The ‘magical moment’ is now: Decarbonise heat in the EU

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15h00 – 16h00

Leonardo ENERGY Webinar Channel
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6th Webinar of the Electrification Academy

Georg Thomaßen, Agora Energiewende

Jan Rosenow, RAP

Electrifying heat would push Europe significantly closer to its decarbonisation goals. And there is no time to wait: The heating and cooling sector currently accounts for 50% of the EU’s final energy consumption. Luckily, we don’t need to wait for a ‘magical moment’ to deploy solutions such as heat pumps. Even with today’s power mix, switching to electrified heat would markedly reduce emissions. Substantially increasing the use of renewable energy sources at the same time is pivotal for cementing the effectiveness of this solution.

May 2021

Electrification of heating in Europe – challenges and opportunities

Electrification Academy

Dr Jan Rosenow

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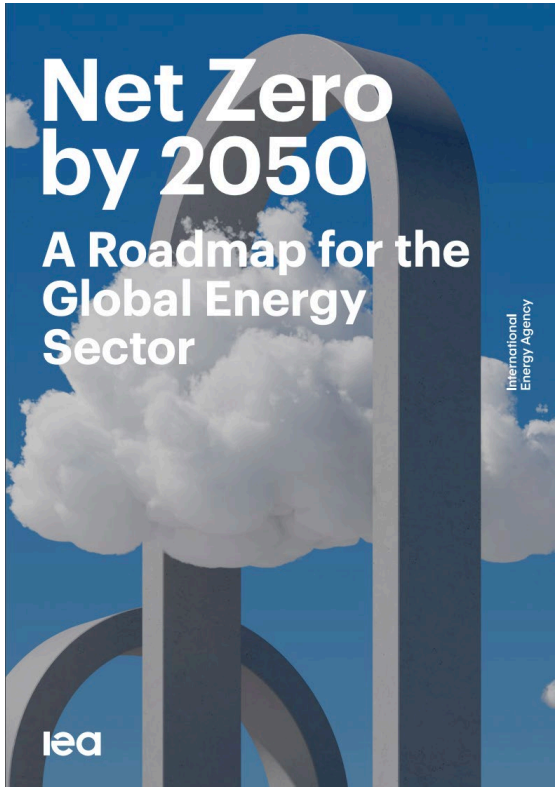
Climate change: Ban new gas boilers from 2025 to reach net-zero

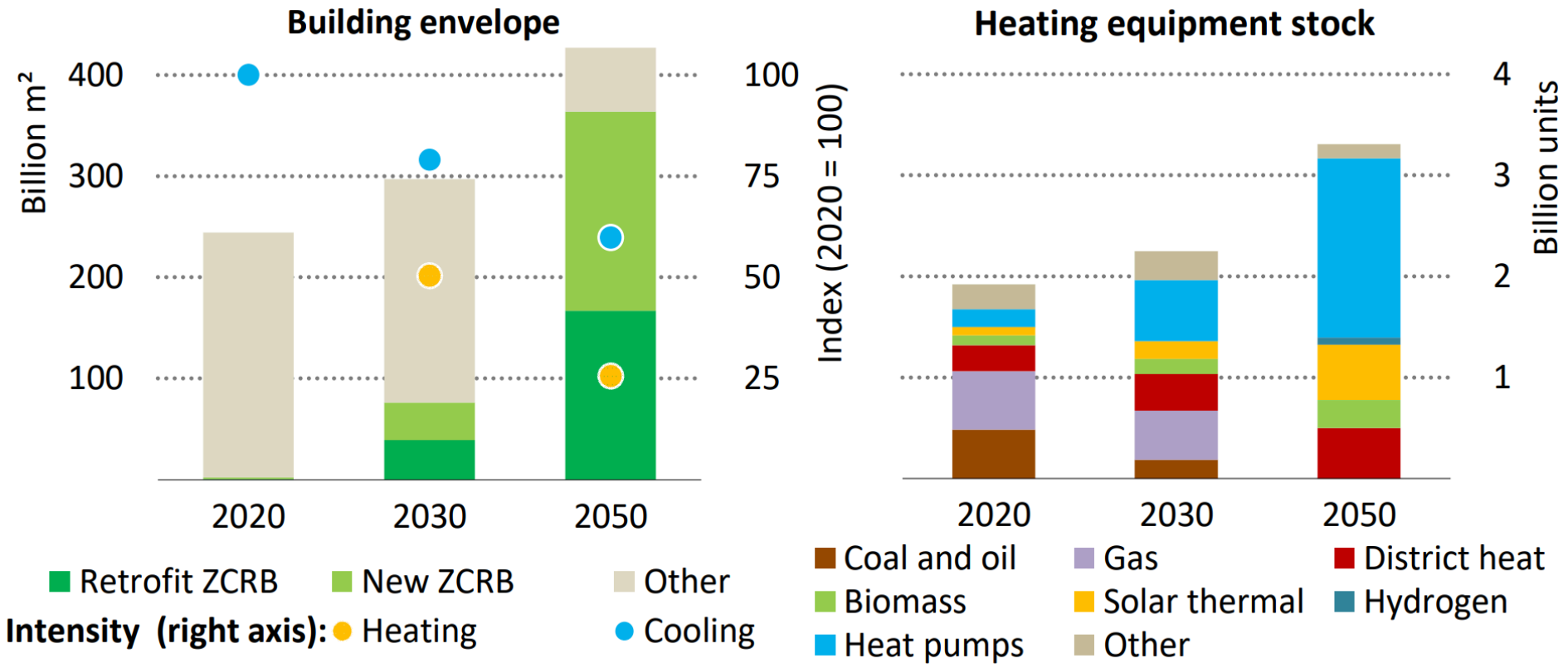
By Matt McGrath
Environment correspondent

15 hours ago | Comments

COP26

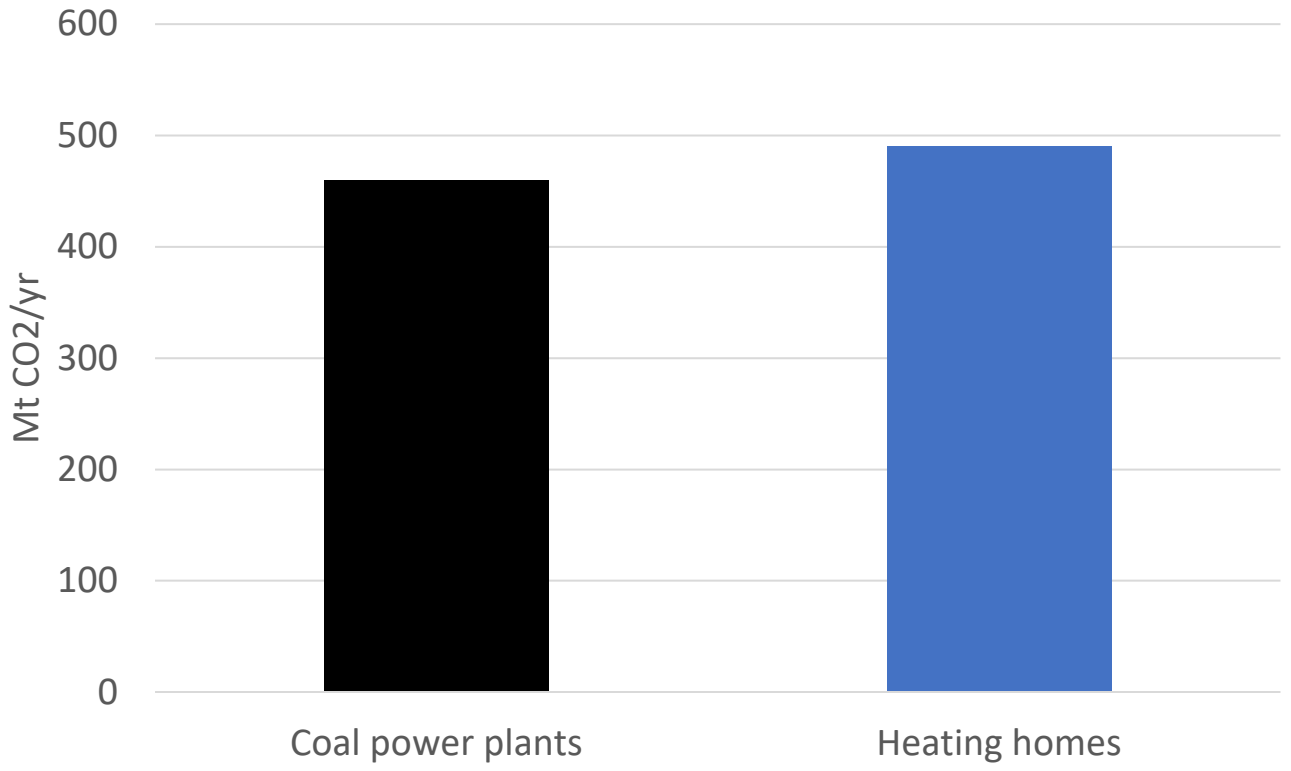


Large increase in number of heat pumps expected

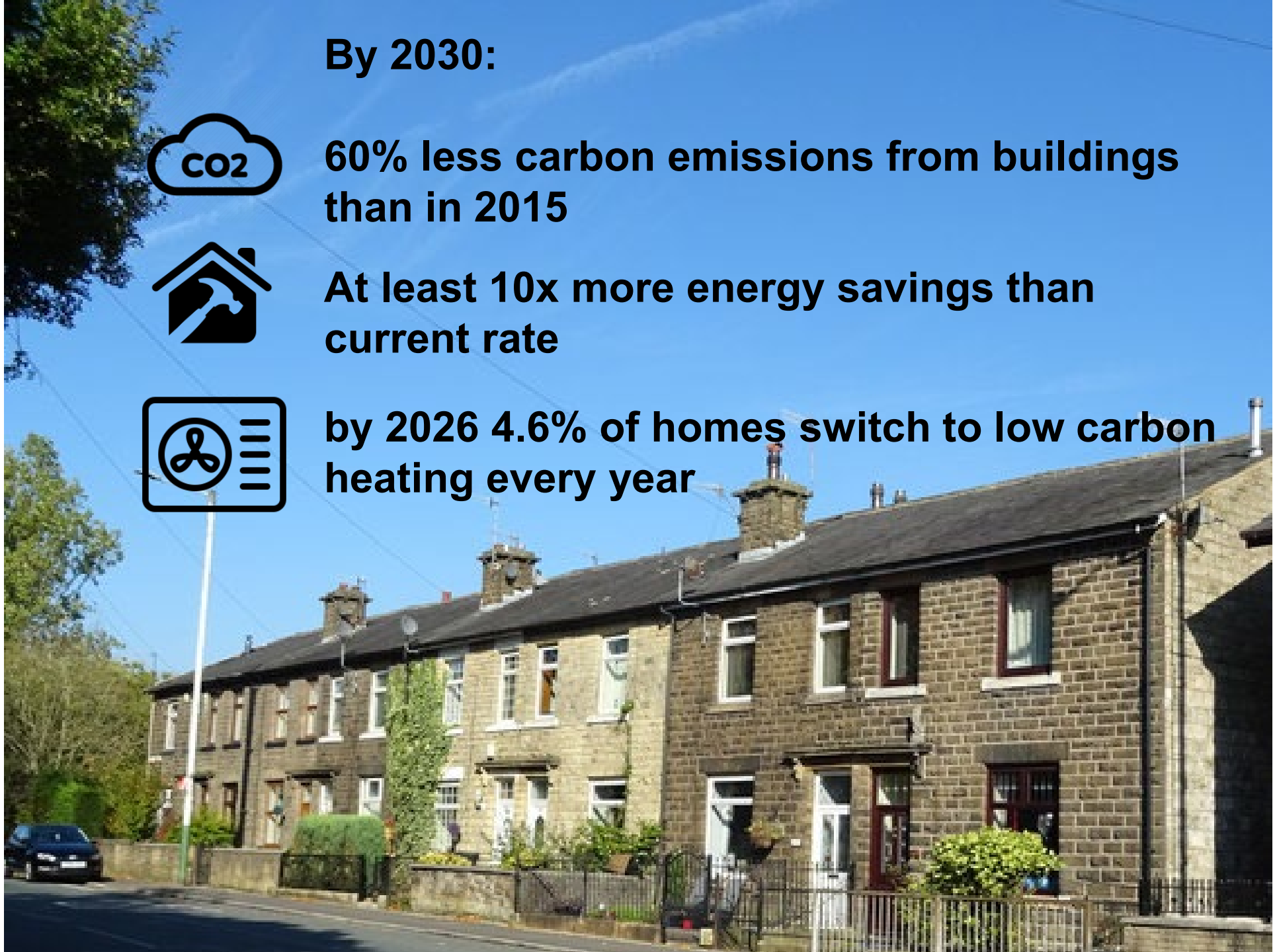


Source: IEA 2021

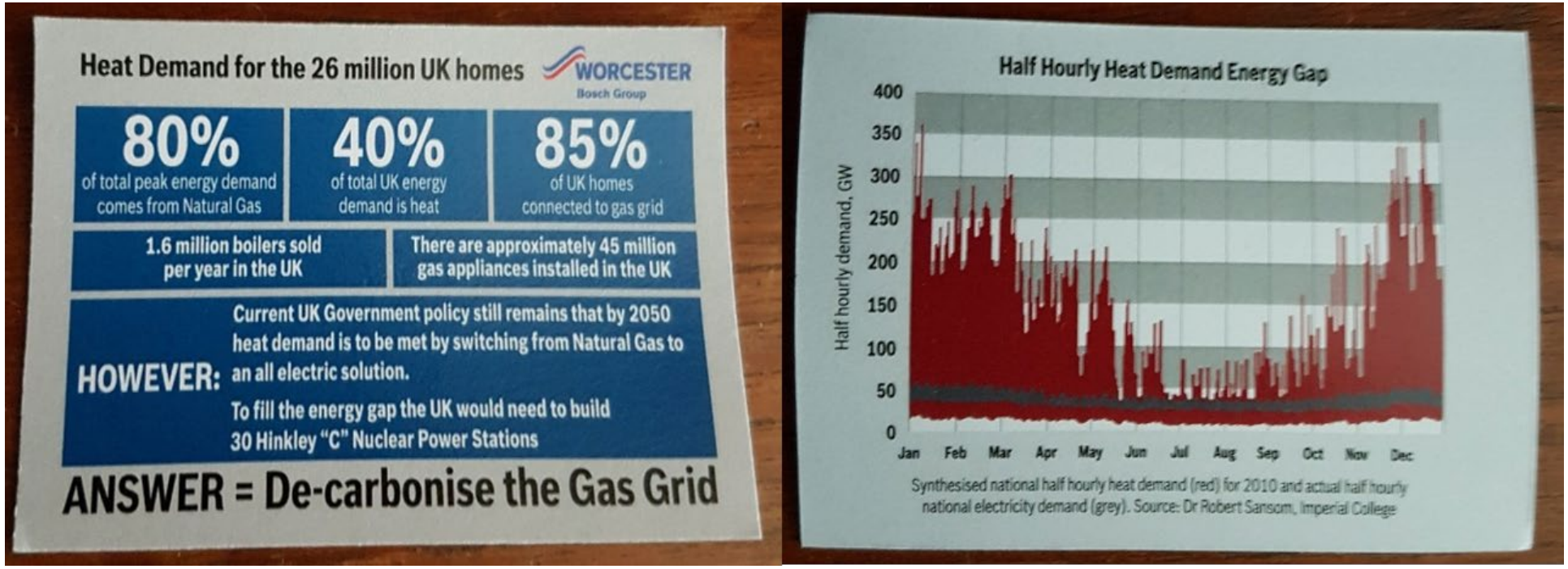
Heating emits more carbon than all coal power plants in Europe



Source: Europe Beyond Coal (2020), Bertelsen and Mathiesen (2020)


By 2030:
CO2
60% less carbon emissions from buildings than in 2015
At least 10x more energy savings than current rate
by 2026 4.6% of homes switch to low carbon heating every year

How big a problem is peak heat?



Source: https://blogs.exeter.ac.uk/energy/2017/07/10/is-the-peak-heat-issue-all-its-made-out-to-be/

About RAP

The Regulatory Assistance Project (RAP)® is an independent, non-partisan, non-governmental organization dedicated to accelerating the transition to a clean, reliable, and efficient energy future.

Learn more about our work at raponline.org

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The decarbonization of EU heating through electrification

RAP Electrification academy

Georg Thomaßen

26.05.2021

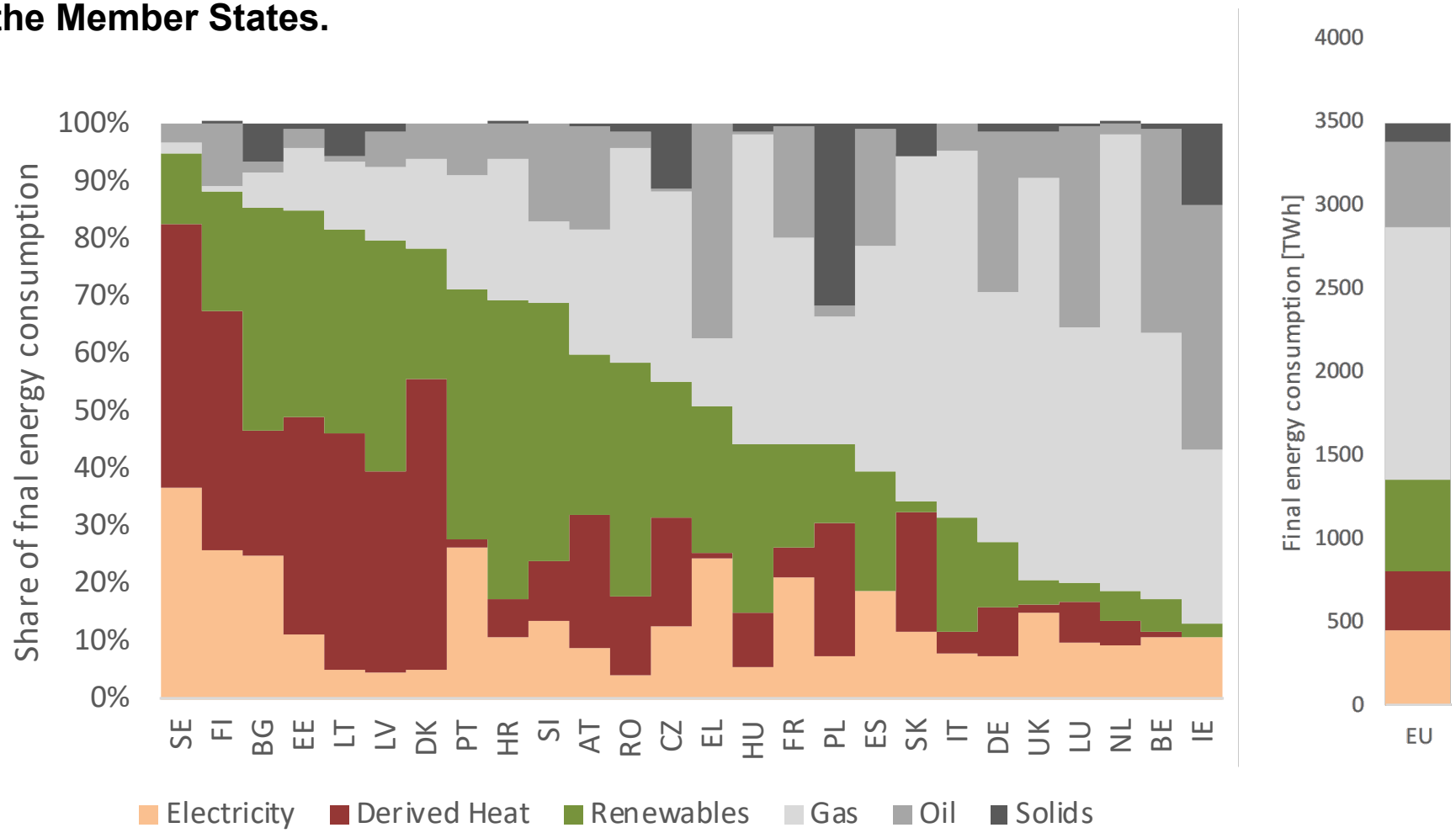
Main messages

1	Some Member States can reduce their carbon footprint by up to 15% through electrification, even if not accompanied by additional deployment of renewable electricity.
2	All Member States are far away from critical levels of heat pump deployment. A majority of Member States has enough firm capacities readily available, even for far reaching electrification.
3	29 – 45% of the EUs space heating needs could be provided by heat pumps without overstressing today's system.
4	If heat pump deployment is accompanied by an expansion of renewable capacities, up to 16% of the EUs total emissions could be eliminated.

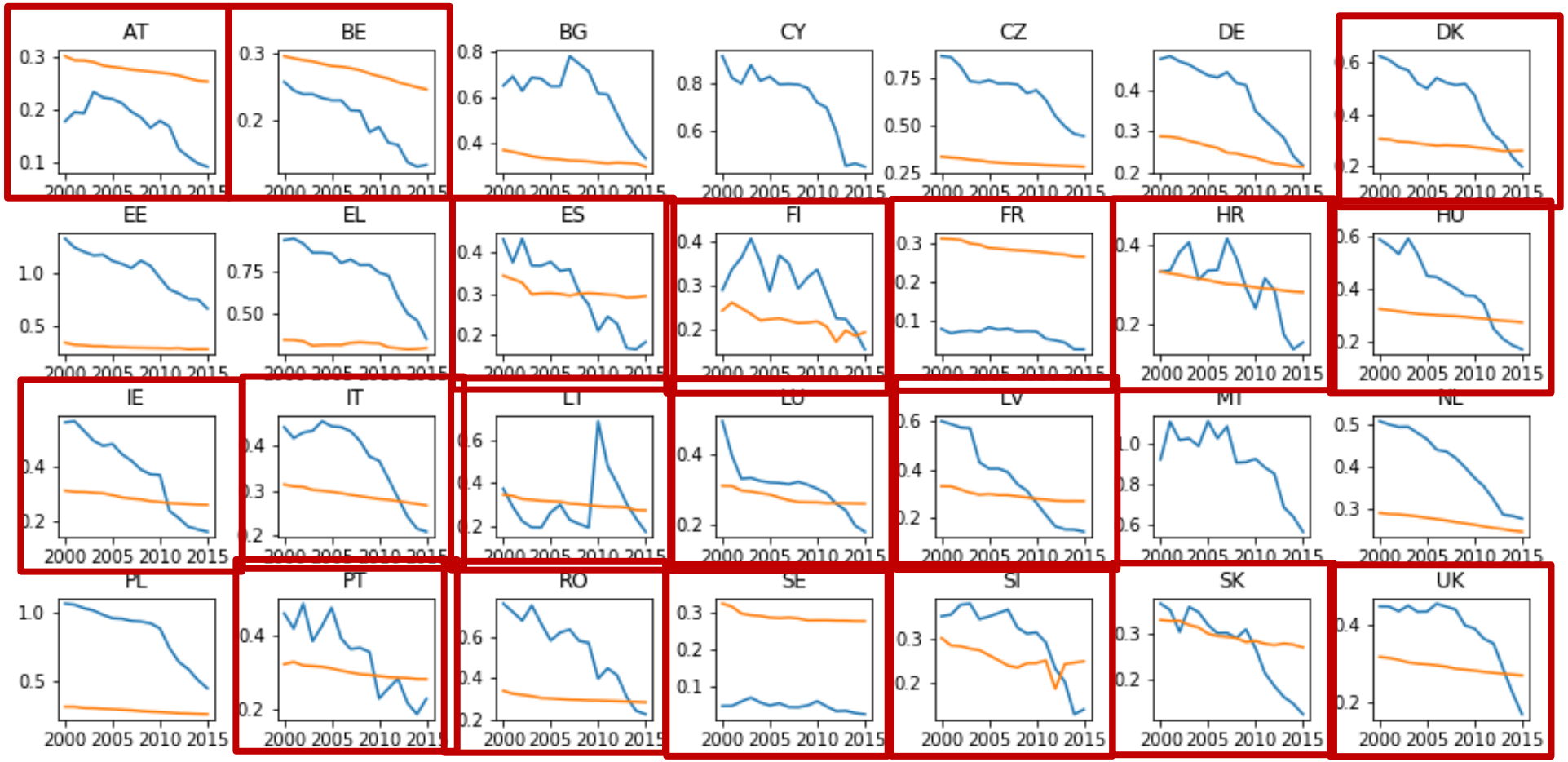
Content

1.	Current state of play in the EU
2.	Generation of heat pump profiles and electrification scenarios
3.	Results

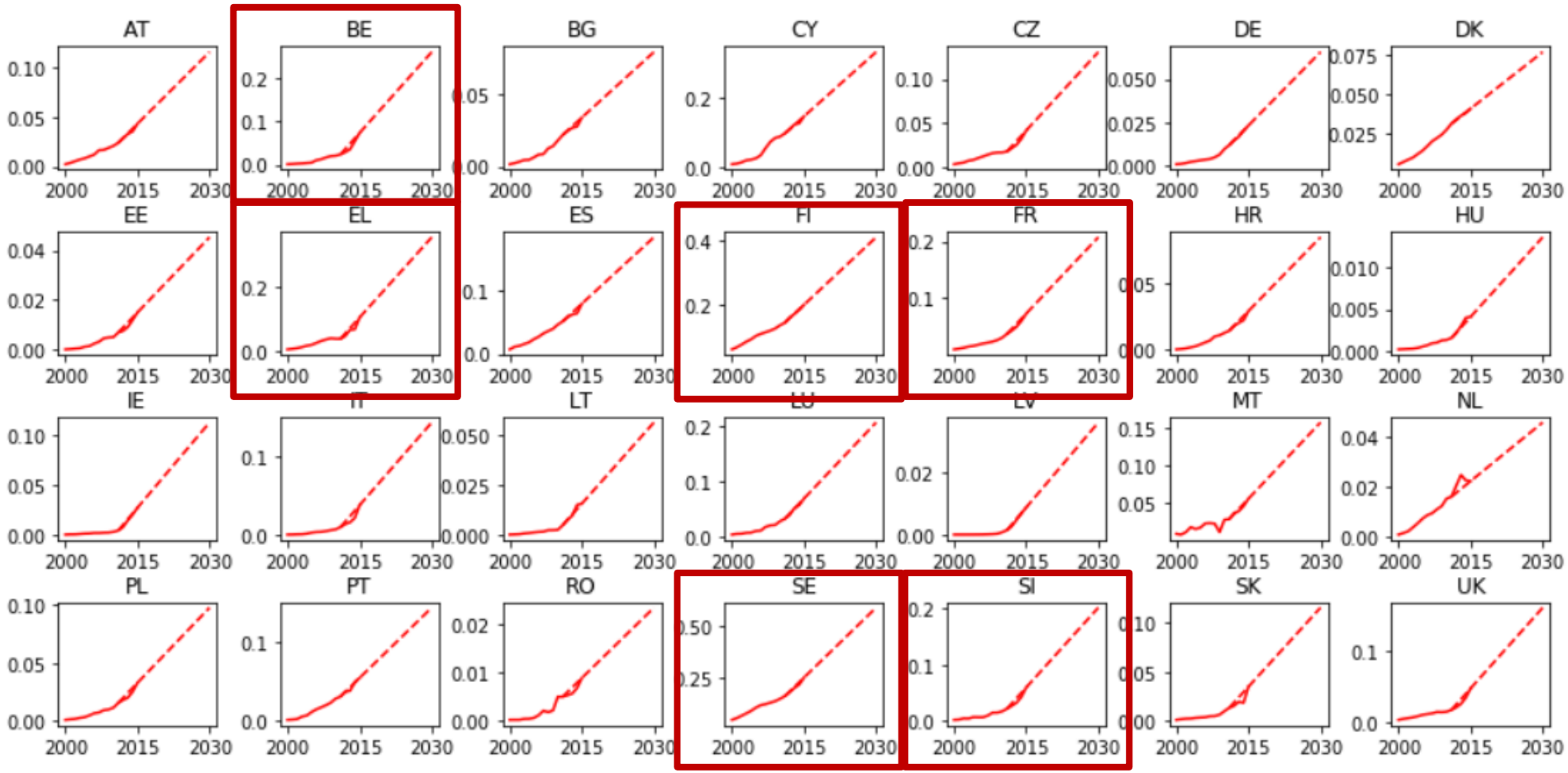
Current fuel mix in space heating:
The share of NetZero-ready heating technologies ranges from 10% up to 95% across the Member States.



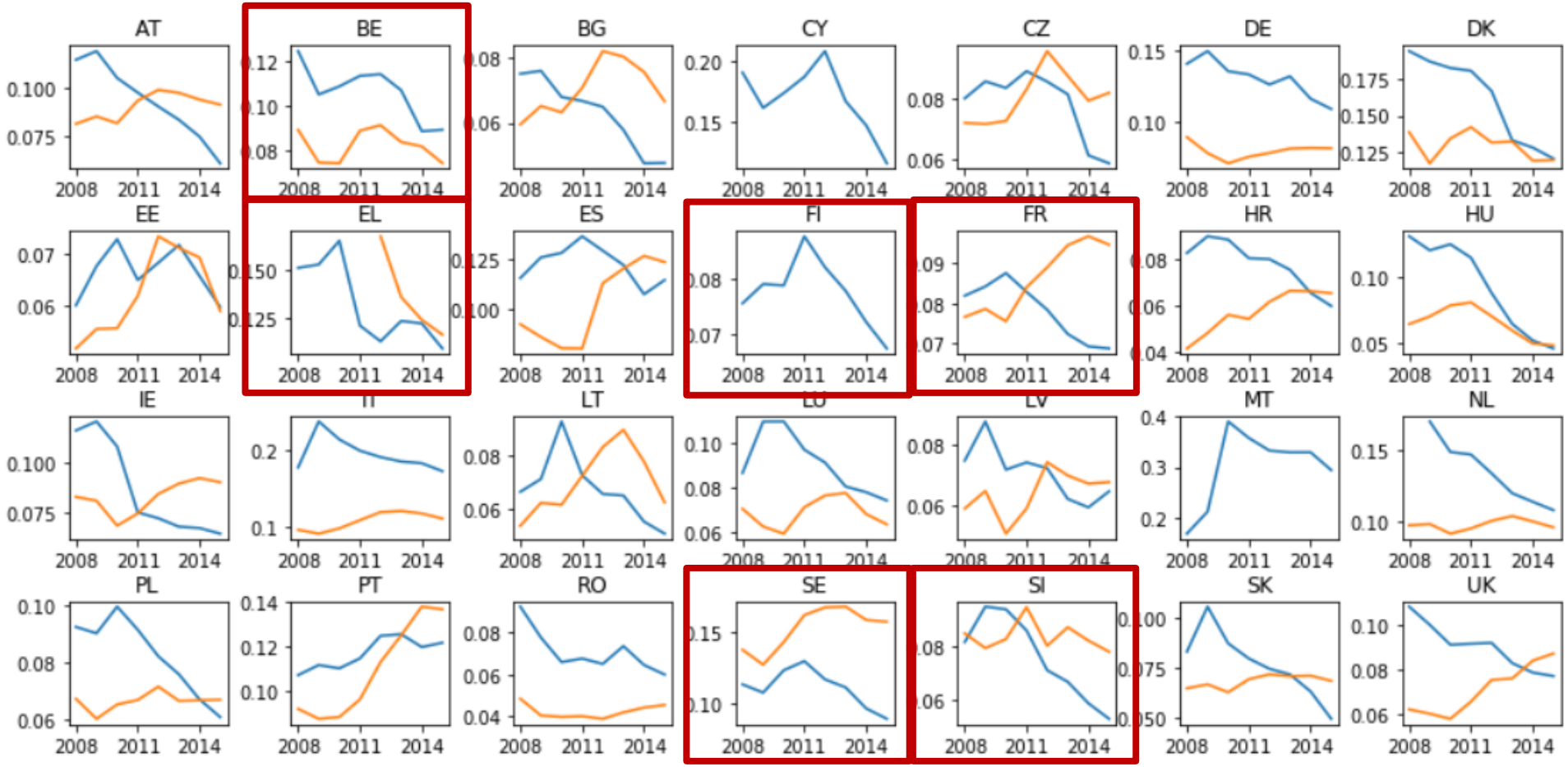
In most Member States, heat pumps (blue) produce less emissions per kWh heat than a gas boiler (yellow).



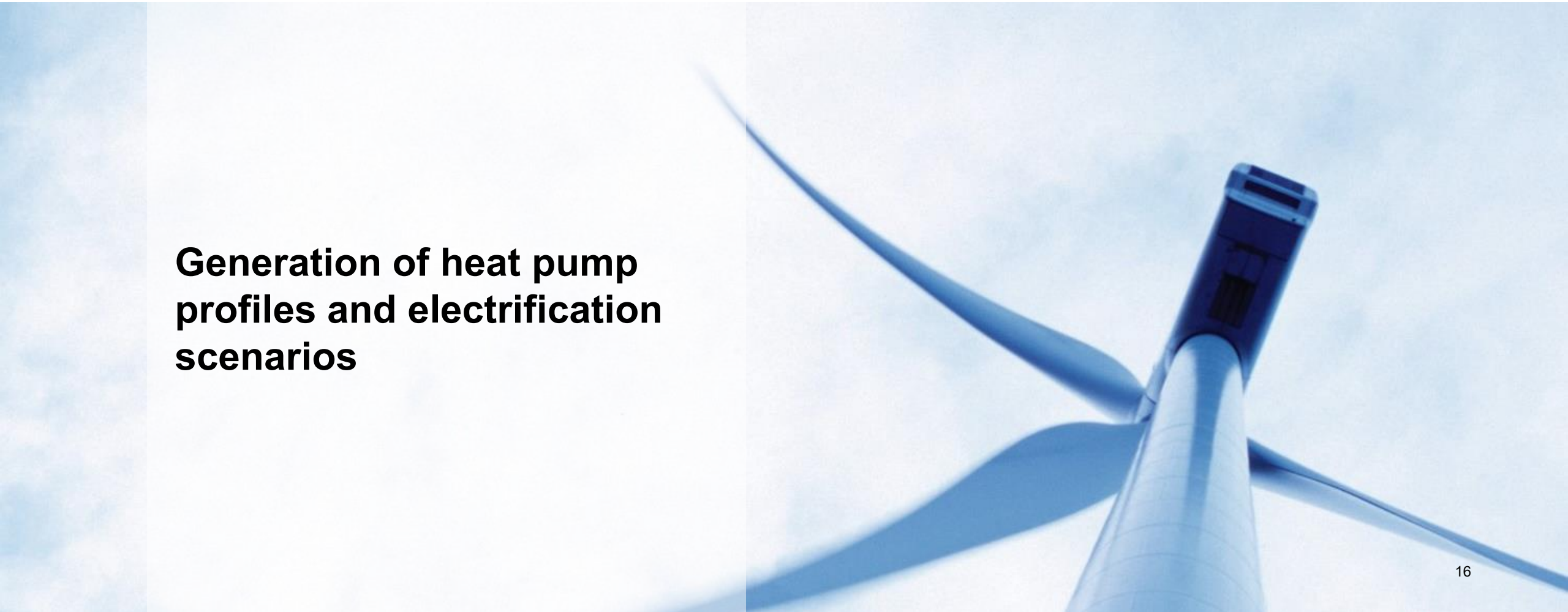
But only 6 countries aim at market shares beyond 20% in 2030



Operating costs appear to be a major driver for heat pump deployment, although cost parity alone is not sufficient.

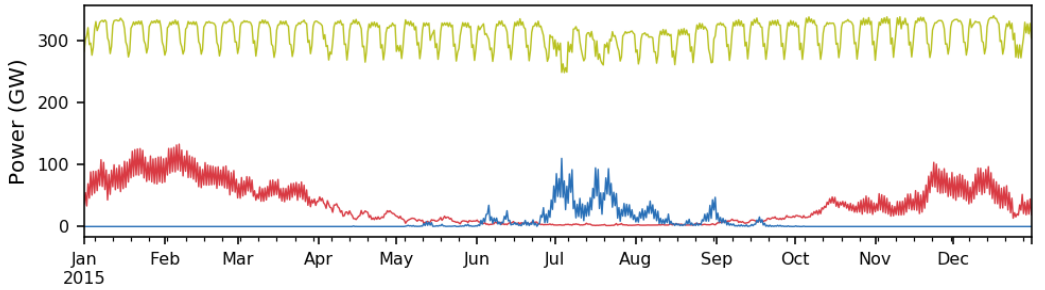


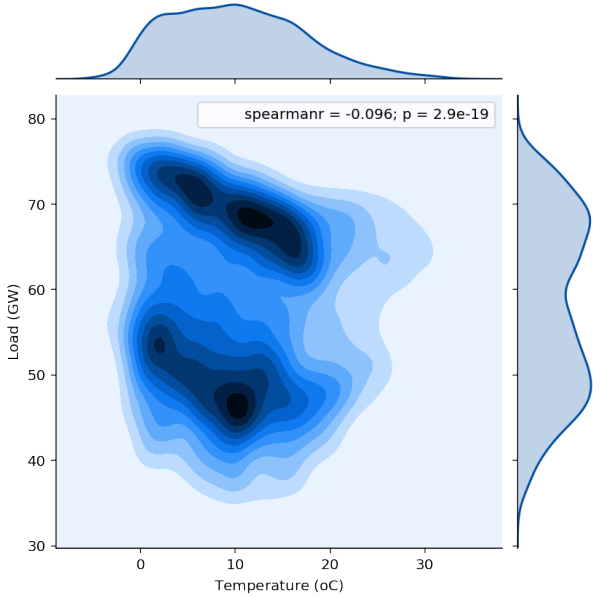
Generation of heat pump profiles and electrification scenarios



Method: Generating heat-pump profiles from temperature time series and electrical load

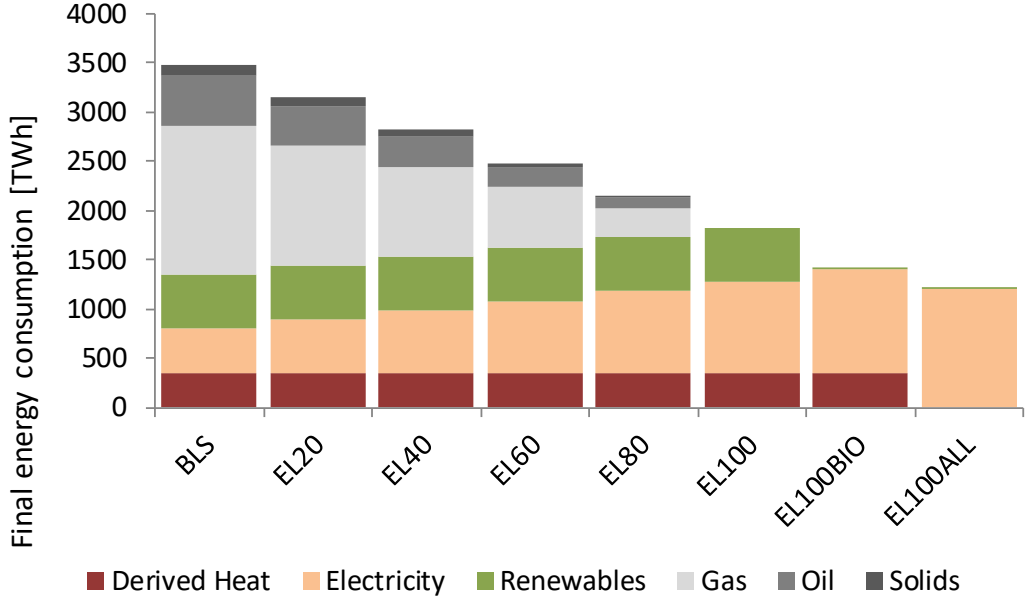
- Determine the point at which households start heating.
- Calculate heating-degree-hours time series.
- Disaggregation model based on heating-degree-hour, temperature dependent time series for COP and a rescaling function.
- Result is compliant with national statistics on electricity demand.





Heat sector scenarios

- ELXX scenarios describe a gradual replacement of decentralized fossil heating technologies by heat pumps. XX describes the share of fossils being replaced in percent.
- EL100BIO scenario assumes additionally a replacement of biomass fueled boilers.
- EL100ALL describes a scenario where, additionally, district heating is replaced by heat pumps, and can be seen as the maximum degree of electrification theoretically possible.
- Derived heat pump profiles are scaled to match the resulting numbers for annual consumption.

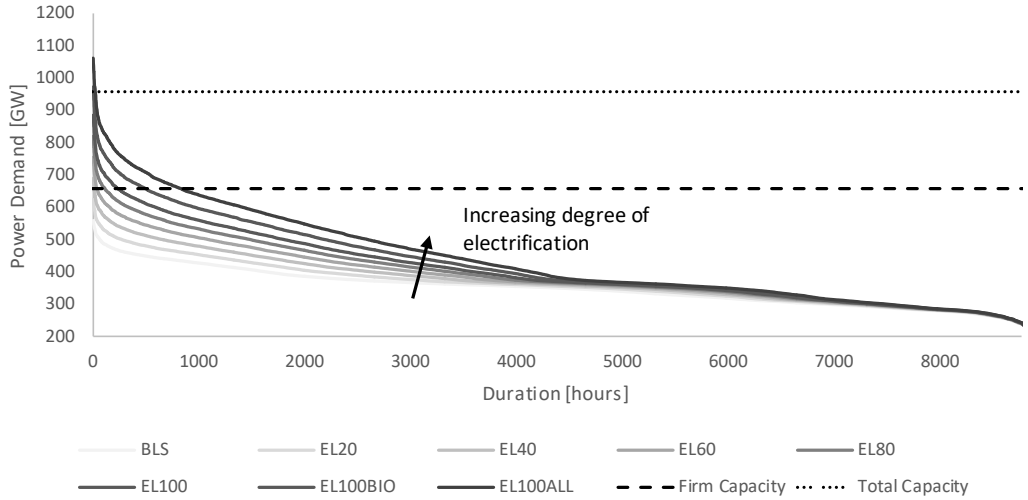


Projection trend 2030:

AT	BE	BG	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	NL	PL	PT	RO	SE	SI	SK	UK
EL20	**EL40**	EL20	EL20	EL20	EL20	EL20	**EL40**	EL20	**EL80**	EL20	EL20	EL20	EL20	EL20	EL20	EL20	EL20	EL20	EL20	EL20	EL20	**EL100BIO**	**EL40**	EL20	EL20

Scope of the analysis

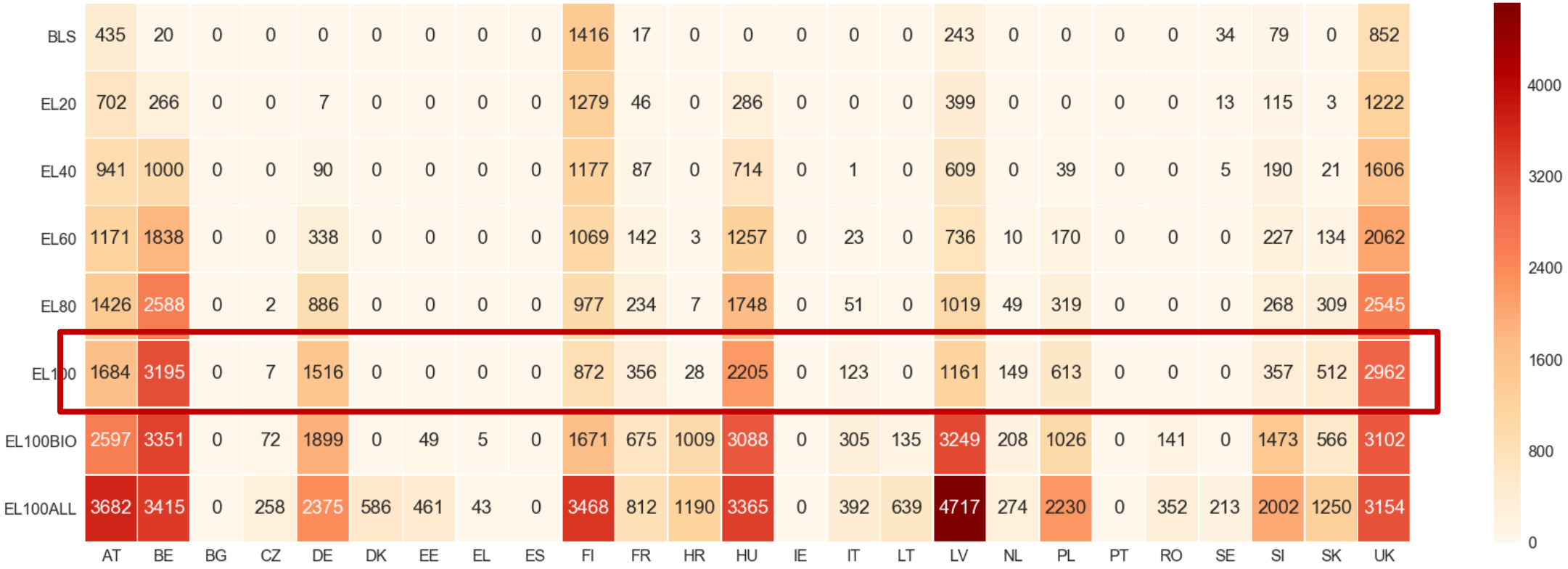
- **Is there enough firm capacity to safeguard the demand increase?** Matching demand with firm capacity levels in the EU Member States.
- This is a very conservative indicator, as variable renewables and interconnectors can contribute to satisfying additional heat pump demand (correlation between wind production and heat demand is proven in several studies). Exceeding the firm capacity level therefore **does not automatically mean load shedding**.



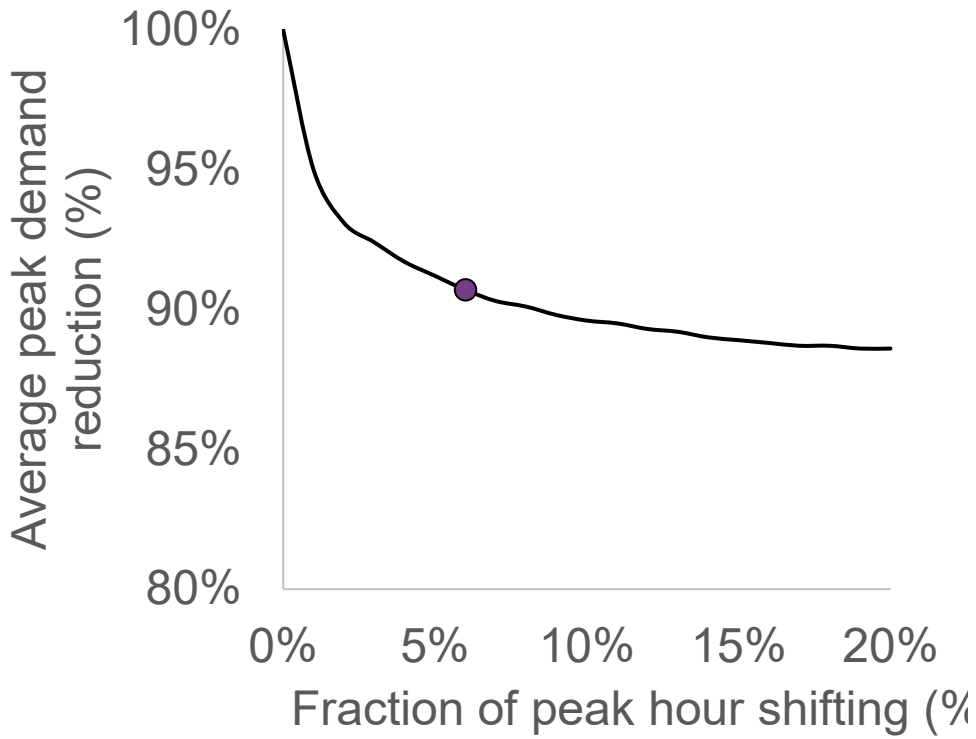
- **What is the impact on emissions?**
- Assumption: Additional demand is satisfied by gas-fired power plant (no additional transformation in the power sector).
- Sensitivity: What is the impact if heat pump deployment is accompanied by additional renewable deployment?

Results

Number of hours during which demand exceeds the firm capacity level: Many MS are well equipped for heat pump deployment. Some, however, need to monitor deployment to make sure that supply security is maintained.

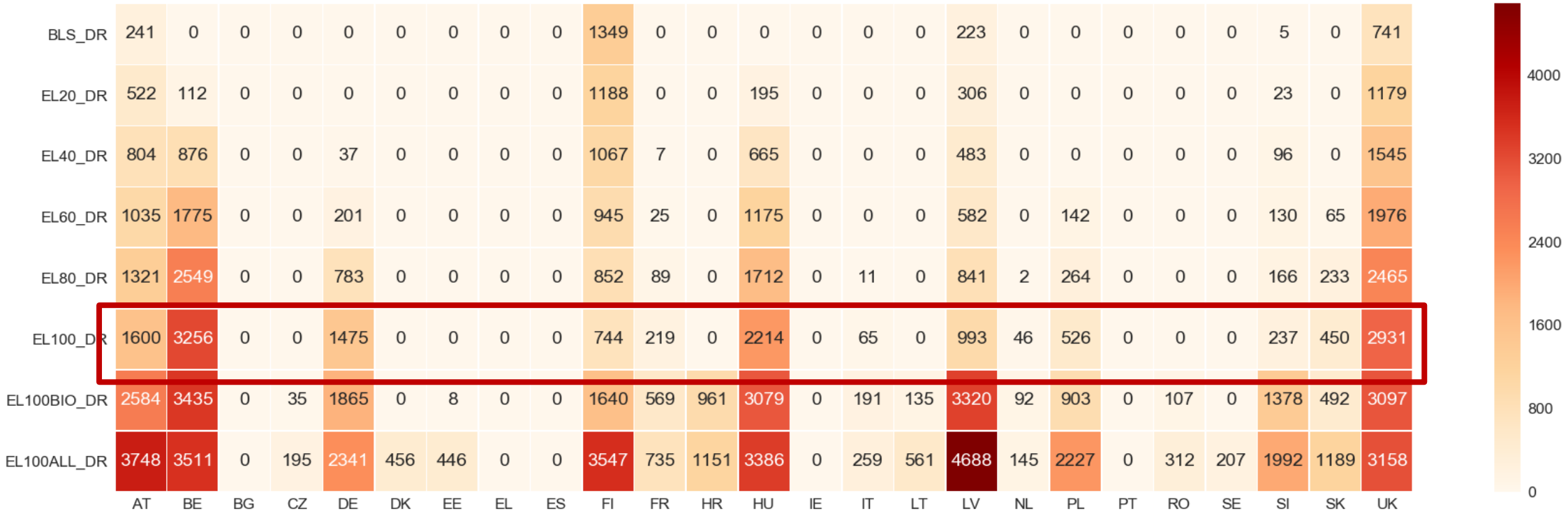


Sensitivity: What happens if we shift demand based on the thermal inertia of the buildings stock

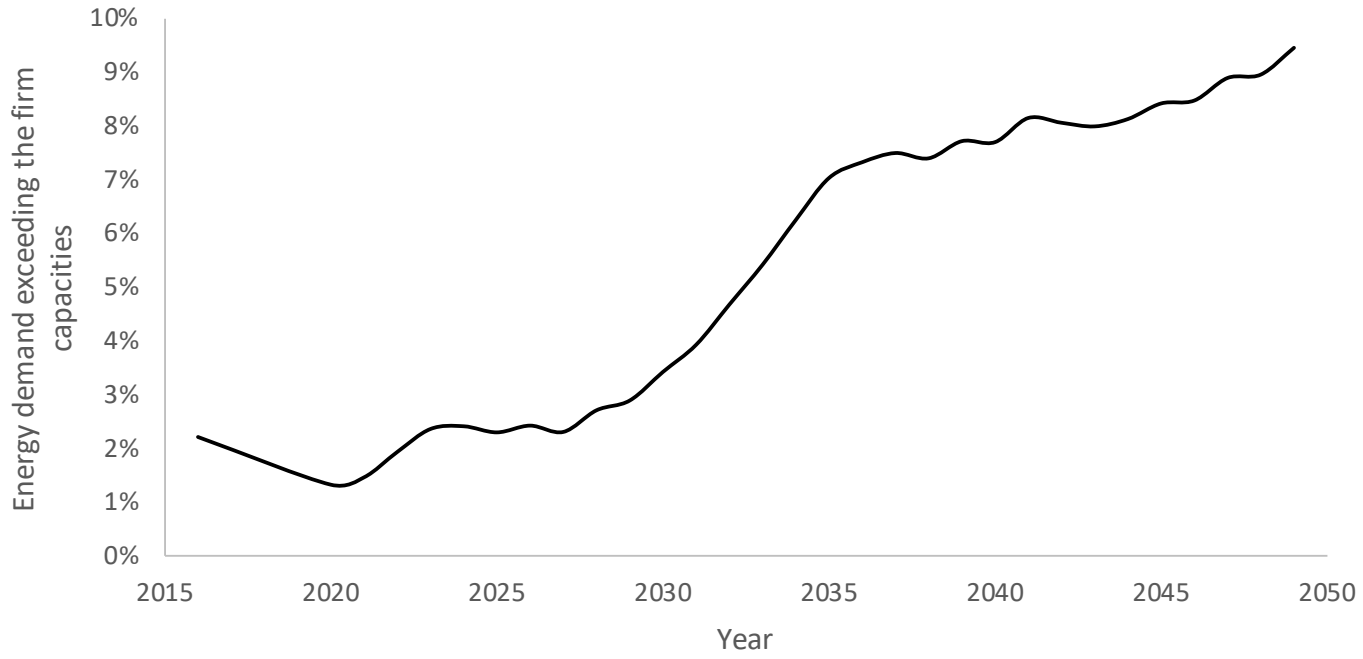


- Thermal inertia of buildings rectifies shifting 6% of peak demand to off peak hours
- Assumption: Temperature deviation of up to 0.5 °C is acceptable to inhabitants
- (Kensby et al., 2015): 0.1 kWh/m2 can be stored in buildings

Load shifting increases the number of MS with no hours above the firm capacities in the EL100 scenario from 10 to 12

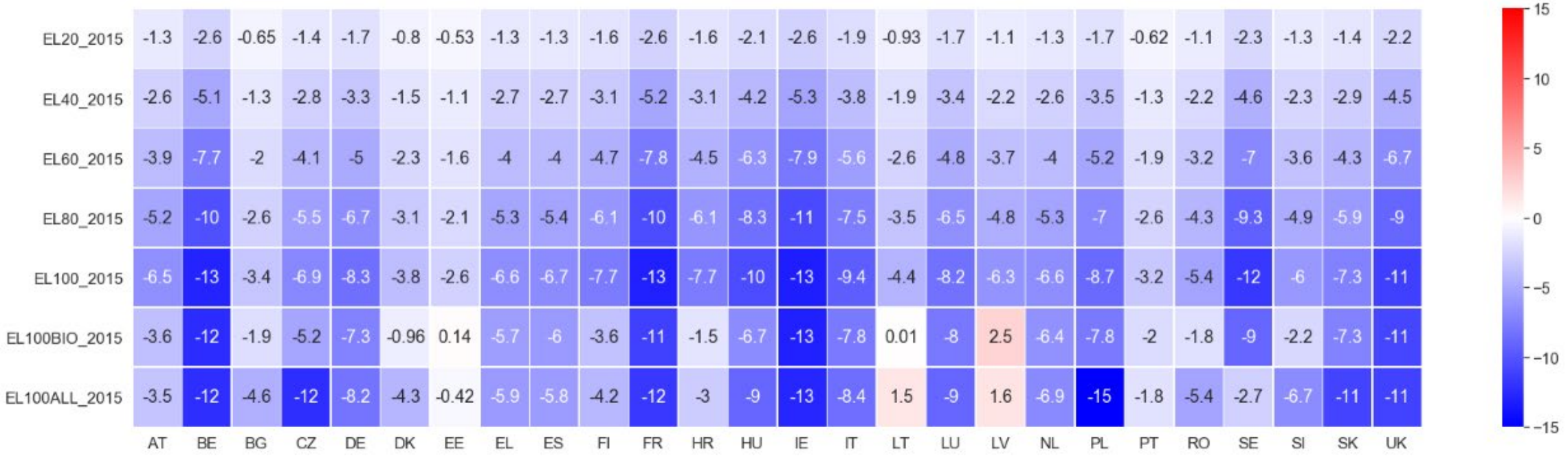


Outlook: Nuclear and coal phase outs might reduce the firm capacity level



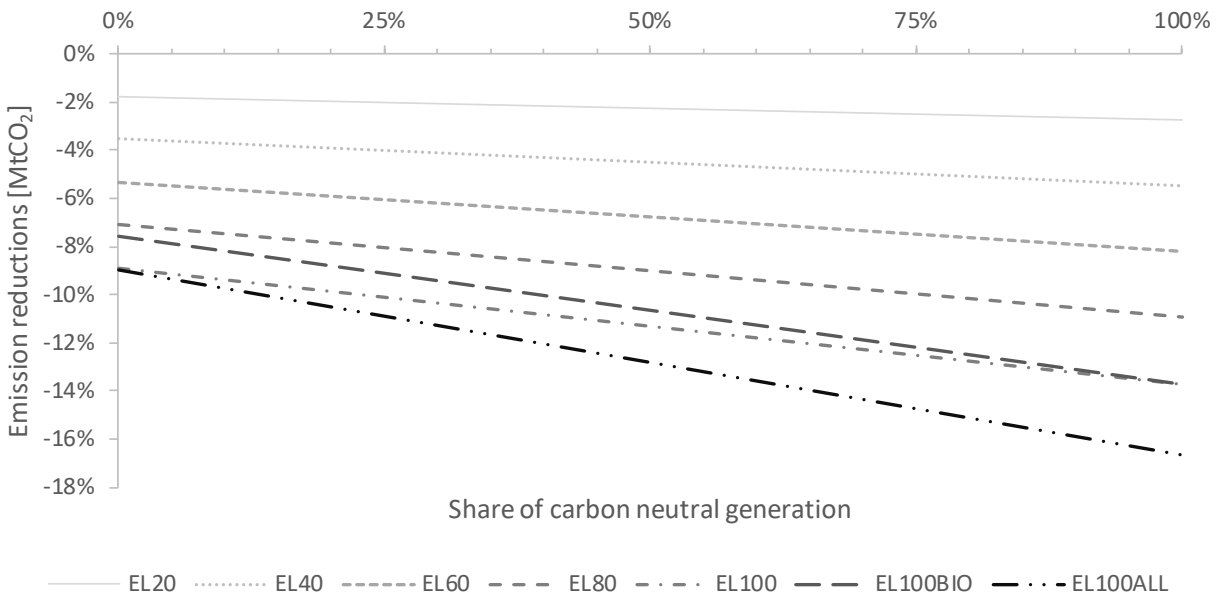
- Comparison with POTEnCIA central scenario.
- Until 2030, no capacity short falls to be expected.
- In the longer run, situation might change: Market monitoring is needed to ensure that necessary investments materialize.

Even with gas-fired power plants supplying heat pumps, emissions savings of up to 15% of total national emissions are possible.



The greener the electricity, the larger the carbon payback.

- The impact of the emission factor becomes more important with higher electrification shares.
- On an EU level, up to 16% of total emissions could be avoided by a complete electrification through heat pumps, if supplied by green electricity.
- Costs of electricity provision could be comparable to the base case, as LCOE of wind power is at a similar level of the marginal cost of a combined-cycle gas turbine. This changes if curtailment increases substantially.



How much heat pump capacity can we deploy taking into consideration todays capacities?

- Present power system is ready to accomodate 1.1 TW of heat pump capacity.
- This number increases up to 1.6 TW, if they are being operated in a flexible way.
- Emissions would be reduced by 116 – 169 MtCO2 anually
- Corresponding to roughly 3.4 – 4.9% of the EUs total emissions

	Inflexible demand			Demand response		
	Currently feasible scenario	Capacity [GWth]	Differential emissions [MtCO2]	Currently feasible scenario	Capacity [GWth]	Differential emissions [MtCO2]
AT	None	0	0	None	0	0
BE	None	0	0	None	0	0
BG	EL100ALL	36	-4.9	EL100ALL	36	-4.9
CZ	EL100	53.7	-6.2	EL100BIO	70.4	-7.5
DE	EL20	121.7	-11.1	EL40	243.1	-22.2
DK	EL100BIO	20.6	-2	EL100BIO	20.6	-2
EE	EL100	4.6	-0.6	EL100BIO	9	-0.8
EL	EL100ALL	78.8	-5.1	EL100ALL	78.8	-5.1
ES	EL100ALL	193.5	-19.7	EL100ALL	193.5	-19.7
FI	None	0	0	None	0	0
FR	EL20	68.1	-10	EL80	272.3	-40.1
HR	EL100	14.8	-1.4	EL100	14.8	-1.4
HU	None	0	0	None	0	0
IE	EL100ALL	20.6	-3.5	EL100ALL	20.6	-3.5
IT	EL60	202.3	-21.1	EL80	269.7	-28.2
LT	EL100	4.7	-0.4	EL100	4.7	-0.4
LU	EL100ALL	7.4	-1	EL100ALL	7.4	-1
LV	None	0	0	None	0	0
NL	EL80	89.6	-9.8	EL100	111.9	-12.3
PL	EL40	66.7	-5.5	EL40	66.7	-5.5
PT	EL100ALL	30.7	-3	EL100ALL	30.7	-3
RO	EL100	47.5	-4.1	EL100	47.5	-4.1
SE	EL100BIO	42.8	-5.4	EL100BIO	42.8	-5.4
SI	None	0	0	EL60	4.2	-0.5
SK	EL40	9.3	-1	EL60	14	-1.5
UK	None	0	0	None	0	0
EU27 + UK		1113.3	-115.9		1558.6	-169

Key take aways

1	If fossil boilers are replaced, heat pumps lead to emissions reductions in all EU Member States. On a national level, up to 15% can be reduced through electrification, even if not accompanied by additional deployment of renewable electricity.
2	All Member States are far away from critical levels of heat pump deployment. A majority of Member States has enough firm capacities readily available, even for far reaching electrification. The others should be aware of heat pump deployment, and monitor, whether the necessary investments in the power sector materialize to safeguard the additional demand.
3	In total, between 1.1 and 1.6 TW of heat pump capacity can be installed, depending on the flexibility of operation, without overstressing today's system. This would correspond to 29 – 45% of the EUs space heating needs and reduce carbon emissions by 3.4 – 4.9%.
4	The larger the level of electrification, the bigger the impact of the electricity mix. If heat pump deployment is accompanied by an expansion of renewable capacities, up to 16% of the EUs total emissions could be eliminated.

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