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Energy efficiency first - single stage vs stepwise renovation and the question of rapid energy saving actions

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TU Wien

27 April, 2022

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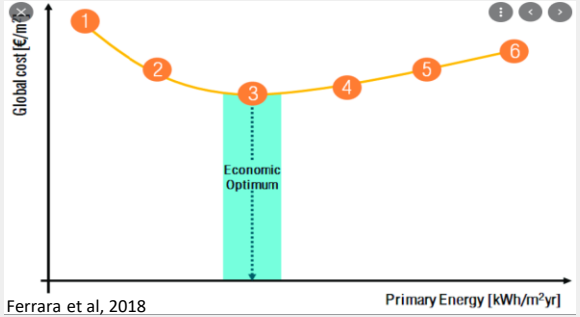
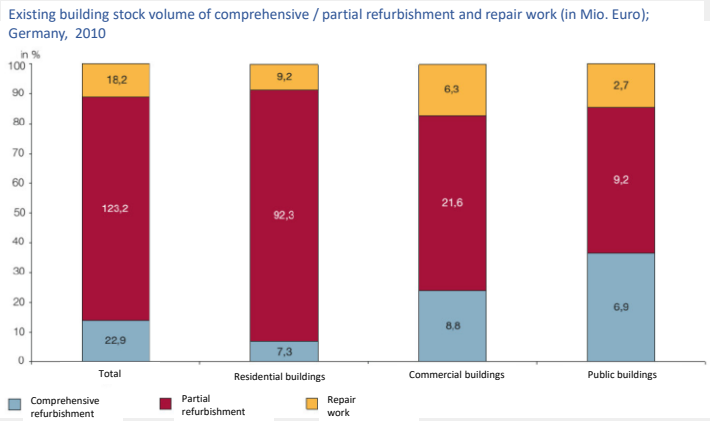
Motivation

- Cost-optimality calculations of efficiency levels (following the EPBD) to identify “cost-effective” efficiency levels
- These calculations focus on new building construction and single stage renovation



Ferrara et al, 2018

- However, empirical evidence shows that staged renovation is (and will remain) a reality, with different timing of different measures
- The EPBD recognizes this fact by introducing building renovation passports



Source: adapted from Fehlhaber, 2017 – PhD Dissertation – Bewertung von Kosten und Risiken bei Sanierungsprojekten

Key questions for this webinar

- What are opportunities and challenges of single-stage vs. step-wise renovation activities and what it does it mean for achieving (cumulative) energy savings?
- What are opportunities and barriers for (really) speeding up energy savings, and in particular gas savings?
- What are implications for the energy efficiency first principle?

Poll

Do you think that stepwise renovation should be supported by Member States?

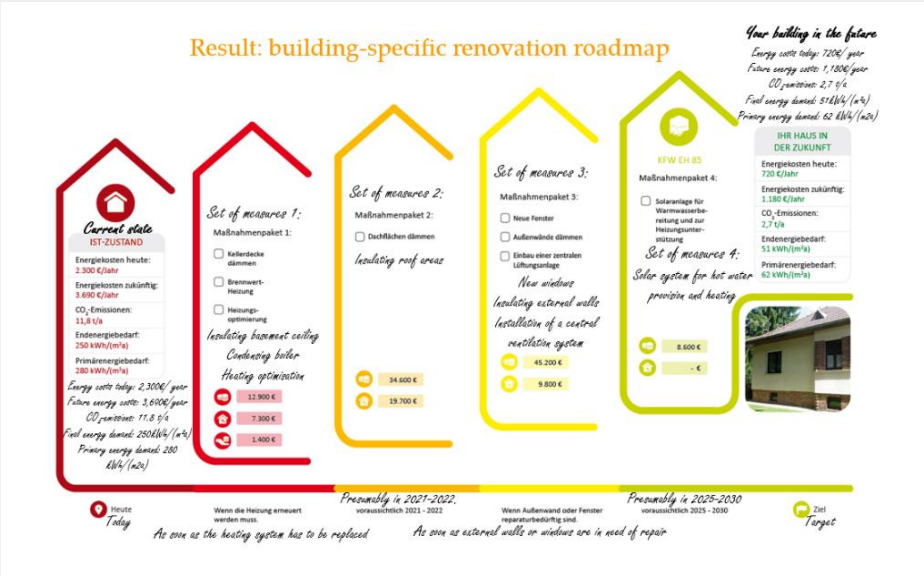
- Yes
- Yes, but single state renovation should remain the preferred option
- Yes, but proper planning is required
- No, stepwise renovation prevents deep renovation
- I don't know

Building passport and stepwise renovation

Explanation: Stepwise improvement of building's energy efficiency and carbon intensity by performing step-by-step a single measure of a package of measures

Pillars of the stepwise renovation:

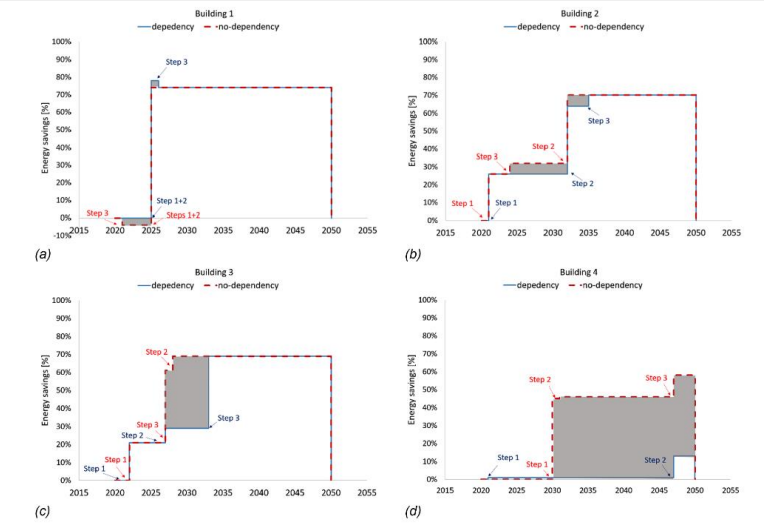
- Number of steps
- Combination of measures per step
- Sequence of the steps performed
- Time when each step is performed



Source: BPIE, https://www.bpie.eu/wp-content/uploads/2017/01/Building-Passport-Report_2nd-edition.pdf, accessed: 26.4.2022

Timing of stepwise renovation

The graphs show: the effect on the cumulative energy savings (grey areas) for the optimal steps timing in different sequence of steps (red and blue)



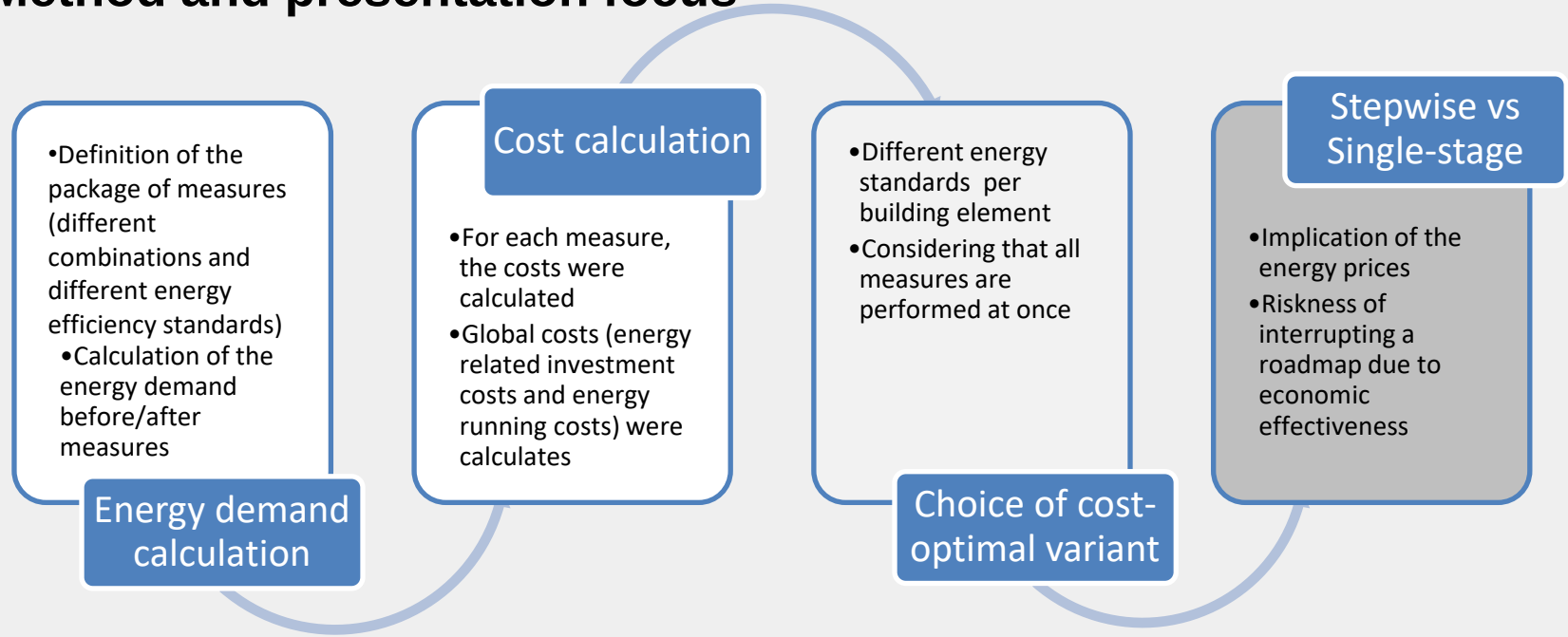
Source: Maia et al., 2021, https://doi.org/10.1016/j.apenergy.2021.116714

Optimal timing depends on:

- the type and age of building
- material life-time
- previous renovation measures
- budget constraints
- ….

=> How do the time of performing each step affects the “economic effectiveness” of cost-optimal roadmaps?

Method and presentation focus



Scope: One construction period

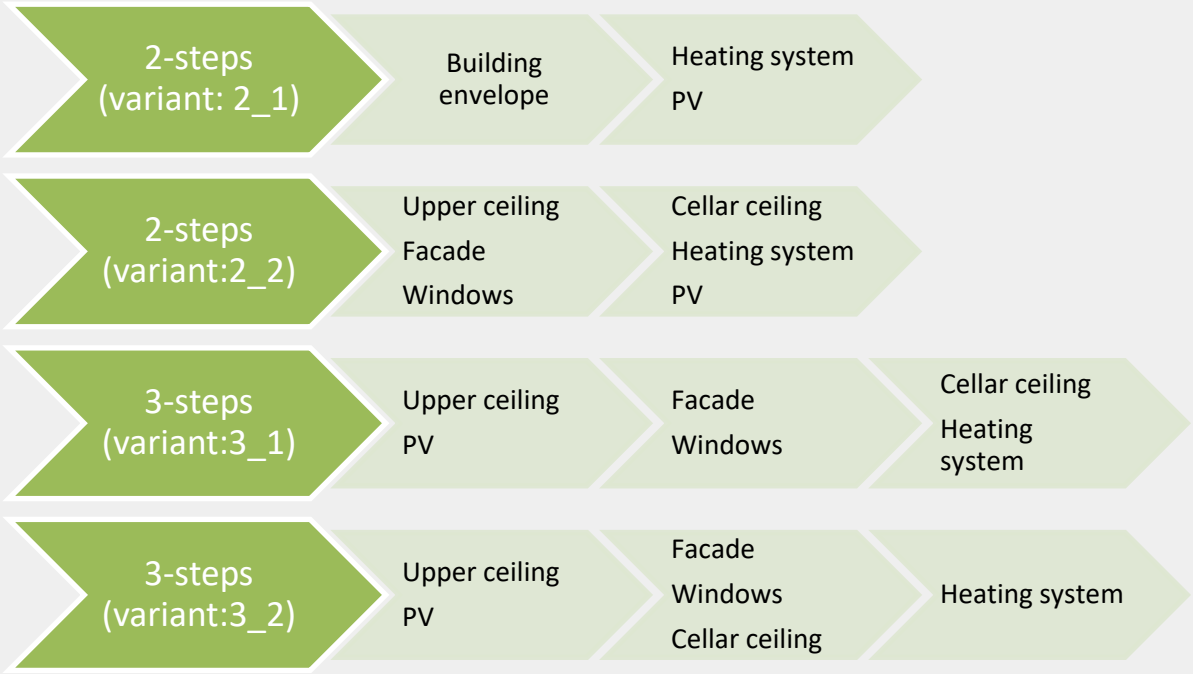
This presentation will be documented in a paper, which will include further construction periods

Considered measures and their energy efficiency standard

Category	Measure	Measure parameter	Insulation range (cm)
Building envelope	Roof (or upper ceiling) insulation	Insulation thickness (cm)	30-10
Building envelope	Facade insulation	Insulation thickness(cm)	20-10
Building envelope	Floor (or cellar ceiling) insulation	Insulation thickness(cm)	20-10
Building envelope	Window/door replacement	U-value (W/K*m²)	20-10
Heat supply	System replacement	Efficiency (%) or COP	
Renewable energy generation	installation of PV for electricity production	kWp	

270 variants calculated per building
+additional calculations for different timing of measures (including energy price levels)

Possible renovation roadmaps, number of steps and combination of measures. Case study: SFH, until 1918



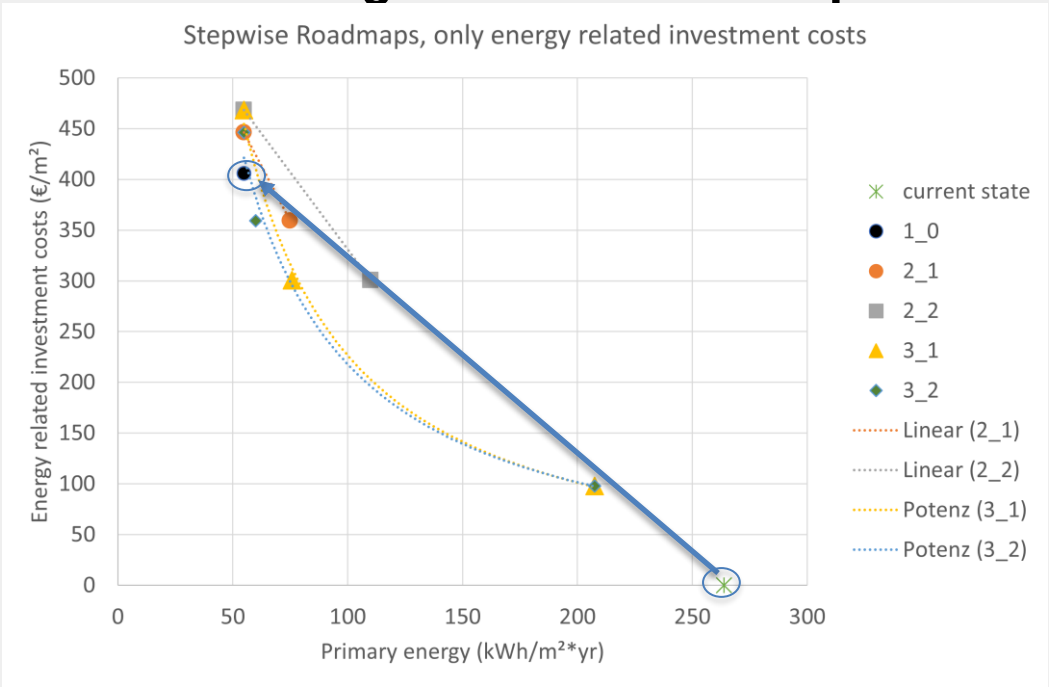
Energy related investment costs and savings for different steps

Single stage scenario versus 4 options of stepwise roadmaps

Roadmaps divided in **2 or 3 steps**

Different combination of measures per step (according to the previous slide)

Sequence is fixed: sequencing of measures results in cumulated energy savings and investment costs



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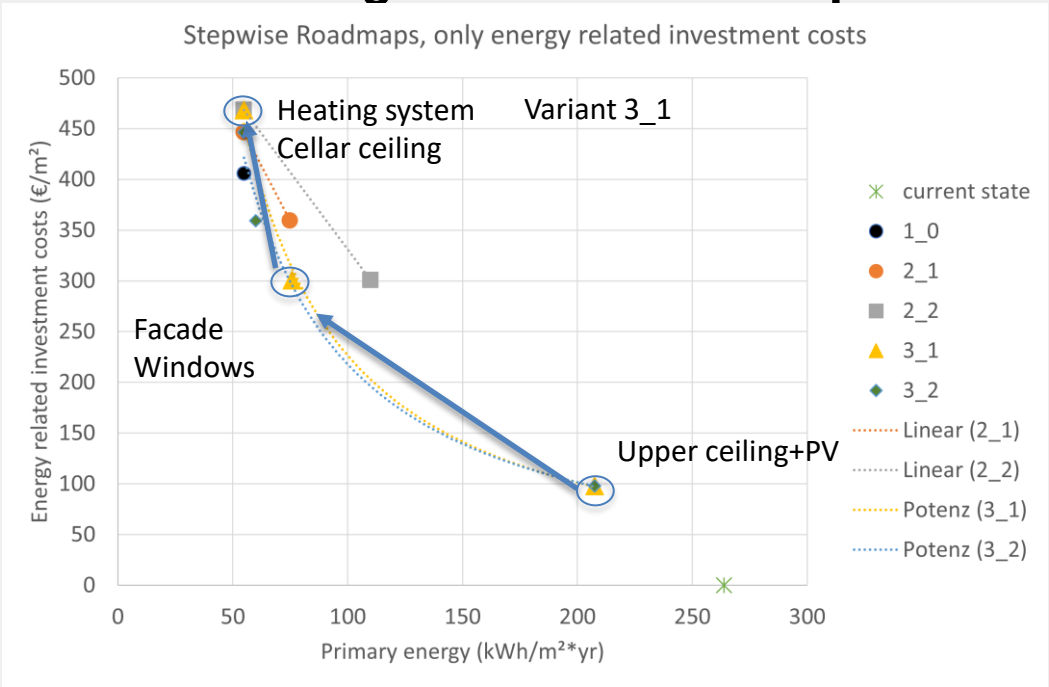
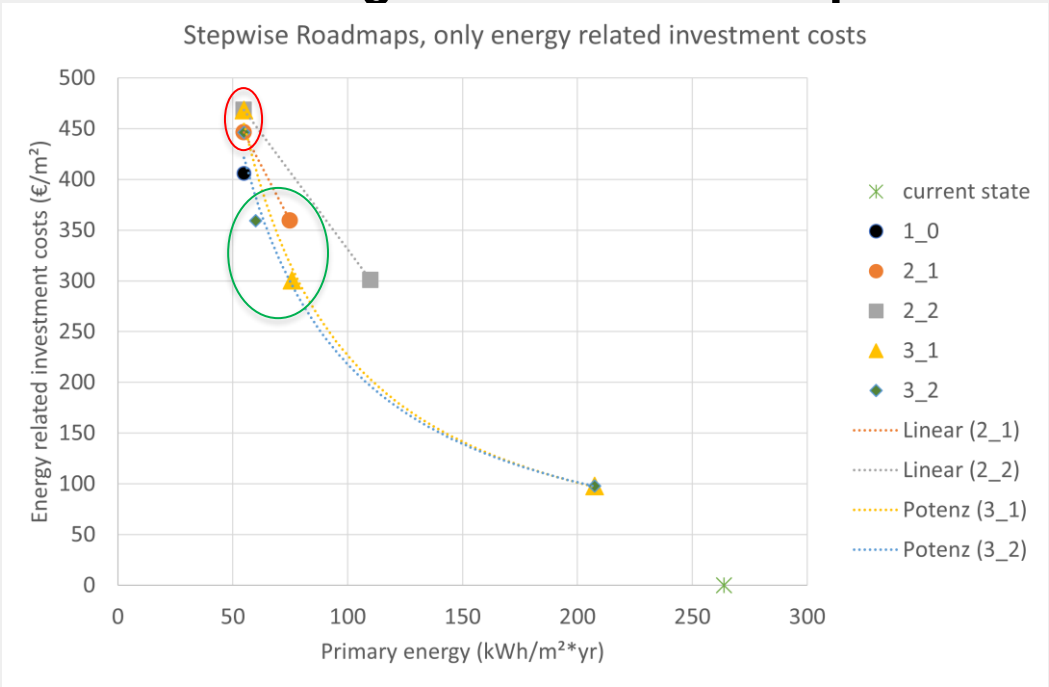


Energy related investment costs and savings for different steps

Conclusions:

If all steps are performed, the stepwise roadmaps present **higher total investment costs**, especially due to more frequent building-site costs (in red)

Stepwise roadmaps present the "risk" of being interrupted. However, if the roadmap is adequally planned, this can still provide **energy savings with lower investment costs** than the single stage (in green)



Next results:

Following concepts are now considered:

- Time when each step is performed
- Energy related investment costs ----> Global costs (energy related investment costs + energy running costs)
- Yearly primary energy demand (kWh/m²*yr) ----> Cumulated primary energy demand (kWh/m²)

Year, when each step is performed

Arrows indicate when each step is performed

Single step:

0 - year 0, 5,10,15 and 20

2-steps:

1 – year 0

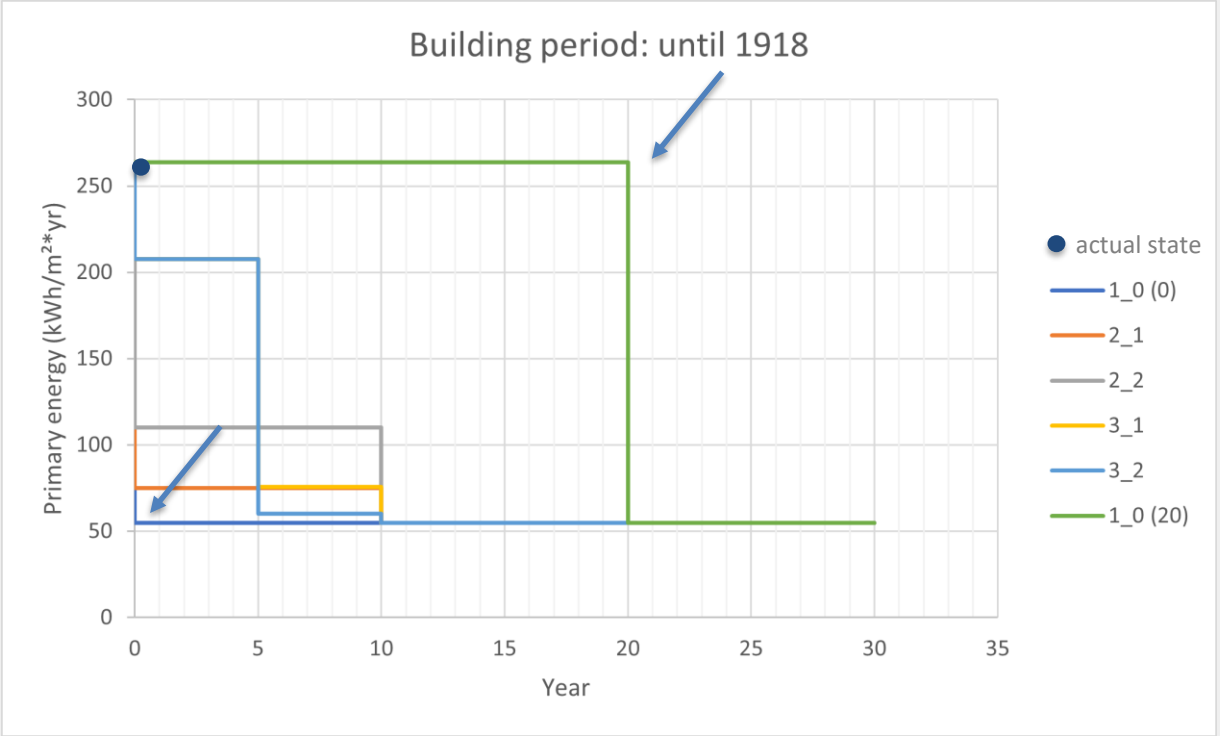
2 – year 10

3-steps:

1 – year 0

2 – year 5

3 – year 10



Year, when each step is performed

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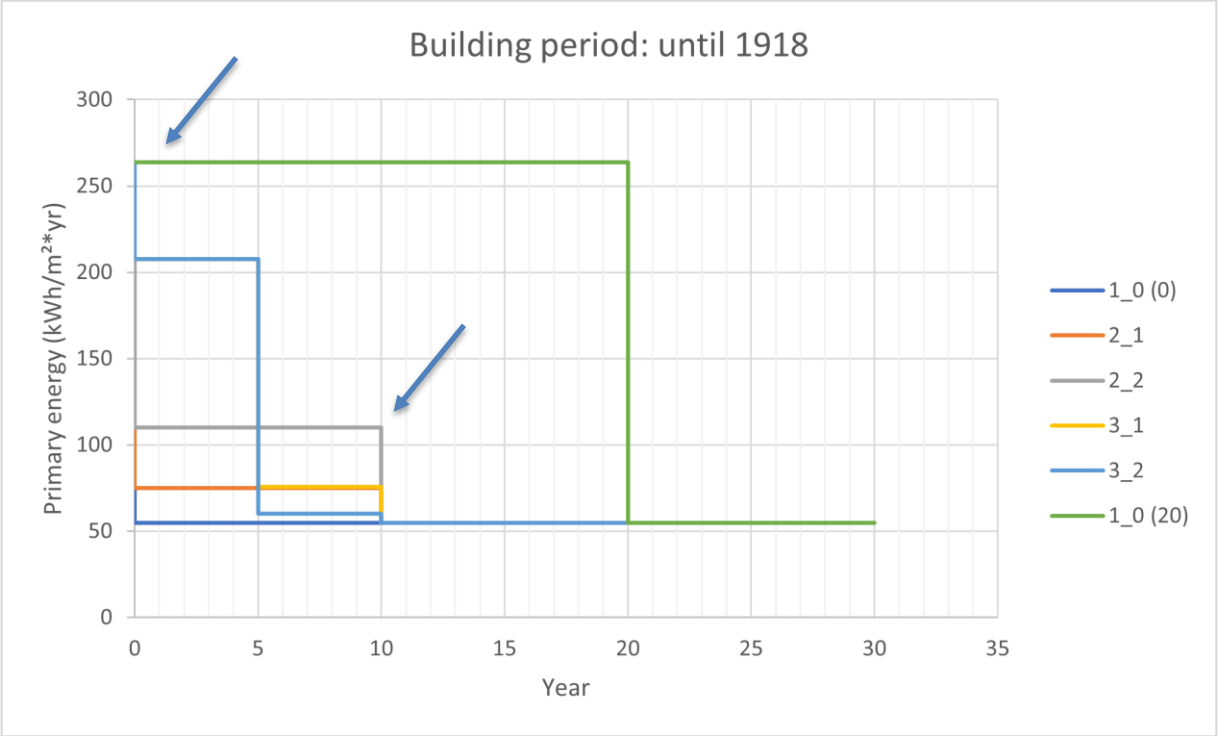

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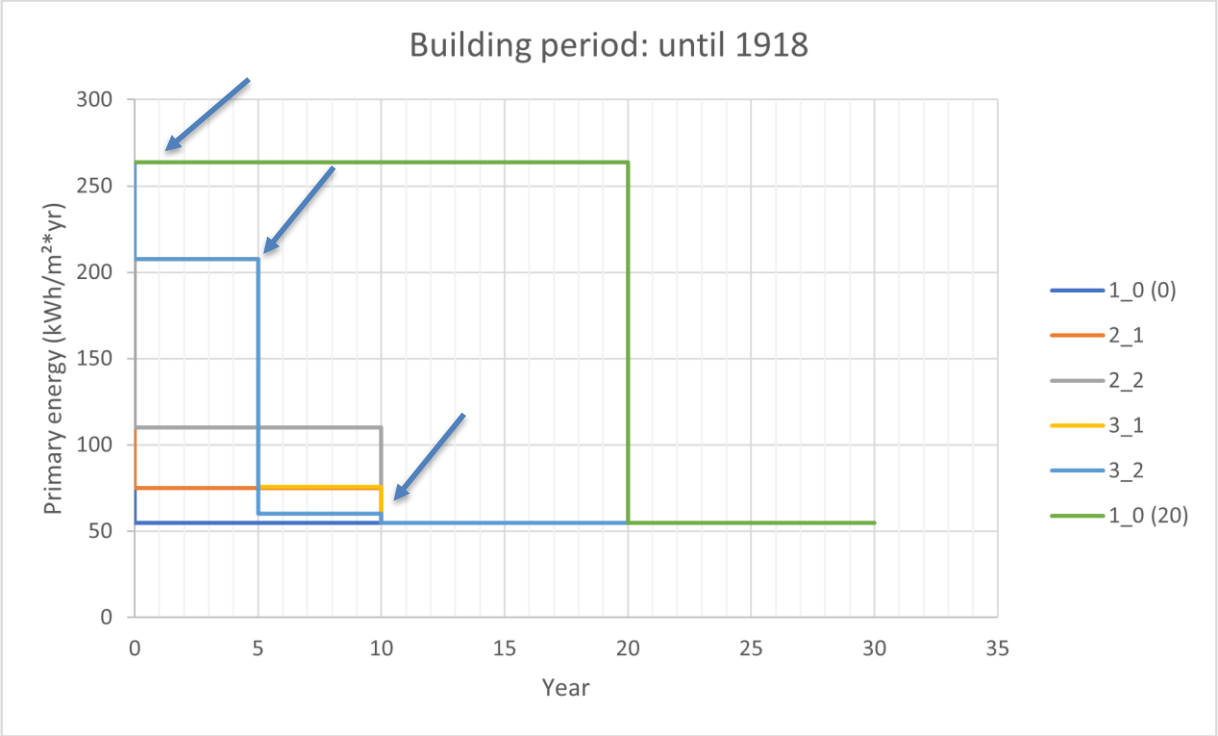
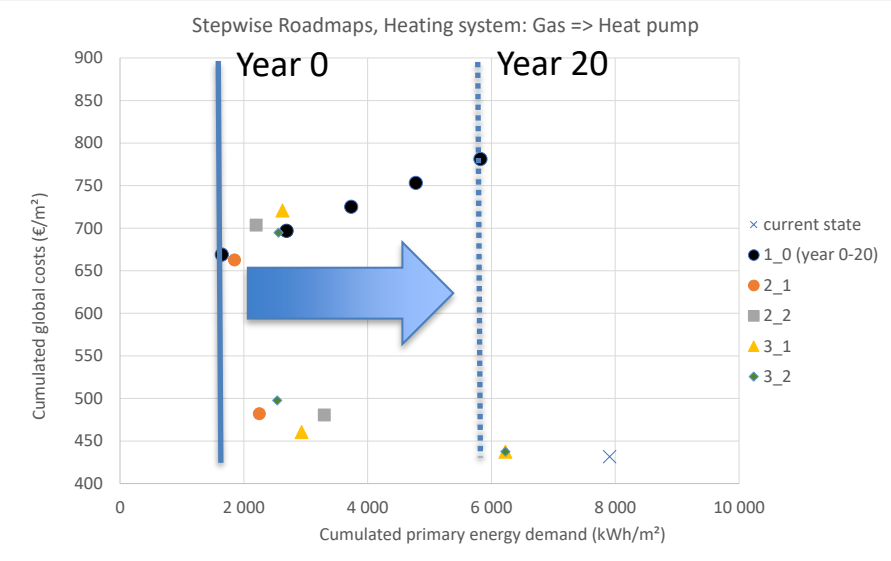
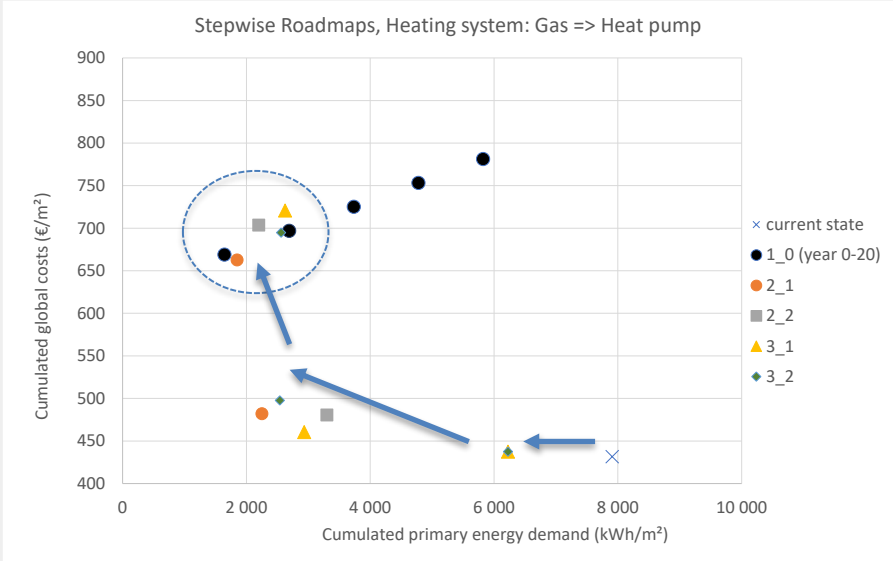


Implications of energy price levels: global costs and savings for different steps and different heating systems

Assumptions: 30 years period of consideration, Gas price: 0.06 Euro/kWh, Electricity price: 0.32 Euro/kWh





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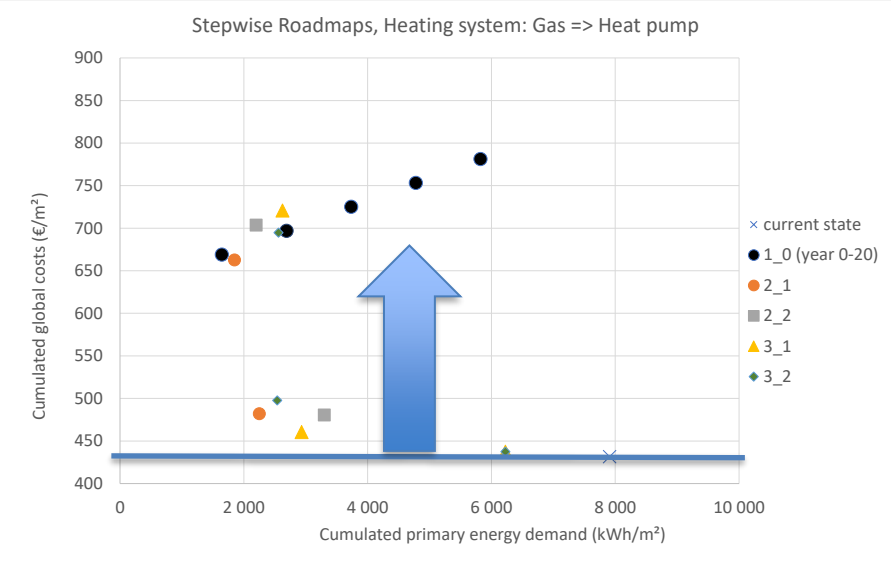
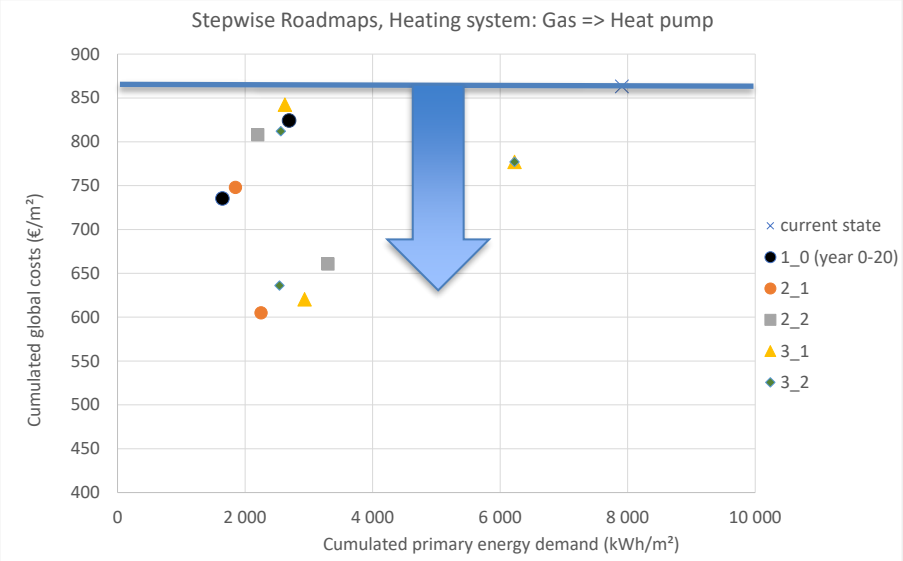
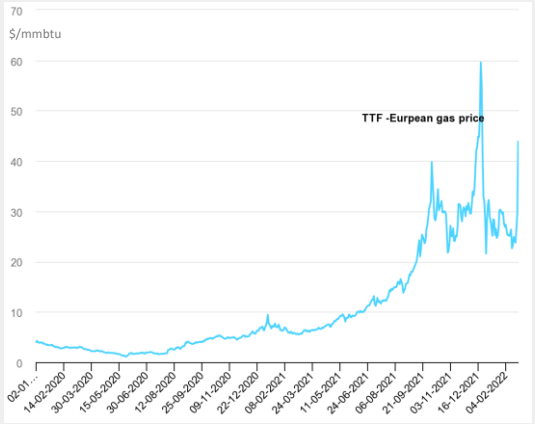


Gas price: 0.12 Euro/kWh, Electricity price: 0.4 Euro/kWh



Conclusions

- All depends on the right timing …
  - Single stage renovation only creates higher cumulated savings, if carried out fast (i.e. in an early stage)
  - In practice, this will not be the case (for a sufficiently large share of buildings)
  - Thus, properly planned single stage renovation is essential which creates the need for renovation passports (individual building renovation roadmaps)
  - At the same time, single stage renovation also needs to be promoted, but not as the only preferred option to achieve energy and climate targets.
- It's all about economics! Is it? If yes: how to deal with uncertainties?
  - Energy price level changes everything.
  - Energy prices by their nature are uncertain.
  - Energy supply security (and other co-benefits)?

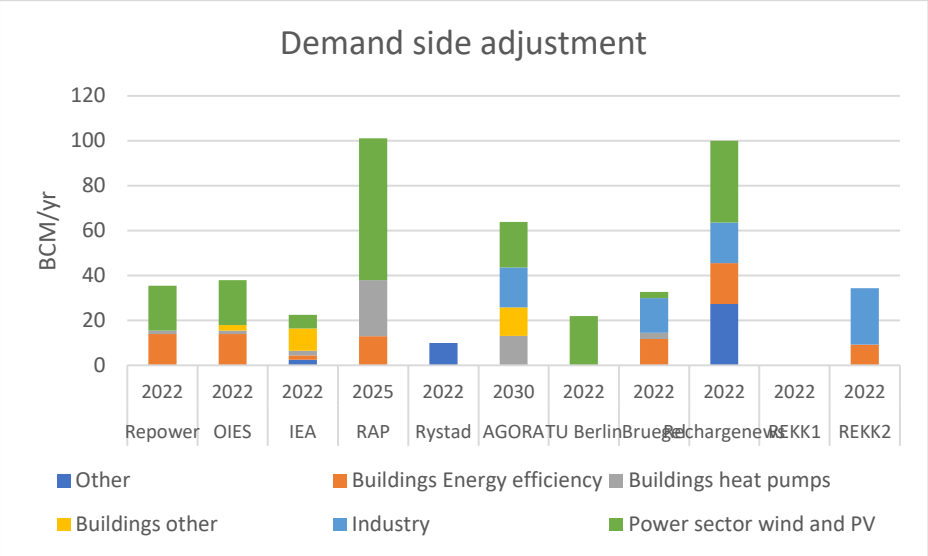


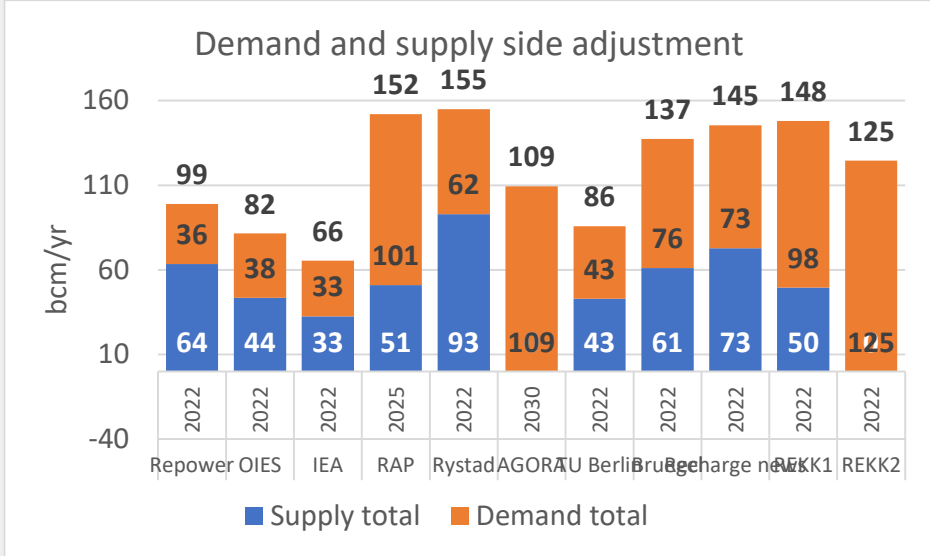
Source: IEA, 2022

Quick energy (and gas) savings?

What are options, expectations and limitations for quick energy savings (and in particular gas savings) in the light of the war in the Ukraine, high gas prices and possible gas-supply cuts?

Short term demand side adjustments?

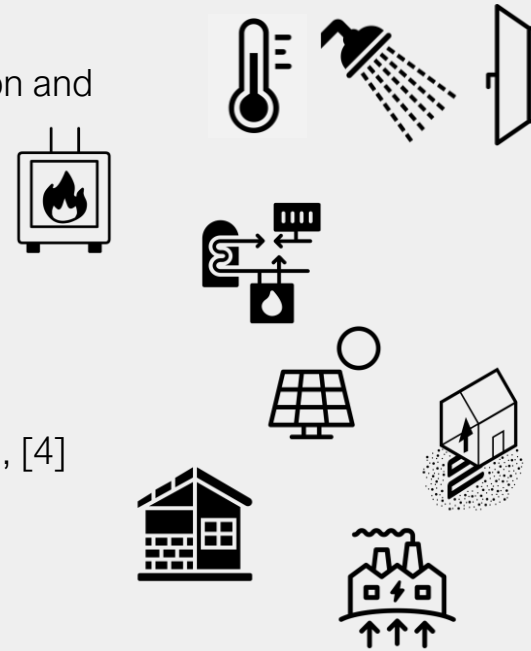




Source: Péter Kotek, REKK, 2022

Measures towards (short term?) reduction of gas demand for space and water heating?

- Behaviour: reducing indoor temperature, optimising ventilation and hot water use [2], [3], [5]
- Increasing use of existing secondary heating systems
- Optimizing existing heating systems [1], [2], [5]



- Solar thermal (and PV), [2], [4]
- Replacing gas boilers by heat pumps and district heating, [1], [4]
- Building retrofitting [1], [2], [4]
- Replacing gas in district heating supply

[1] IEA, https://www.iea.org/reports/a-10-point-plan-to-reduce-the-european-unions-reliance-on-russian-natural-gas
[2] BPIE, https://www.bpie.eu/wp-content/uploads/2022/03/Strategy-paper_Solidarity-and-resilience_An-action-plan-to-save-energy-now-1.pdf
[3] Hirth, Open Letter to European Energy Policymakers and the Broader Public Energy policy and energy industry options for Germany and Europe in view of Russia's attack on Ukraine; https://hertieschool-f4e6.kxcdn.com/fileadmin/CfS_Open_Letter_20220309.pdf
[4] European Commission, COM (2022) 108. REPowerEU: Joint European Action for more affordable, secure and sustainable energy
[5] Silvana Tiedemann , Strommarkt-Verteiler, 11.3.2022

Measures and instruments towards (short term?) reduction of gas demand for space and water heating?

	Information, awareness raising, campaigning [1], [2], [3], [4]	Nudging	Subsidies	Price signal [2], [3]	Monthly billing, [2], [3]	Regulation (and favourable legal conditions)	Training of labour force [2], [5],	Supply of technologies materials
Behaviour: reducing indoor temperature, optimising ventilation and hot water use [2], [3], [5]	X				X			
Increasing use of secondary heating systems	x				X			
Optimizing existing heating systems [1], [2], [5]	(x)	x	x		X	(x)	x	
Solar thermal (and PV), [2], [4]	(x)	x	x		x	x	x	x
Replacing gas boilers by heat pumps and district heating, [1], [4]	(x)	x	x		x	x	x	x
Building retrofitting [1], [2], [4]		x	x		x	x	x	(x)
Replacing gas in district heating supply			x		x	x	x	x

[1] IEA, https://www.iea.org/reports/a-10-point-plan-to-reduce-the-european-unions-reliance-on-russian-natural-gas
[2] BPIE, https://www.bpie.eu/wp-content/uploads/2022/03/Strategy-paper_Solidarity-and-resilience_An-action-plan-to-save-energy-now-1.pdf
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[4] European Commission, COM (2022) 108. REPowerEU: Joint European Action for more affordable, secure and sustainable energy
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Conclusions quick gas demand reduction

- Quick gas demand reductions in the building sector (would) require strong commitment of the building occupants
- Lead times and the need for strong, long-term planning of actions
- The past has shown that myopic economic considerations are no good advisor, when it comes to long-term decisions.
- Implication for the understanding, definition and implementation of the energy efficiency first principle?
    - Proposal for a revised Energy Efficiency Directive, 2021, recital 14: „*The proper application of the principle requires using the right cost-benefit analysis methodology, setting enabling conditions for energy efficient solutions and proper monitoring.*"
    - *"priority to demand-side resources whenever they more* **cost effective from a societal perspective"**
- Consider uncertainties, in particular regarding prices and availability of energy carriers?

Thank you

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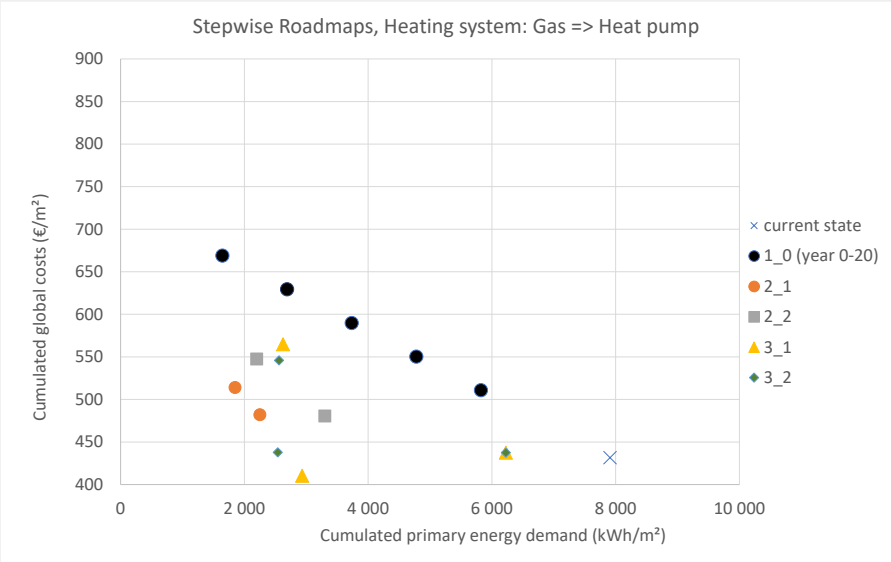
  - Q And A by P Thanga Vignesh from NounProject.com

Implications of energy price levels: global costs and savings for different steps and different heating systems

previous investments and investment cycles are considered; only the share of investments relevant for the observation period (30 years) are considered

Gas price: 0.06 Euro/kWh, Electricity price: 0,32 Euro/kWh



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