20-30 years, effectively a worker's lifetime
- Negative employment effects in the energy supply sector are likely to be overestimated
  - Large fixed costs in energy supply: Job losses are probably in "lumps" – e.g. power stations still need people to maintain them, even if the demand is lowered
  - Some increase in energy demand is expected from other sectors (e.g. commercial, manufacturing) which will compensate the losses from residential sector
  - Possibility to export surplus energy

Further issues (2)

- Supply of labour
  - There is availability of labour in Hungary for all skill levels
    - Entrepreneurs, professionals
    - Skilled, unskilled – among unemployed and inactive
  - However, these workers need to be attracted to the construction industry
    - Training
    - “Promotion” of the sector
    - Possibly higher wages (at least in the beginning)
  - Population aging
  - What if there is no sufficient labour supply?
    - Guest workers might be brought in
- Such a large-scale program is likely to raise the wage level in the country
  - Increases the costs of the project
  - Increases the costs of other investments (because opportunity costs are higher)
  - But also increases consumption (hence more induced effects)
- Supply of materials
  - Manufacturing must keep up with the increased demand from construction sector

Further issues (3)

- Grey labour
  - Opportunity for the State to increase the control on grey labour in construction
- Fuel poverty
  - Such a programme has the potential of eradicating fuel poverty
  - Great attention has to be put in financing, especially for the lower income households
- Real estate markets
  - The value of buildings increases
  - The lifetime of buildings is extended

Financing

- Such programme will need a vast amount of financing
  - E.g. in 2020:
    - S-DEEP1 – 3.5 B€$_{2005}$ (13% of 2009 HU budget)
    - S-DEEP2 – 2.1 B€$_{2005}$ (8% of 2009 HU budget)
    - S-DEEP3 – 1.4 B€$_{2005}$ (5% of 2009 HU budget)
- The energy savings are higher than the investments, but they accrue later
- However, at least part of the initial funds can come from:
  - the EU (up to 400M€ per year)
  - Redirecting the current energy subsidies (about 800M€ per year)
  - An ESCO-type scheme of financing in which part of the savings go into repaying the investment costs

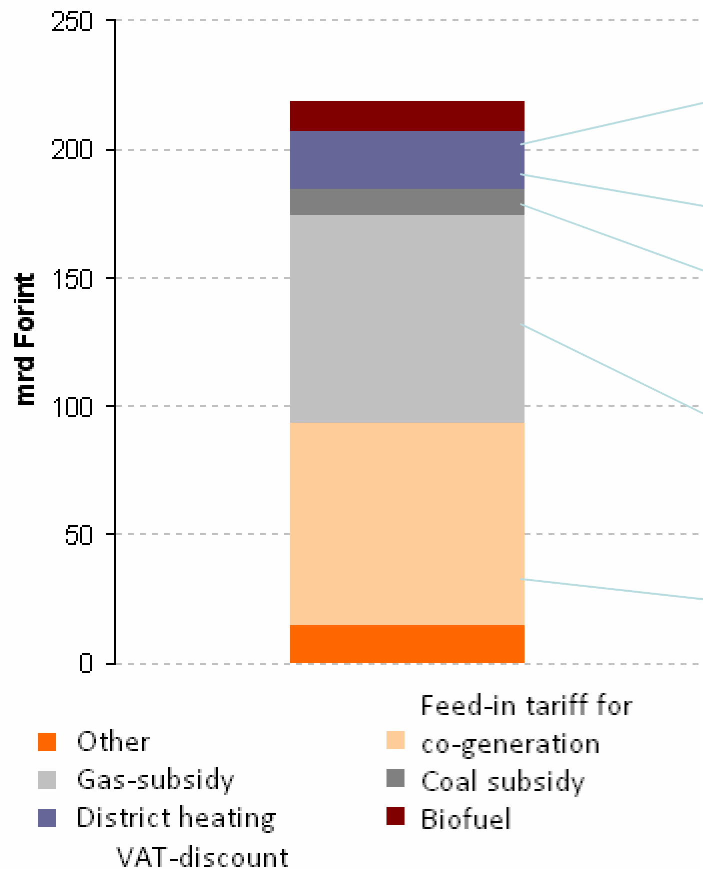
European Climate Foundation

3CSEP

Energy subsidies in Hungary

Energy subsidies

Source: slides from Mr. Laszlo Varro, Strategy Director at MOL



Biofuel: relatively little CO2 emission mitigation at a high cost

District heating VAT discount: further decreases energy efficiency

Coal subsidy: artificially increases the competitiveness of high carbon intensity energy

Gas subsidy: decreases energy efficiency and competitiveness of renewable heat

Feed-in tariff for co-generation: predominantly subsidy of gas based co-generation, decresaes competitiveness of renewable heat

\+

- 300 Bn HUF state investment to a new lignite plant.
- 1 Mt additional CO2 emission compared to a BAT gas turbine

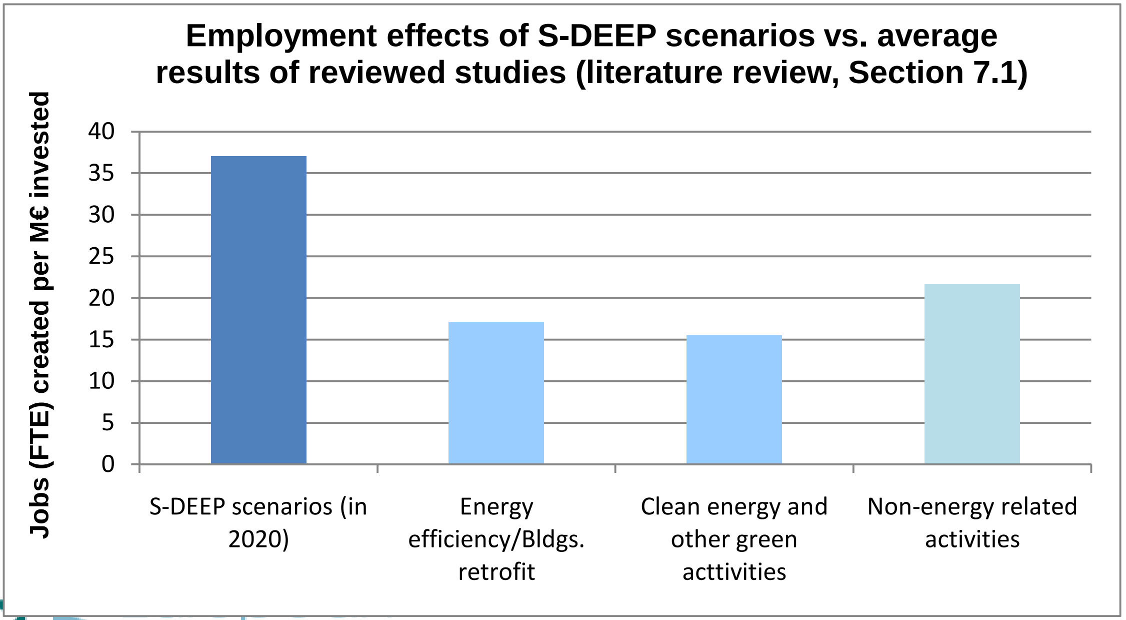
European Climate Foundation

3CSEP

Results compared with other investment initiatives

- The scenarios have an average FTE generated (direct + indirect + induced) per Million Euro invested much higher than the studies reviewed

Deep renovation scenarios	FTE generated (direct + indirect + induced) per M€ invested in 2020
S-DEEP	37.3
Studies reviewed	
Energy effciency/Bldgs. retrofit	17.07
Other mitigation	15.56
Non-energy related activities	21.64



Climate Foundation

3CSEP

Summary of results: conclusions

- Deep renovation scenarios give higher climate and energy benefits compared to suboptimal renovation scenarios
  - Deep retrofit scenarios can save 85% of energy use and relative carbon emissions
  - A suboptimal scenario locks in 45% of 2010 heating-related emissions
  - Deep retrofit scenarios can reduce up to 39% of annual natural gas needs in 2030, 59% in the critical month of January (compared to average 2006-2008 values)
  - A suboptimal scenario will reduce imports of 10% only (18% in January)
  - The construction sector has the opportunity of learning new techniques which will inevitably be state-of-the-art in a few years
- Employment impacts are highly positive in the short to medium term, especially for deep renovation scenarios
  - 131,000 jobs created in *S-DEEP1*, 78,000 in *S-DEEP2*, 52,000 in *S-DEEP3,* 43,000 in *S-SUB*
    - Around 38% are indirect and induced effects in other sectors
  - Labour intensity in deep retrofit is higher than if the money was invested in other initiatives (e.g., 5 times higher than road construction)
- The major issue is financing
  - The renovation programmes would have a high impact on the state's budget (up to 13% for S-DEEP1, 8% for S-DEEP2, 5% for S-DEEP3)
  - However, a large amount of money (up to 1 billion Euros) can come from the EU or from redirecting current energy subsidies (e.g. to gas and district heating)
  - Part of the initial investment costs can be financed by a pay-as-you-save financing scheme

Summary of results: recommendations

- The recommendation is to promote a deep renovation scenario with a less ambitious rate of renovation
  - e.g. *S-DEEP3* (2.3% of the floor area, 100,000 dwellings-equivalent)
  - 52,000 jobs created by 2020
  - Less than 2 Billion Euros of peak annual investment, app. 1 bln in later program phases
- The impacts are slightly lower but sustained: no shock in the economy and in the industry
  - The slower rate of renovation allows for a “smooth” transition period
  - Time is allowed for the firms to learn, train employees and increase production of materials
  - The learning factor ensures that the costs become lower throughout the years
    - The investment shock is reduced
    - Less money is “locked in” on renovations which could have been less expensive in following years
  - Labour supply issues and wage effects are reduced
- The public administration should be involved in planning and financing
  - To assure the achievement of deep savings through deep retrofits
  - To reduce potential supply bottlenecks

European Climate Foundation

3CSEP

The research team

Principal investigator

Prof. Dr. Diana Ürge-Vorsatz

Further Authors

Daniele Arena – Project coordinator
Sergio Tirado Herrero – Economics
Andrew Butcher – Building stock model and scenarios

Lead Experts

Prof. Dr. Álmos Telegdy– Senior Labour Economist
Mr. Sándor Fegyverneky – Chief Government Architect

Contributing Author

Dr. Tamás Csoknyai – BME

Research Assistants

Éva Kőpataki
Alexandra Jankó
Research and data collection in Hungary and Austria

European Climate Foundation

3CSEP

Report on the Employment Impacts of a Large-Scale Deep Building Energy Retrofit Programme in Hungary

CENTER FOR CLIMATE CHANGE AND SUSTAINABLE ENERGY POLICY

CENTRAL EUROPEAN UNIVERSITY

Thank you for your attention

http://3csep.ceu.hu/

3csep@ceu.hu

Report on the Employment Impacts of a Large-Scale Deep Building Energy Retrofit Programme in Hungary

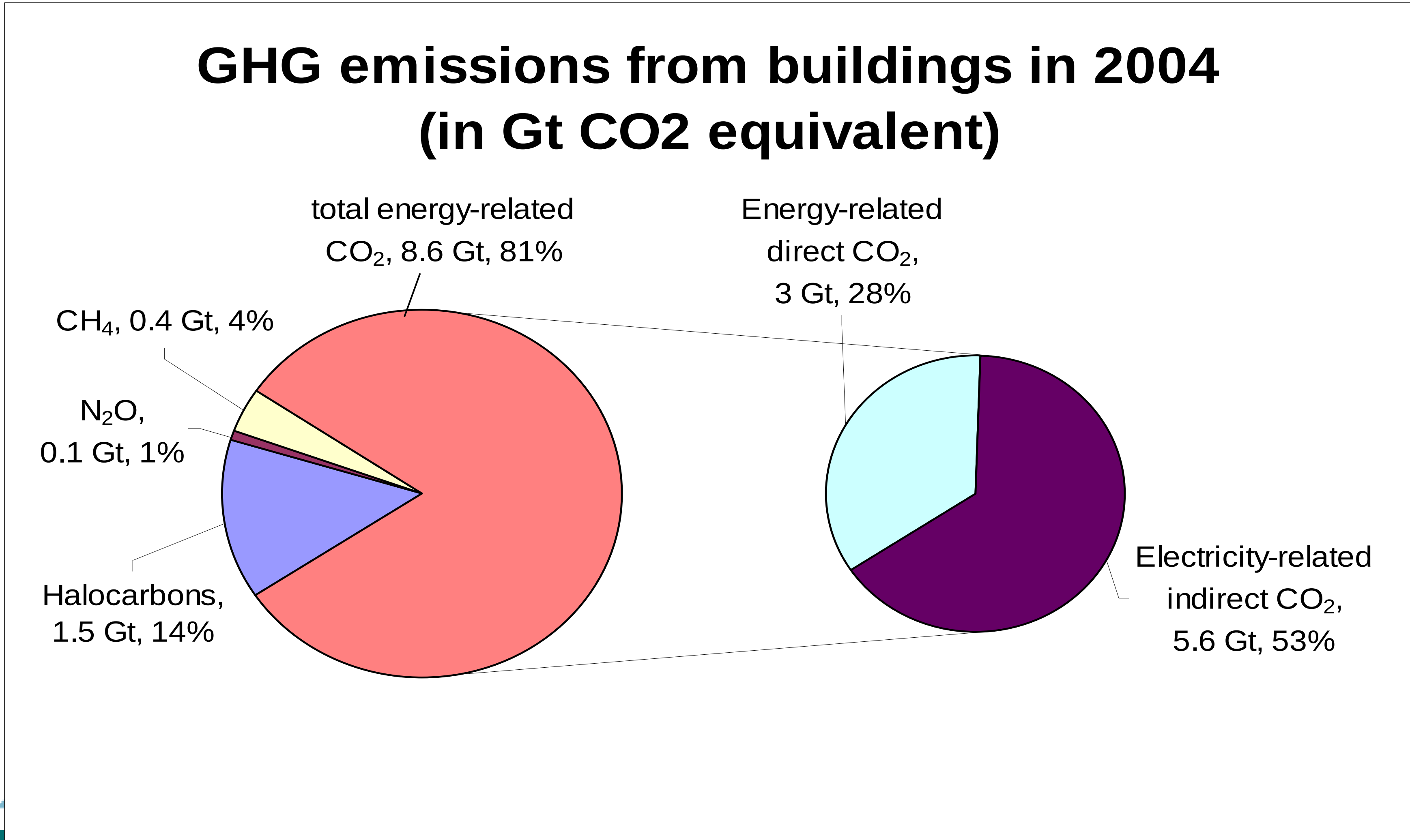
Center for Climate Change
and Sustainable Energy Policy

Central European University

Supplementary slides

Building sector: global importance

In 2004, in buildings were responsible for app. 1/3 of global energy-related CO_2 (incl. indirect) and 2/3 of halocarbon emissions



Climate Foundation

3CSEP

Co-benefits

- Co-benefits of buildings energy efficiency
- Some examples:
  - Improved air quality
  - Improved productivity
  - Noise reduction
  - Increased real estate value
  - Improved energy security
  - Reduced fuel poverty
  - Employment creation

European Climate Foundation

3CSEP

Hungarian building stock

- **Residential (92% of floor area considered)**
  - Historical Residential Buildings
  - Traditional Multi-Family (19th Century until 1960s)
  - Panel Multi-Family (Industrial Technology)
  - Traditional Single-Family (Built until 1992)
  - Modern Single-Family (Between 1993-2010)
  - Modern Multi-Family (Between 1993-2010)
- **Public (8% of floor area considered)**
  - Historical Public Buildings
  - Traditional Multi-Story (19th Century until 1960s)
  - Panel Multi-Story (Industrial Technology)
  - Traditional Single-Story (Built until 1992)
  - Modern Single-Story (Between 1993-2010)
  - Modern Multi-Story (Between 1993-2010)
- **Total Energy for Space Heating and Cooling Public and Residential Buildings – 63 TWh/year**
- **Commercial buildings are not considered in this research**

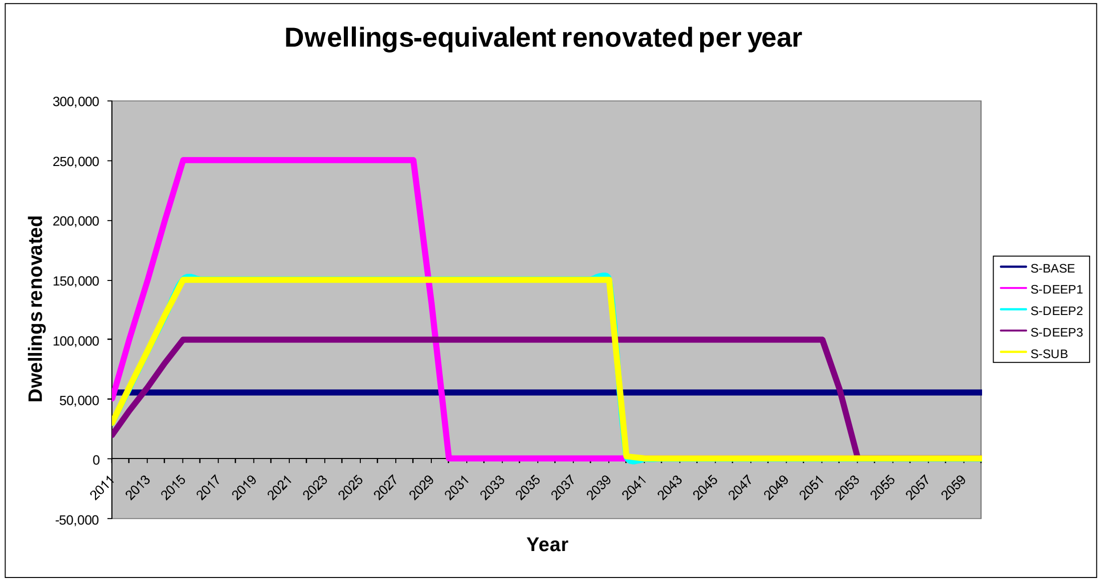
European Climate Foundation

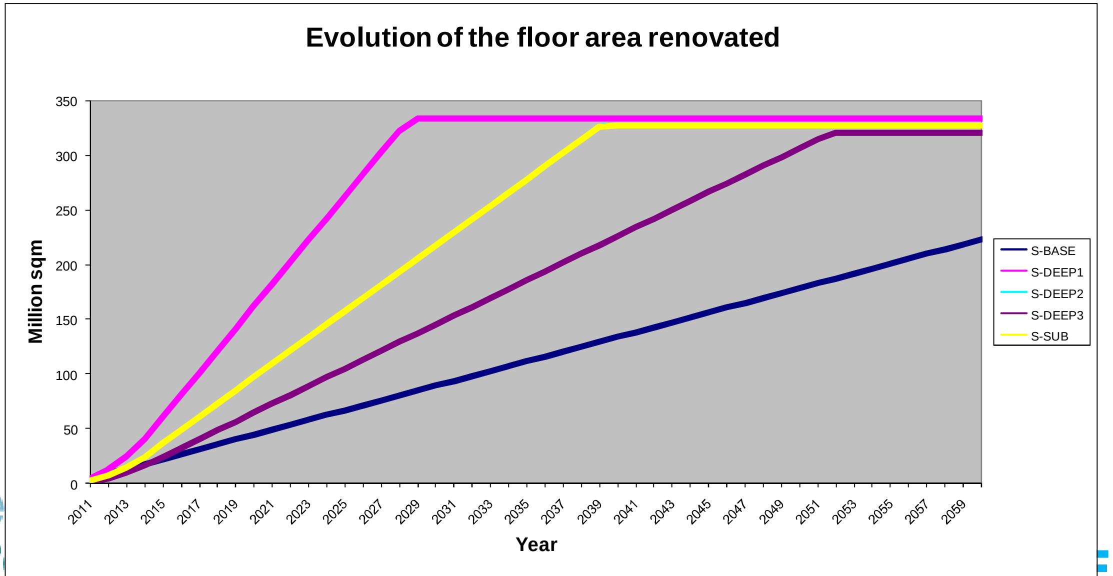
3CSEP

Scenario variables

- Type of retrofit
  - “Deep” (towards Passive House standard, 15kWh/sqm/y for residential and 30 kWh/sqm/y for public buildings: 75-90% energy savings)
  - Suboptimal (saves 40% energy on average)
    - Risk of lock-in effect
- Rates of renovation
  - *S-DEEP1*: 20 million sqm (250k dwellings-equivalent) a year
    - Completed in 16-20 years
  - *S-DEEP2* and *S-SUB*: 12 million sqm (150k dwellings-equivalent) a year
    - Completed in 26-30 years
  - *S-DEEP3*: 8 million sqm (100k dwellings-equivalent) a year
    - Completed in 42-43 years
- *S-BASE* is the reference scenario
  - 1.3% of buildings renovated per year
  - Very little energy savings (10% assumed on average)
- Main assumptions
  - Ramp-Up Period: 5 Years
  - Study results:
    - In 2020 – Completion of EU2020 strategies (on climate/energy and on employment)
    - Trends of results throughout the years
  - All the financial estimates are in EUR2005

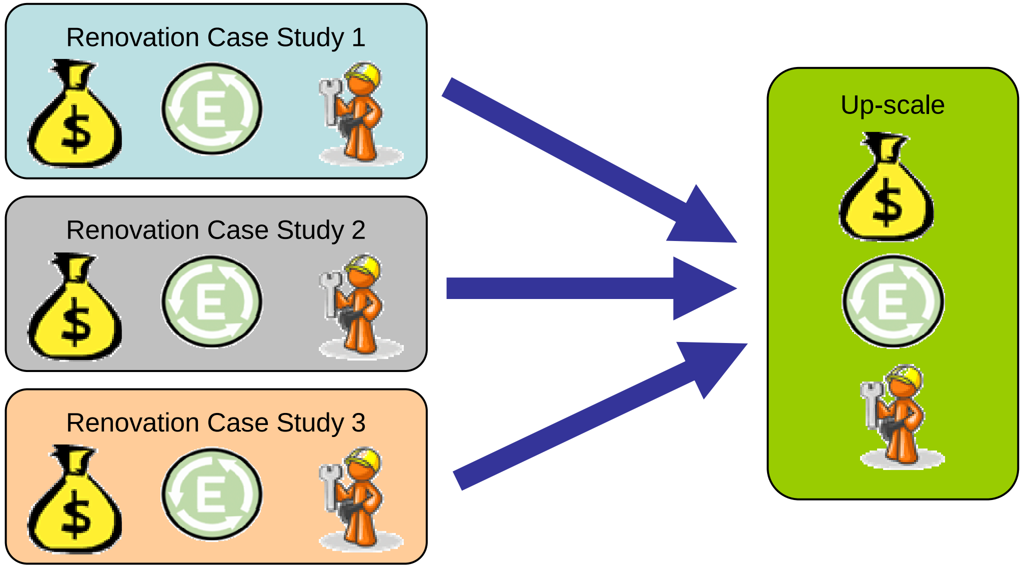
Renovation Scenarios: characteristics





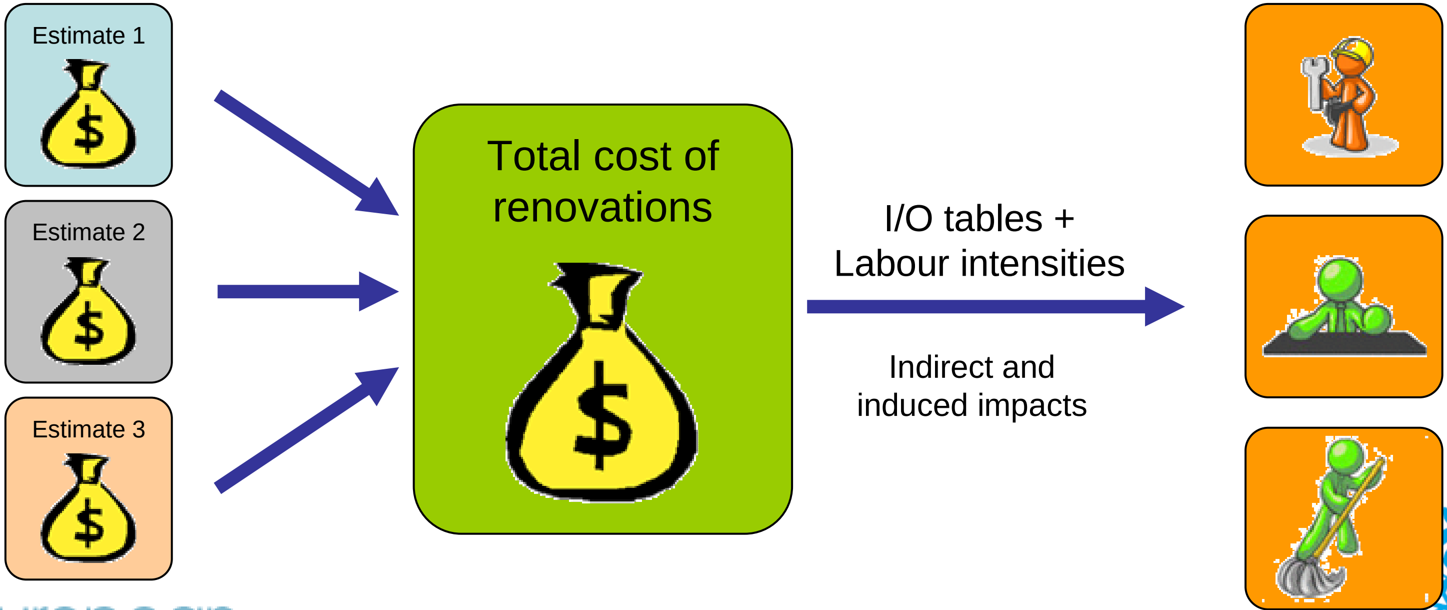
Direct impacts in construction: "bottom-up" Scaling-up of case studies

- Gather detailed information for a number of renovation projects
  - Man-months involved (divided by skill level)
  - Labour costs (multiply man-months by average salary per skill level)
  - Energy savings
  - Ideally: one or more projects for each building type and retrofit type
- Up-scale these cases to the whole building stock



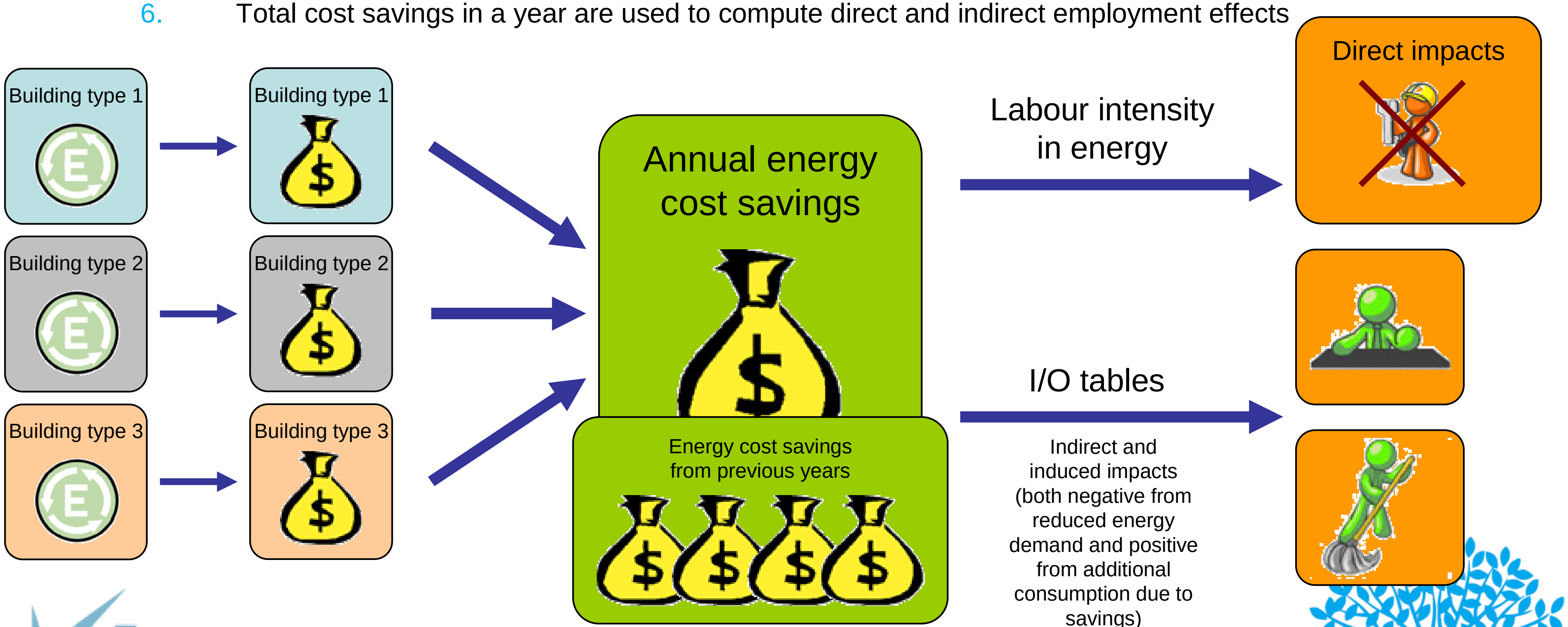
Indirect and induced impacts in construction: "top-down" Input-Output analysis

- Procedure:
  1. Classify case studies by renovation rate and type of building
  2. Estimate total costs per sqm for each case study
  3. Up-scale results for each scenario to get total annual costs
  4. Total annual costs are used to be entered into I-O table, which gives indirect and induced effects in demand
     - Labour intensity is then used to estimate employment impacts



Impacts from energy savings

- A similar process is followed for energy cost savings
  1. Estimate energy savings per type of building
  2. Use fuel split to compute energy savings by type of fuel
  3. Use price estimates of fuel types to calculate energy cost savings
  4. Up-scale results for each scenario to get annual cost savings
  5. Cost savings accumulate!
  6. Total cost savings in a year are used to compute direct and indirect employment effects



European Climate Foundation

3CSEP

The input-output tables

- Tables that show the transactions between industries
- It is possible to “reverse” them to see how much output is generated by each industry to make 1EUR (or USD, or HUF) of product
  - The “Leontief inverse” matrix is what we use: the increase in output of construction (and the decrease in energy) are reflected in the outputs of the other industries
  - The output change is multiplied by the labour intensity to obtain the employment impacts

Example Inverse I/O table (Leontief Inverse)	Energy	Construction	Transport
Agriculture	0.1	0.2	0.05
Manufacturing	0.05	0.12	0.2
Energy	1.3	0.23	0.3
Construction	0.05	1.15	0.15
Transport	0.3	0.2	1.1
Other services	0.2	0.1	0.2

Example

Labour intensity

- How many people are employed per output
  - FTE per million EUR
- Is assumed to be linear
- Labour intensity of sectors is very variable
  - E.g. intensity for construction much higher than energy
- Labour intensity is the inverse of labour productivity
  - It typically decreases over the years (as labour productivity increases)

Labour intensity in Hungary	FTE per Million EUR (2006)
Construction	12.03
Energy	2.66
Average for all sectors	8.52

Source: KSH

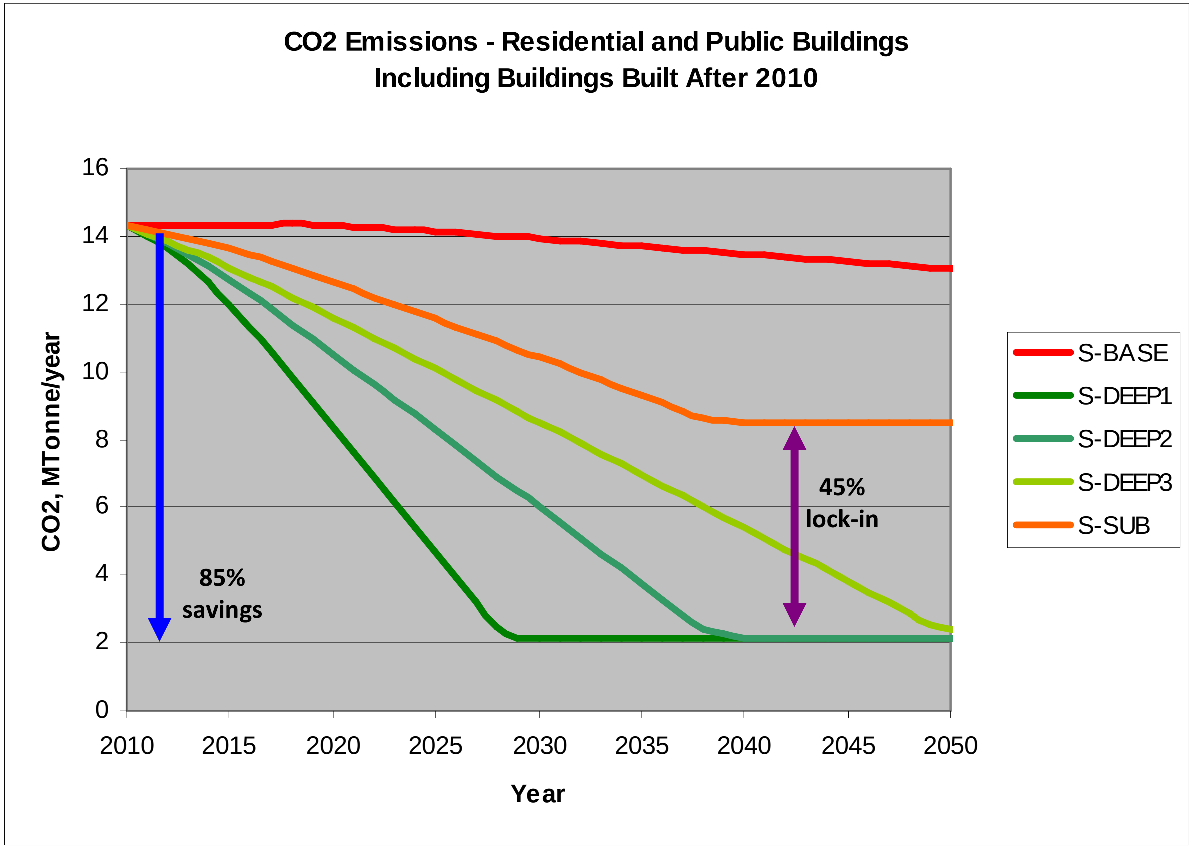
European Climate Foundation

3CSEP

Limitations of I/O method

- I/O method is the most widely used for calculating employment effects
- Caveats of I/O-based estimates:
  - I/O tables are a snapshot of the economy: static coefficients and prices
  - No complex analysis of dynamic effects on input prices, income, etc.
  - Better fit for estimating the effects of marginal changes
    - The proposed interventions (*S-DEEP*) will have a larger impact on the Hungarian economy
- For our analysis:
  - Total investment costs depend on the quality of information
    - Small amount of case studies available in Hungary, uncertainty for case study transfer from abroad
  - Labour intensity not available for the specific researched sectors (deep and sub-optimal retrofit)
  - Implications of informal labour in the construction sector
  - Rebound effect only partially considered
    - Rebound effect: offsetting of energy savings because of additional household income and lower energy prices
    - The study assumes an increase of heated floor area in dwellings after deep renovations

Scenario results: CO_2 emission reductions until 2050

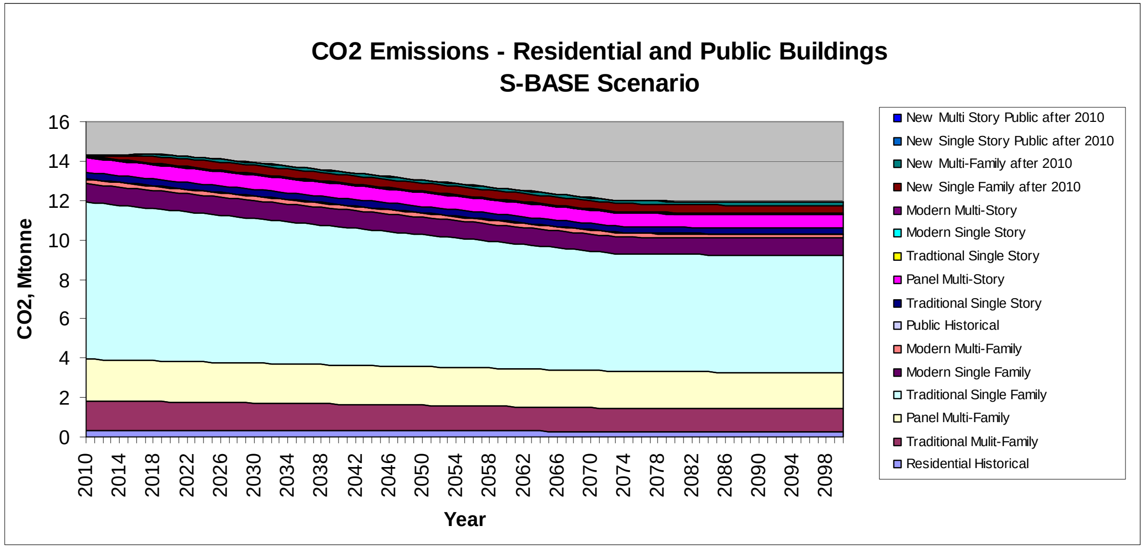


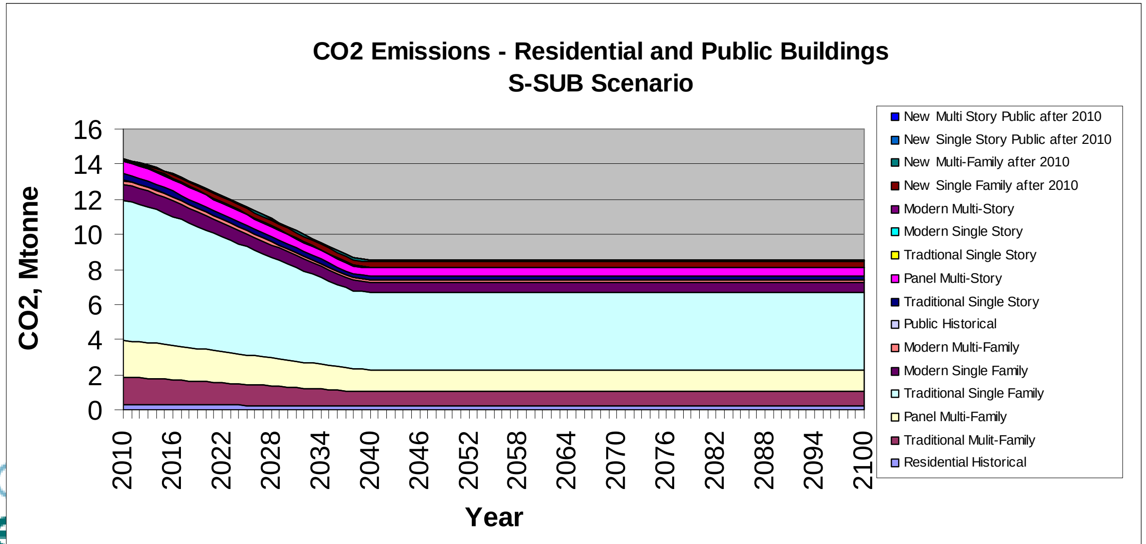
- 85% of emissions are saved in deep scenarios
- 45% of emissions remain locked-in by the suboptimal scenario

European Climate Foundation

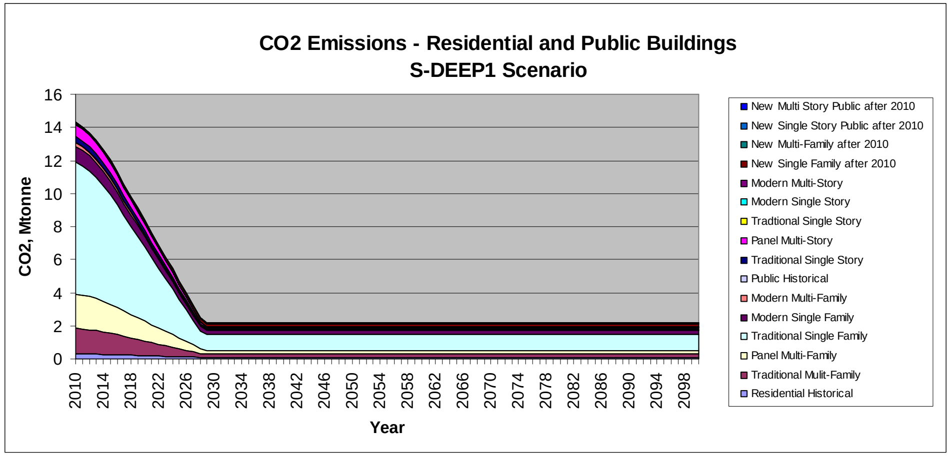
3CSEP

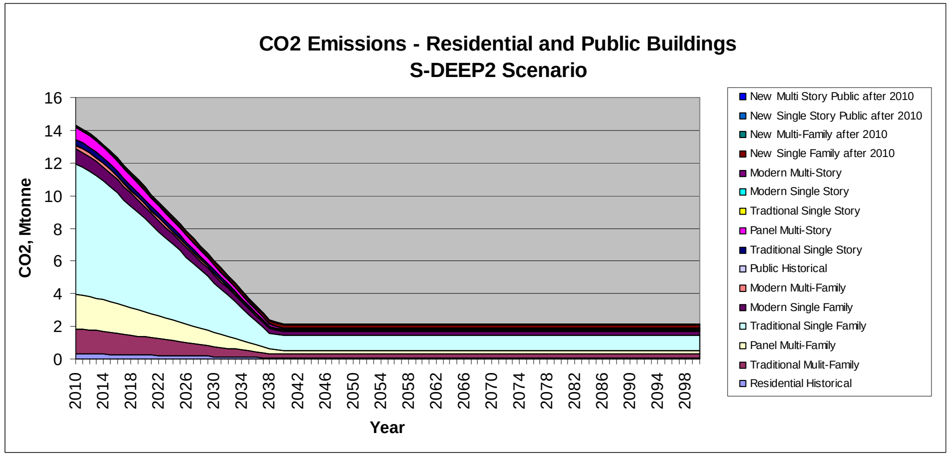
Scenario results: CO2 savings by building category

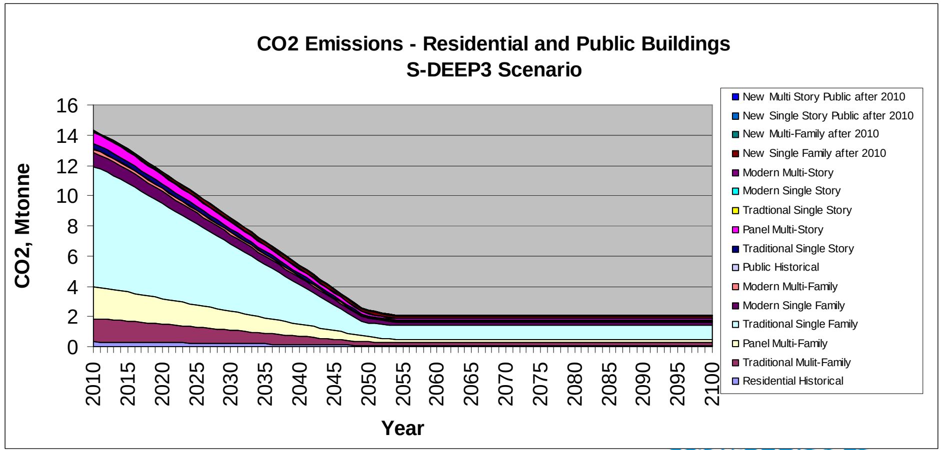




Scenario results: CO2 savings by building category







European Climate Foundation

3CSEP

Estimated investments per sqm

Residential Building Stock: estimated investments (Euro per sqm)	S-BASE	S-DEEP	S-SUB
Historical and Protected Buildings	80	550	146
Traditional Multi-Family Homes (<1960)	48	280	83
Multi-Family Homes - Industrial technology (Panel Buildings) to 1992	45	250	75
Single Family Homes to 1992	52	330	86
Single Family Homes 1993 -2010	45	330	92
Multi-Family Homes 1993-2010	45	270	75

Public Building Stock: estimated investments (Euro per sqm)	S-BASE	S-DEEP	S-SUB
Historical and Protected Buildings	80	550	146
Traditional Public Buildings (similar to MF)	48	280	83
Panel Public Buidlings (similar to MF)	45	250	75
Traditional Public Buildings (similar to SF)	52	330	86
New Public buildings (similar to SF)	45	330	92
New Public Buildings (similar to MF)	45	270	75

- These investments are estimated in EUR2005 for the beginning of the programme
- Due to the learning factor, the costs will decrease throughout the years for deep renovations
  - Baseline and suboptimal renovation costs do not change – the technology is mature

European Climate Foundation

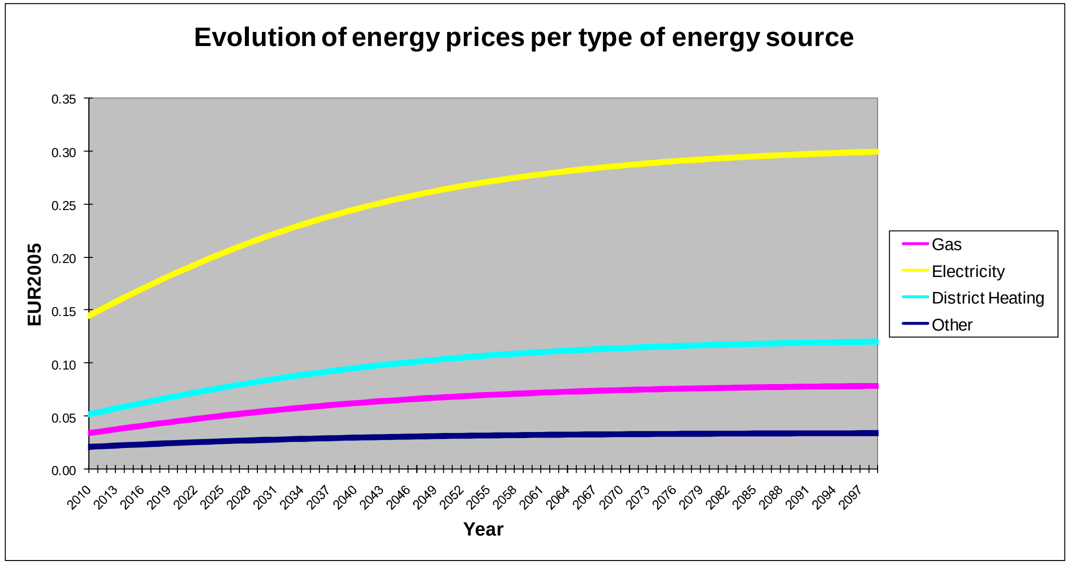
3CSEP

Scenario Results: Energy Savings

❖ Fuel Prices and Emission Factors

Fuel Prices and Emission Factors	Prices in 2010 (EUR2005/kWh)	Prices in 2020	CO2 Emission Factors (g/kWh)
Natural Gas, Domestic Customers	0.034	0.045	202
Electricity, Domestic Customers	0.145	0.186	366
District Heating	0.052	0.069	255
Other (Avg. of fuels)	0.021	0.025	350

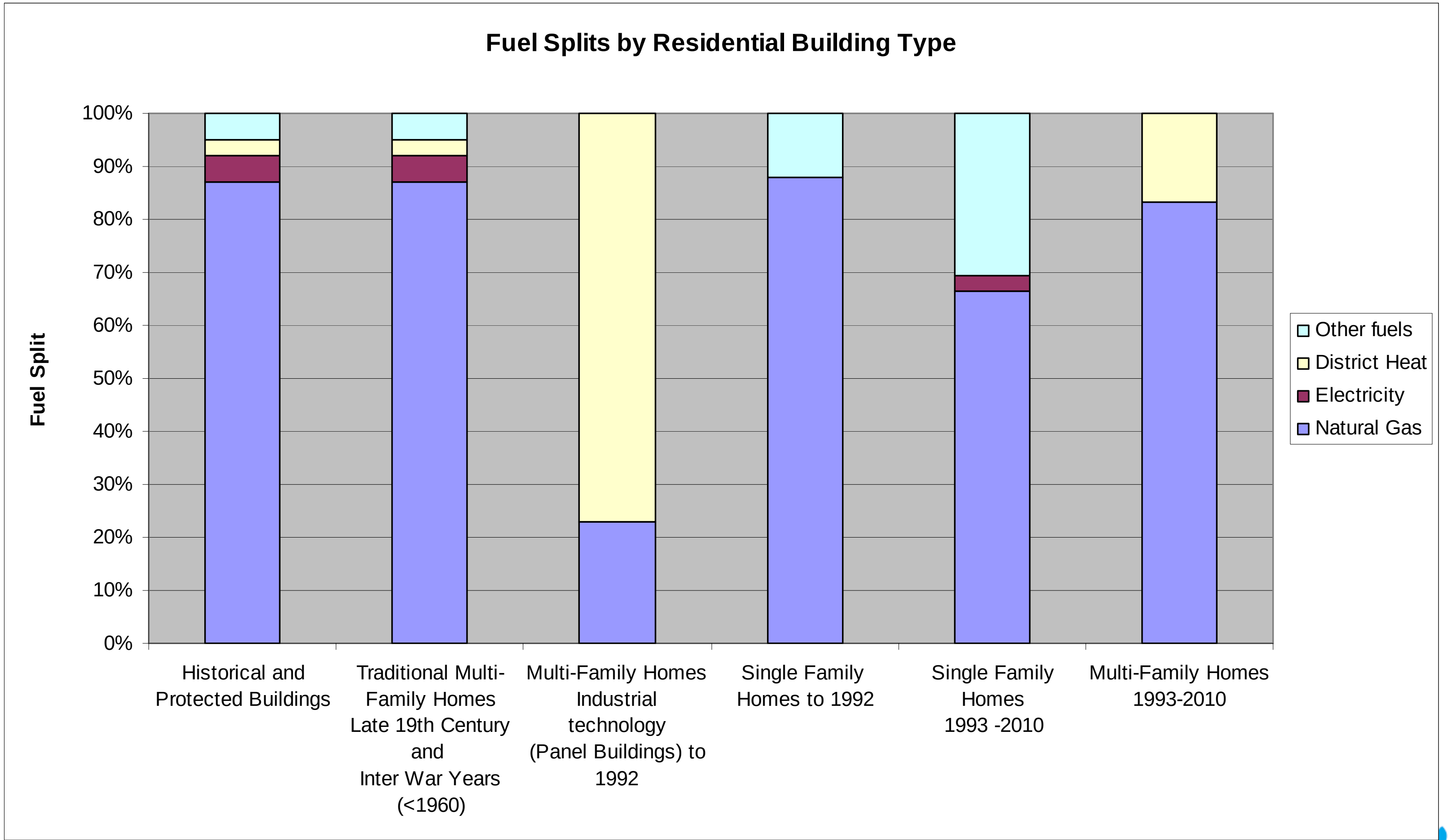
Sources: own elaborations based on data from KSH, IEA World Energy Outlook 2009, Hungarian Ministry of Water and Environment (KVVM)



European Climate Foundation

3CSEP

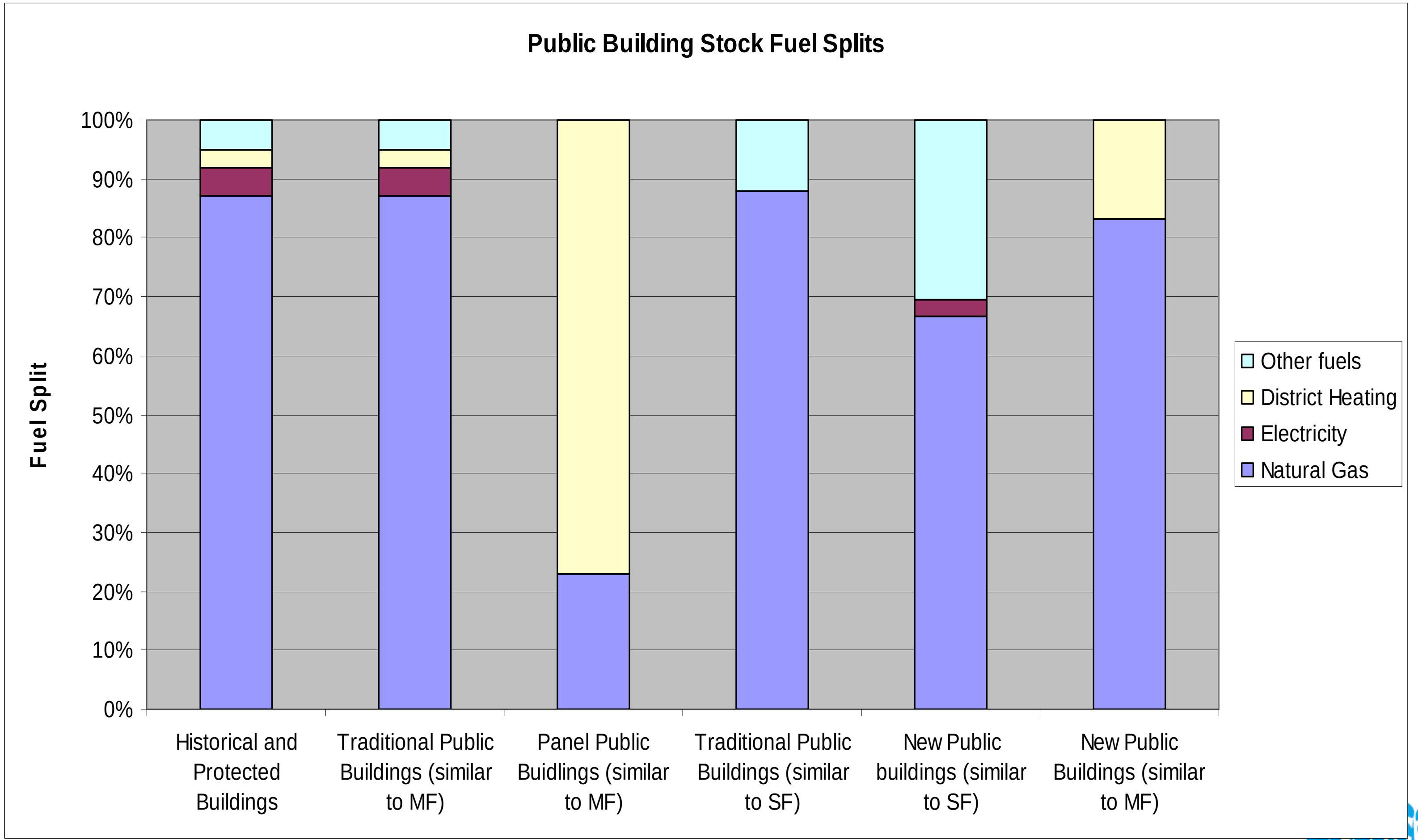
Fuel Splits: Residential Buildings



European Climate Foundation

3CSEP

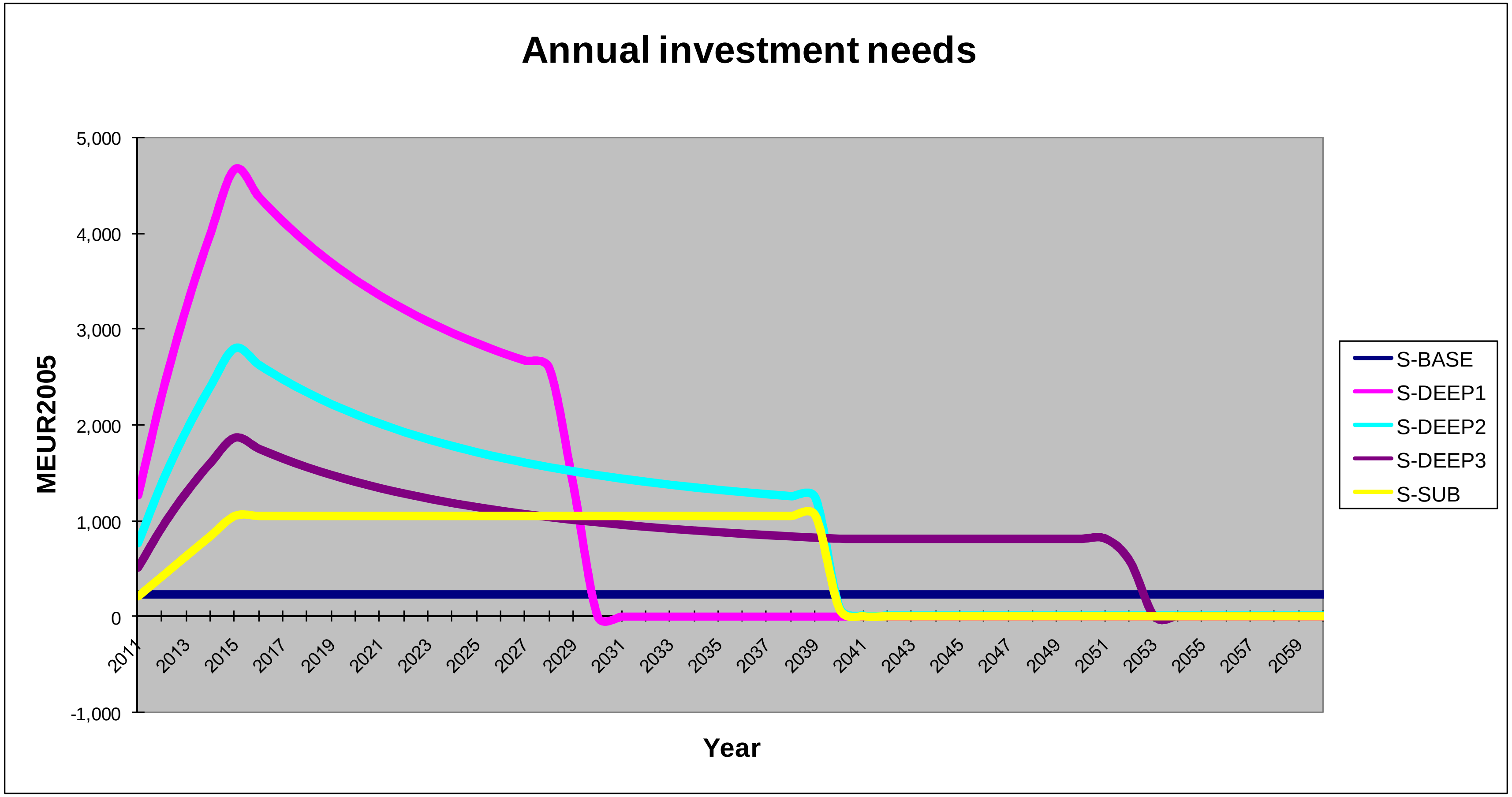
Fuel Splits: Public Buildings



European Climate Foundation

3CSEP

Scenario results: Investments for the programme



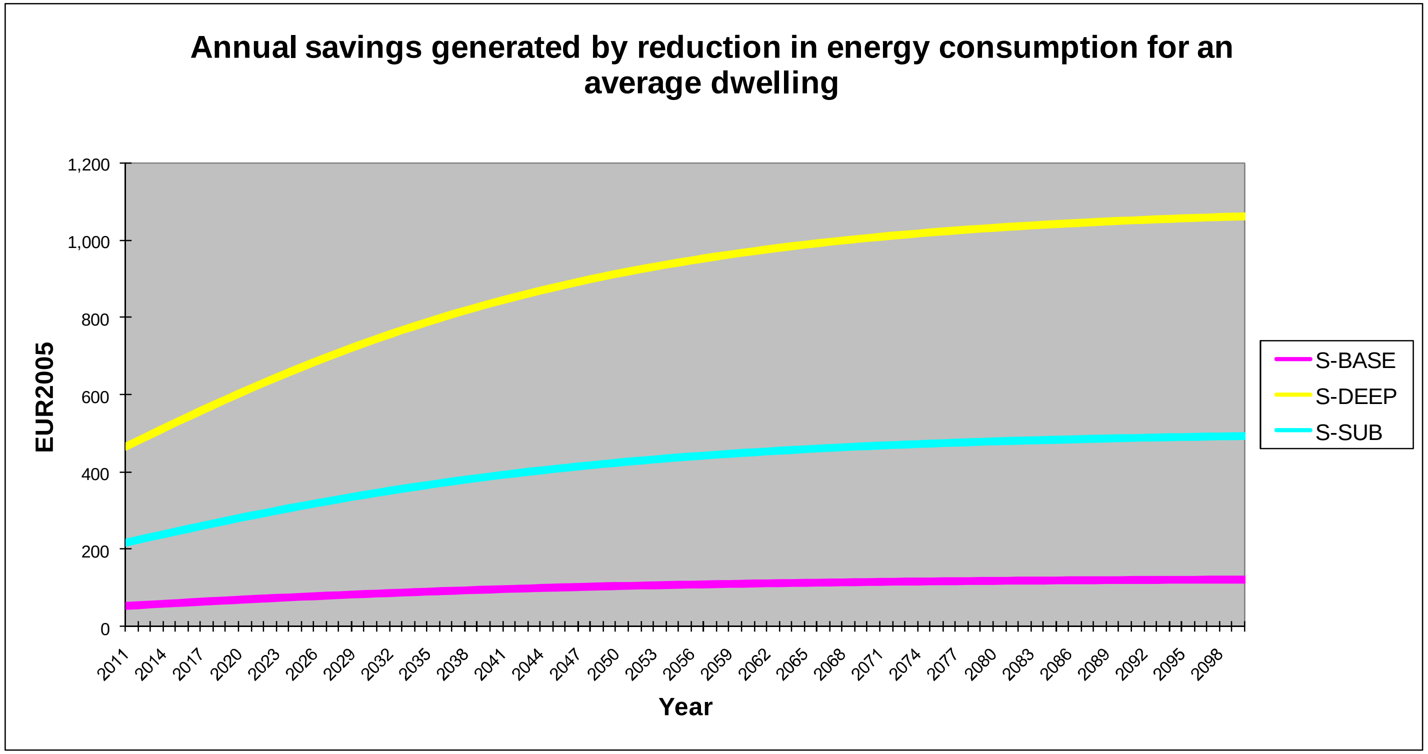
- Initial 5-year ramp-up period
- Subsequent decrease thanks to learning factor

European Climate Foundation

3CSEP

Scenario results: energy cost savings

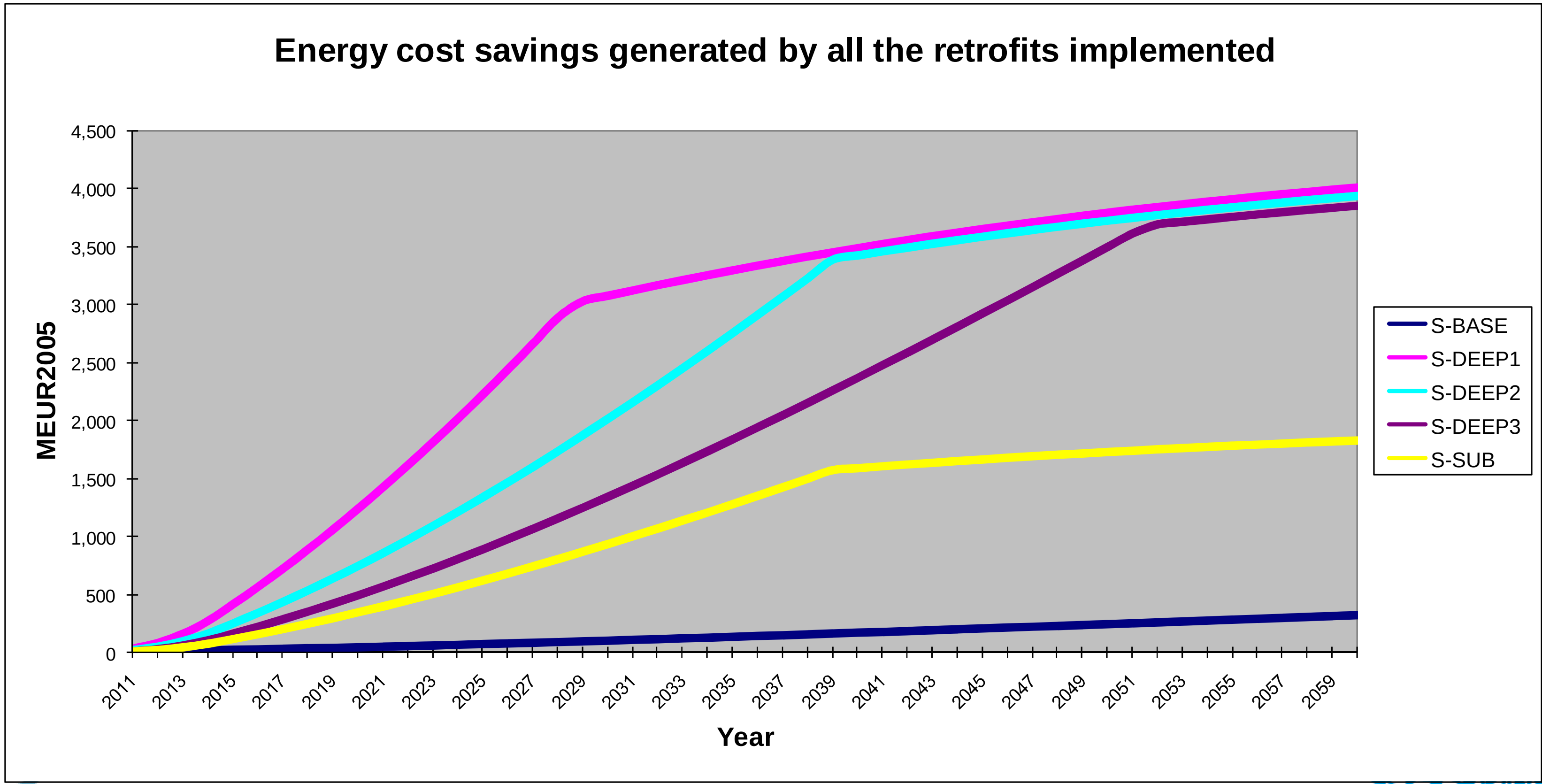
- Energy expenditure savings for an average dwelling
- Energy prices are forecasted to increase and drive up the savings



3CSEP

Scenario results: energy cost savings

- Energy savings generated each year by all retrofits implemented until that year



European Climate Foundation

3CSEP

Employment effects: literature review

- Studies reviewed show effects of 10-30 jobs per M€ invested
- The studies are mainly from Western Europe/USA
  - Difficult to transfer to transition economies (e.g. Hungary)

Resource	Reference	Year	Location	Intervention	Jobs/M€ invested
EU SAVE Programme	Wade et al., 2000	1995	European Union	Energy Efficiency	26.60
SAVE: UK Case Studies	EST, 2000	1996	United Kingdom	Energy Efficiency in Buildings	82.65
The Size of the U.S. Energy Efficiency Market	Ehrhardt-Martinez and Laitner, 2008	2004	U.S.A.	Energy Efficiency	6.76
				Energy Efficiency in Residential Buildings	10.08
Green Collar Jobs in the U.S. and Colorado	Bezdek, 2009b	2007	U.S.A.	USA: Base scenario	10.97
				USA: Moderate scenario	11.21
				USA: Advanced scenario	10.97
Investing in Clean Energy	Pollin, Heintz and Garrett-Peltier, 2009	2009	U.S.A.	Building retrofits	16.60
Danish Green Jobs	Juul, Hansen, Hansen and Ege, 2009	2009	Denmark	Energy renovation of poorly insulated housing	4.05
				Energy savings in buildings operated by local authorities	16.67
Rebuilding America	Hendricks, Goldstein, Detchon and Shickman, 2009	2009	U.S.A.	Building retrofits	17.44

European Climate Foundation

3CSEP

Direct employment impacts: snapshot in 2020

- The results are calculated in 2020
  - Programme in full activity
  - 5-year ramp-up period is over
- Direct effects
  - Construction: calculated with bottom-up method
    - 17% to 48% more jobs in construction
  - Energy: calculated with labour intensity
    - Loss of 3% to 10% of jobs in energy

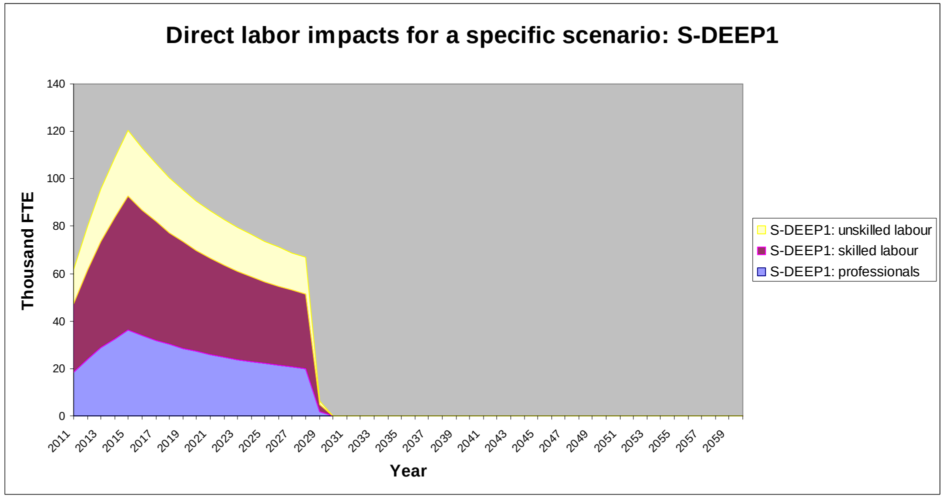
Scenario	Investments in construction in 2020 (M€)	Direct effects in construction (thousand FTE units)	Percentage of the FTE units working in construction (2006 data, KSH)
S-BASE	224	7.6	**4%**
S-DEEP1	3,506	90.6	**48.5%**
S-DEEP2	2,104	54.3	**29%**
S-DEEP3	1,402	36.2	**19.5%**
S-SUB	1,040	31.3	**17%**

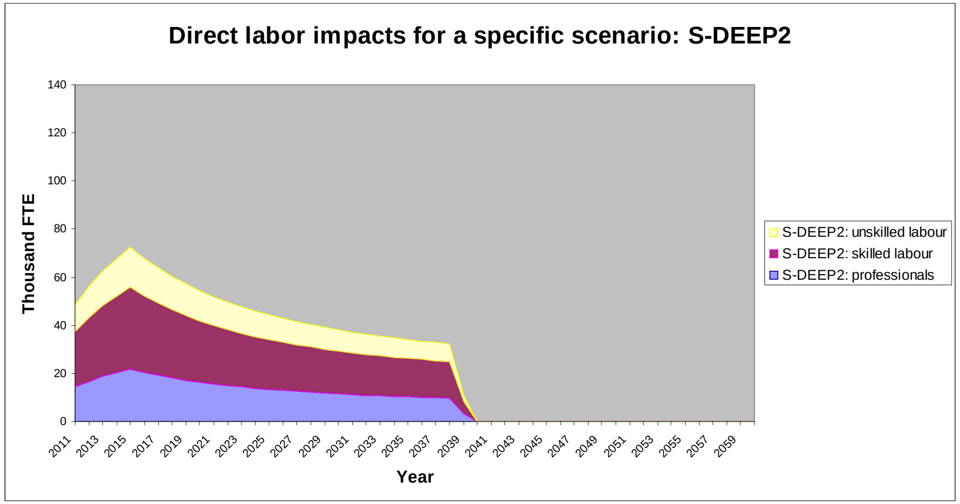
	Energy savings in 2020 (M€)	Direct effects in energy (thousand FTE units)	Percentage of the FTE units working in energy (2006 data, OECD)
S-BASE	40	-0.1	**-0.3%**
S-DEEP1	1,234	-3.2	**-10.5%**
S-DEEP2	740	-1.9	**-6.5%**
S-DEEP3	493	-1.3	**-4.5%**
S-SUB	344	-0.9	**-3%**

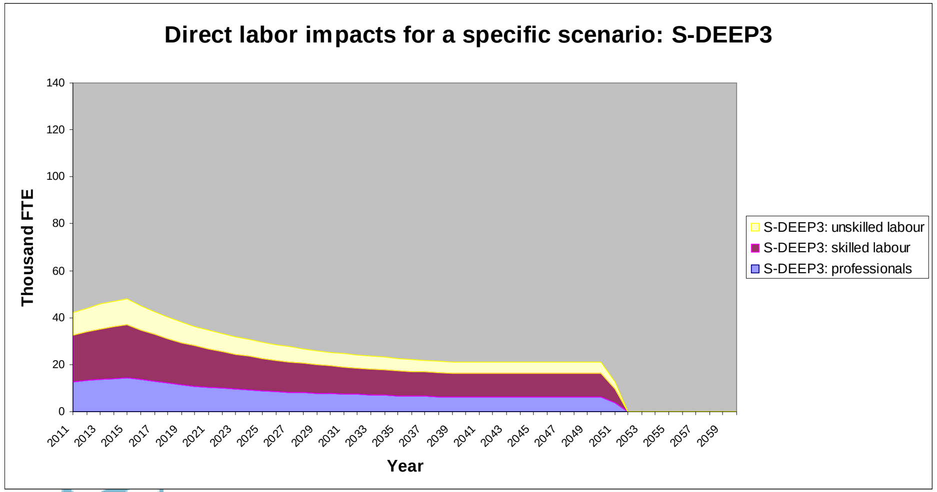
European Climate Foundation

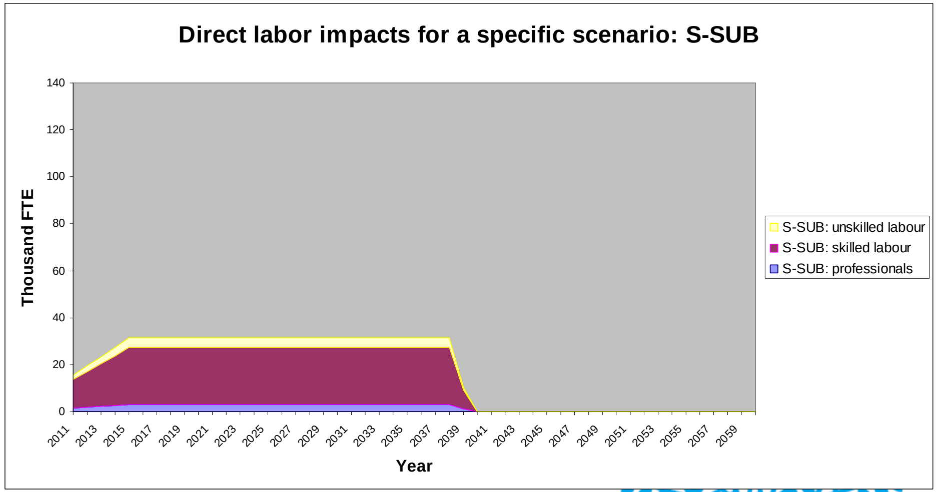
3CSEP

Direct employment impacts in construction: medium-term view (by skills)









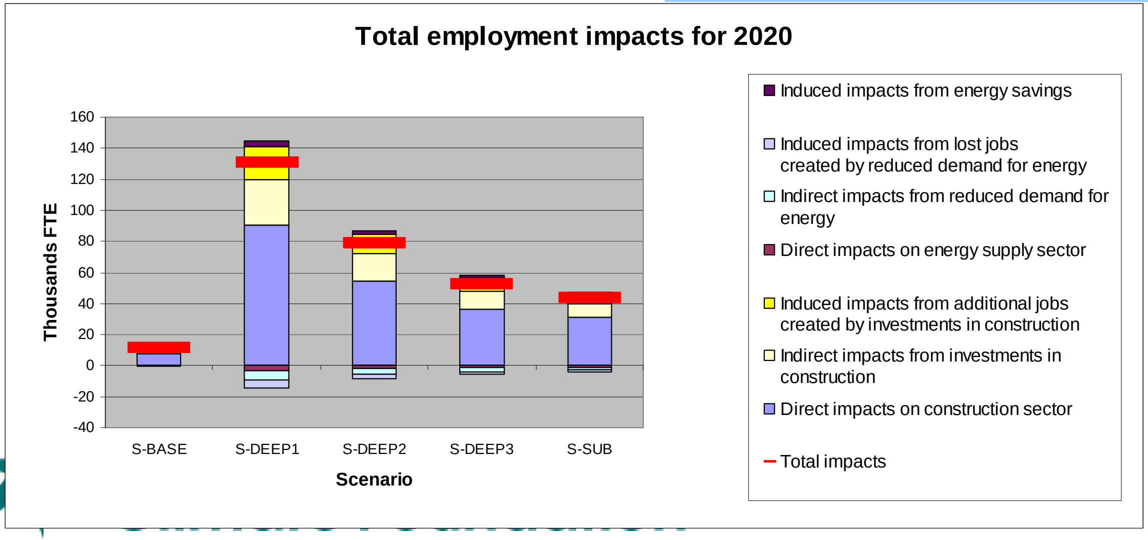
European Climate Foundation

3CSEP

Total net employment impacts: snapshot in 2020

- Direct effects
  - Calculated with bottom-up method
  - Shown in the previous slides
- Indirect + induced effects
  - Application of I/O tables
  - Indirect + induced impacts have the same order of magnitude as the direct impacts

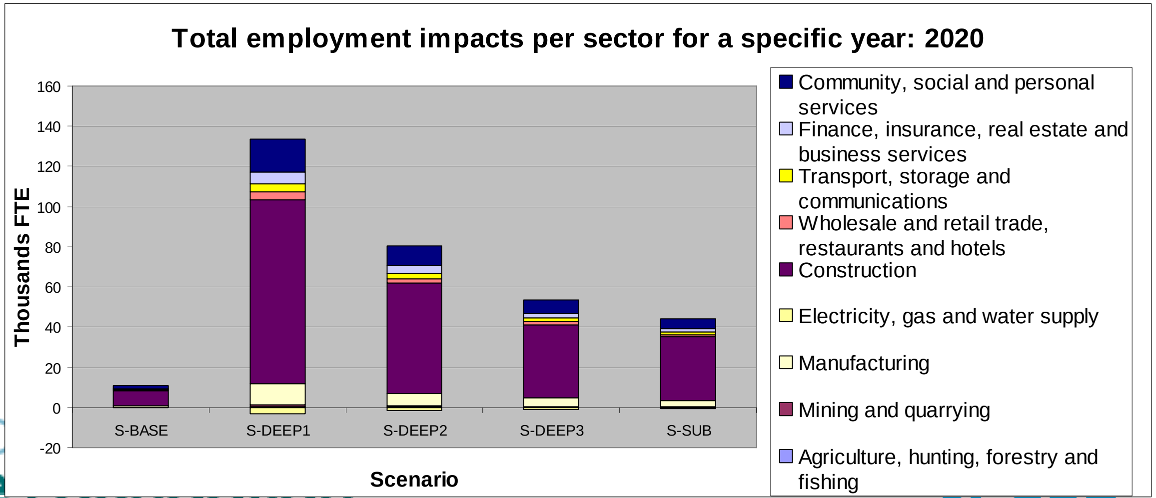
Thousands FTE	S-BASE	S-DEEP1	S-DEEP2	S-DEEP3	S-SUB
Million EUR invested in 2020	224	3,506	2,104	1,402	1,040
Direct impacts on construction sector	8	91	54	36	31
Direct impacts on energy supply sector	0	-3	-2	-1	-1
Indirect impacts from investments in construction	2	29	18	12	9
Induced impacts from additional jobs created by investments in construction	1	21	13	9	6
Indirect impacts from reduced demand for energy	0	-6	-4	-2	-2
Induced impacts from lost jobs created by reduced demand for energy	0	-5	-3	-2	-1
Induced impacts from energy savings	1	4	2	1	1
Total net employment impacts in 2020	11	131	78	52	43



3CSEP

Total net employment impacts divided by sector: snapshot in 2020

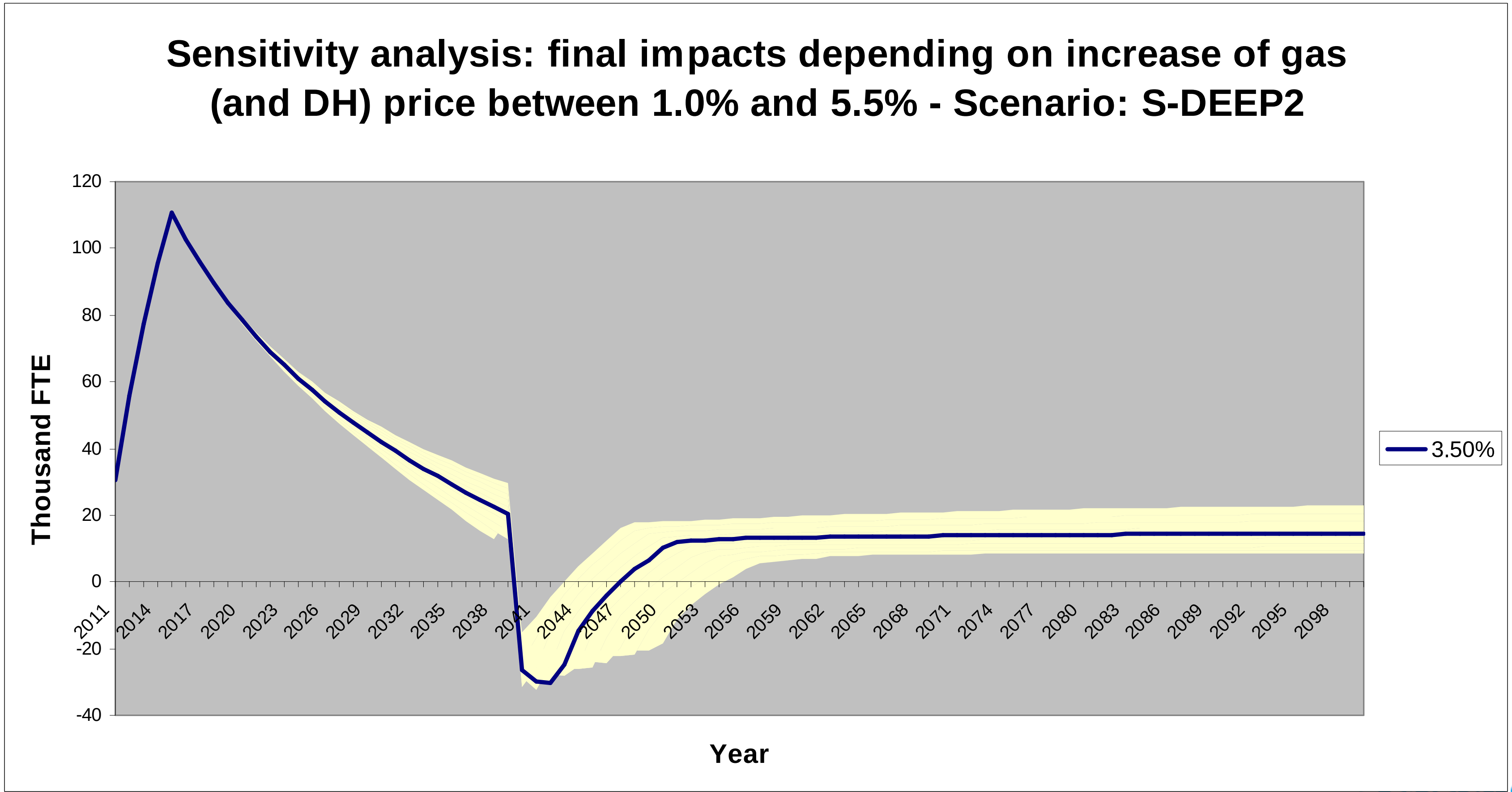
Thousands FTE	S-BASE	S-DEEP1	S-DEEP2	S-DEEP3	S-SUB
Agriculture, hunting, forestry and fishing	0.1	0.5	0.3	0.2	0.2
Mining and quarrying	0.0	0.7	0.4	0.3	0.2
Manufacturing	0.7	10.5	6.3	4.2	3.2
Electricity, gas and water supply	-0.1	-3.1	-1.8	-1.2	-0.8
Construction	7.7	91.8	55.1	36.7	31.7
Wholesale and retail trade, restaurants and hotels	0.3	3.6	2.2	1.4	1.1
Transport, storage and communications	0.3	4.2	2.5	1.7	1.3
Finance, insurance, real estate and business services	0.5	5.8	3.5	2.3	1.8
Community, social and personal services	1.5	16.7	10.0	6.7	5.0
Total	11.0	130.7	78.4	52.3	43.4



European Climate Foundation

SCSEP

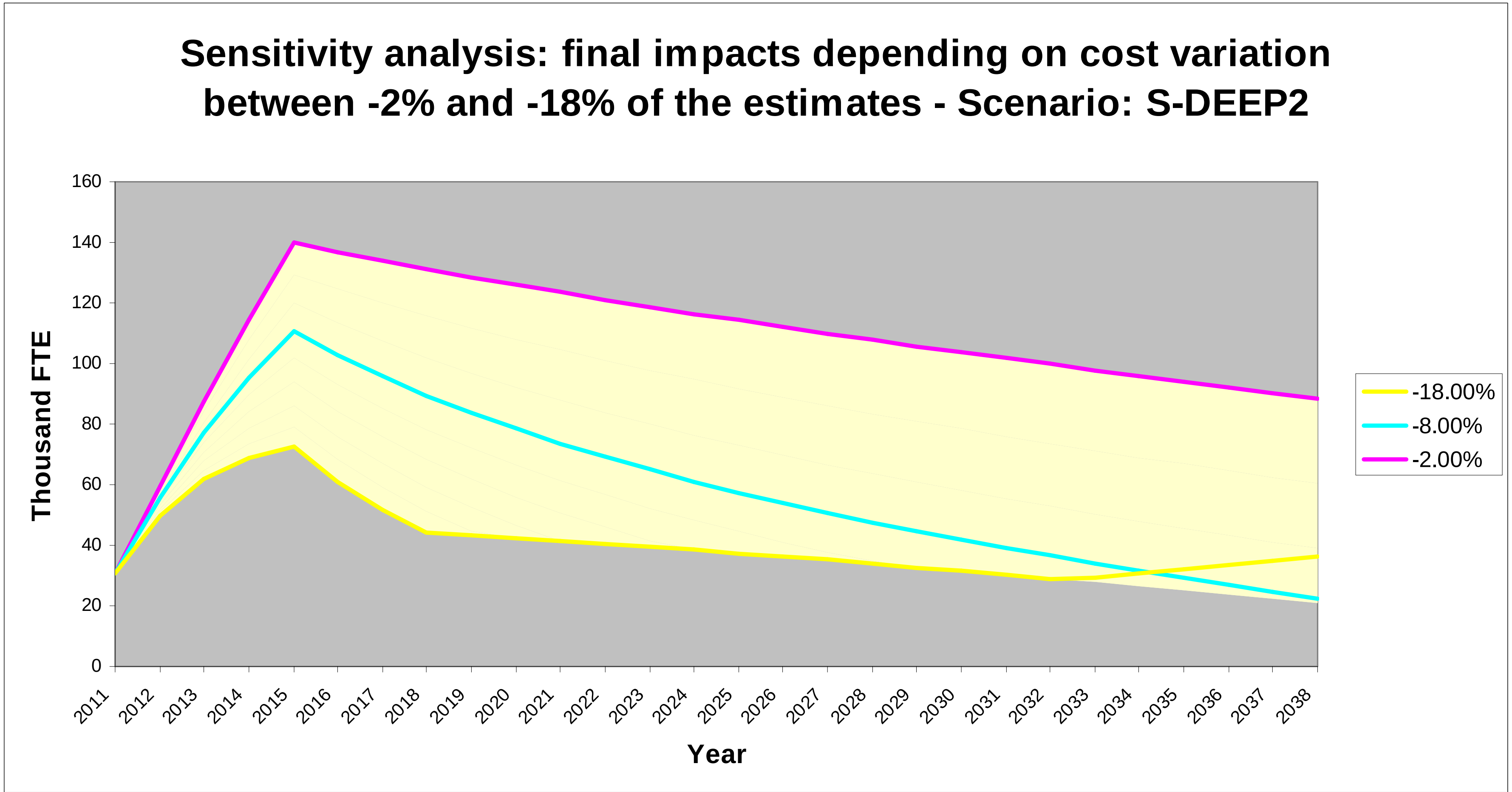
Sensitivity analysis: variation of increase of energy prices



European Climate Foundation

3CSEP

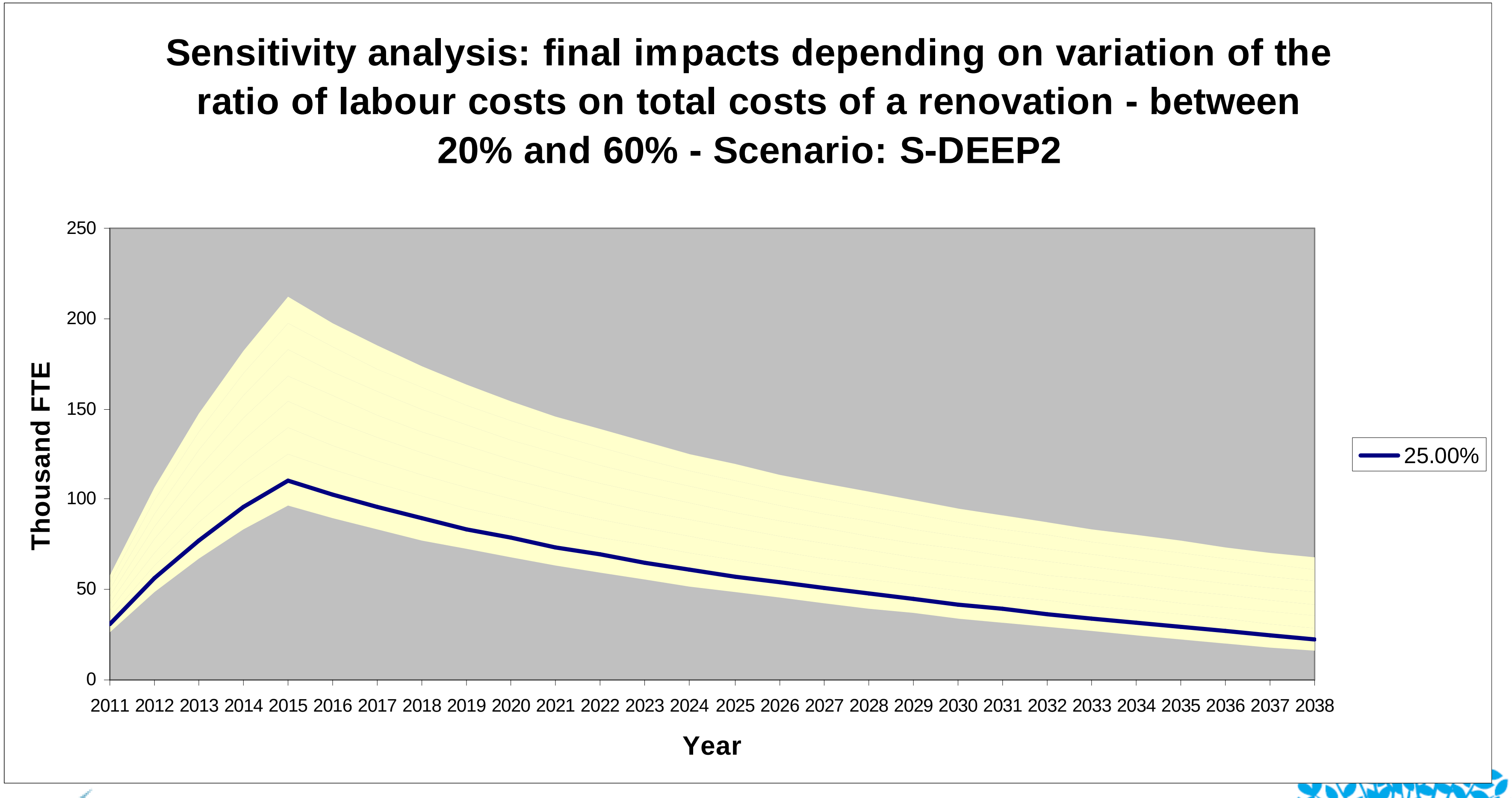
Sensitivity analysis: variation of learning factor



European Climate Foundation

3CSEP

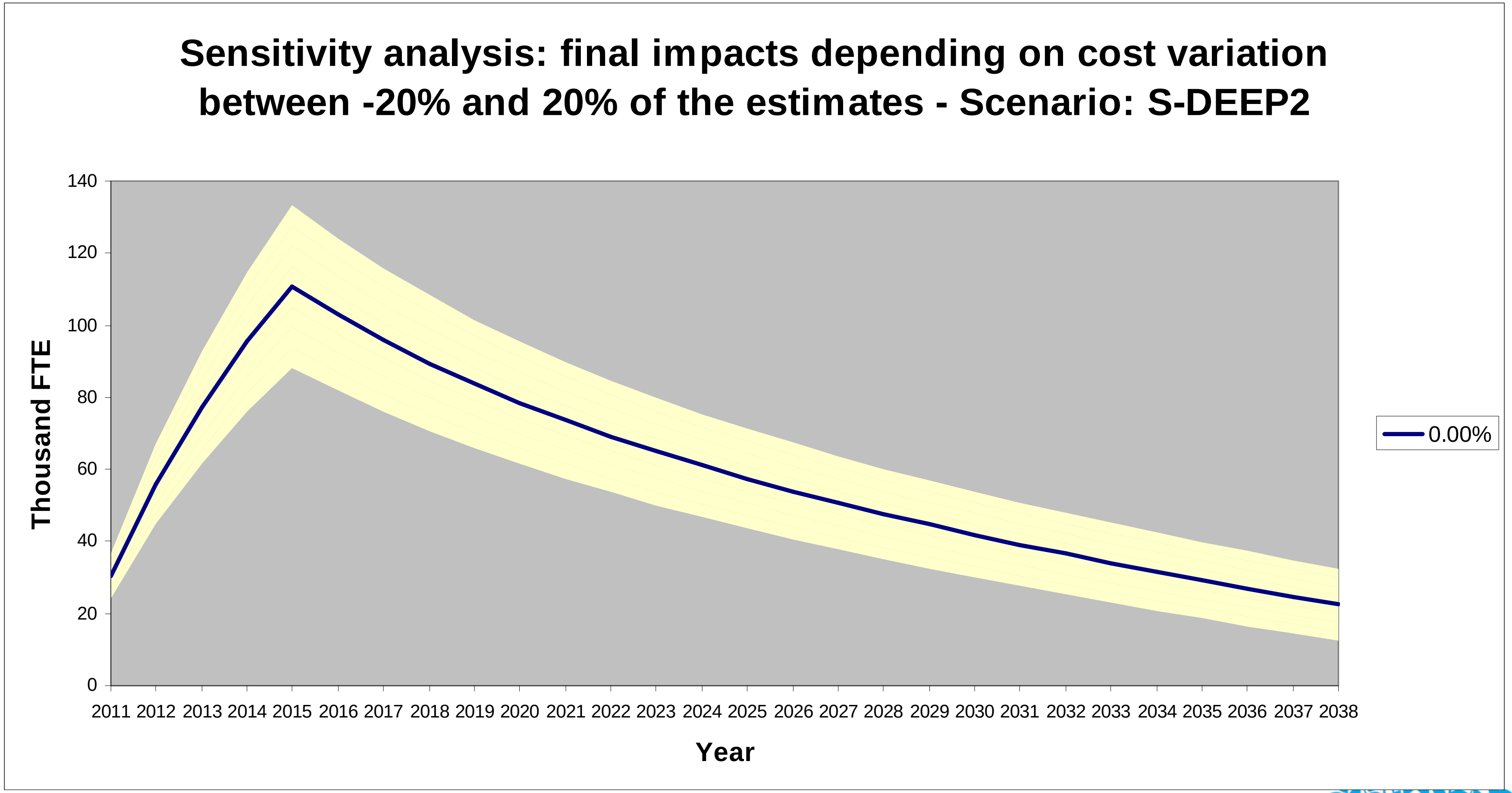
Sensitivity analysis: variation of ratio labour costs / total costs



European Climate Foundation

3CSEP

Sensitivity analysis: variation of cost estimates



European Climate Foundation

3CSEP