Paris Agreement compatible scenario for Europe until 2040: leveraging circularity for reflections on supply chain implications

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PAC
Paris Agreement Compatible
Scenarios for Energy Infrastructure

Closing the Circle: Supply chains and circularity approaches for delivering a decarbonised energy system

Modellers' Exchange Workshop
EEB Office, Brussels, Belgium, June 26, 2024

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PAC Paris Agreement Compatible Scenarios for Energy Infrastructure

We are fighting dangerous climate change, following scientific findings

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Over 200 member organisations active in 38 European countries, representing over 1.700 NGOs and more than 40 million citizens, CAN Europe promotes sustainable climate, energy and development policies throughout Europe

Creating +1.5 C compatible scenario for Europe

What is the Paris Agreement Compatible (PAC) 2.0 project?

At its core, the Scenario is **an attempt to construct a European-wide energy scenario which is aligned with the Paris Agreement's objective to limit global warming to 1.5°C** and which embodies the policy demands of civil society.

- Paris Agreement Compatible (PAC) energy scenario project 2.0 (CAN Europe with RGI, EEB, REN21, 2021-2024)
  - **Updated EU27 scenario** aggregates 27 national pathways
  - Also **national pathways for each EU27 member-state**
- More detailed findings, specialised modelling tools, as a software, use of national data and projections.
- Provides a policy-oriented pathway to climate neutrality 2040, created together with national member organisations, stakeholders and experts, to inform European and national decision-makers.
- This project has been financed by the German Federal Ministry for Economic Affairs and Climate Action with two rounds of grants realised in the timeframe of: 2018-2020 and 2021-2024.

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Renewables Grid Initiative

REN21 RENEWABLES NOW

EEB European Environmental Bureau

Supported by:
Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag

Paris Agreement Compatible (PAC) energy scenario - aiming for climate-neutrality in 2040

Scenario-building guided by three major goals for civil society views:

1. At least 65% reduction in greenhouse gas emissions by 2030
2. Net-zero greenhouse gas emissions by 2040
3. 100% renewables in Europe by 2040 in all sectors

Specific aims and objectives

- Achieving at least 65% GHG emissions reductions on 1990 levels by 2030
- At least 50% renewable energy share in gross final energy consumption in 2030 and 100% in 2040.
- At least 20% energy efficiency in 2030 (compared to 2020 EU Reference Scenario)

- EU-wide coal phase out by 2030
- EU-wide gas phase out by 2035 in the power sector
- EU-wide phase out of fossil oil products by 2040
- Gradual nuclear phase-out by 2040 (in light of existing capacities)
- EU-wide phase out for sale of Internal Combustion Engine (ICE) cars - by 2035

The use of hydrogen as domestically (European) produced, renewable hydrogen (H2). As part of the scenario-building, also land-use change (LULUCF) requirements are acknowledged and modelled.




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A climate and energy pathway 2040

NECP revision 2023 - 2024

Energy demand → Disaggregate country-specific PAC scenarios with national experts and member organisations → **EU27 + National pathways for climate neutrality**

Socio-economic dimension → Analyse socio-economic indicators for the costs and benefits of an accelerated energy transition → **Costs of inaction, co-benefits, also energy system costs**

Energy supply → Estimate energy infrastructure needs reflecting integration and flexibility options → **100% renewable energy system in the EU27**

Support CAN Europe members to use the PAC scenario as a monitoring tool

CAN Climate Action Network Europe

Coupling demand and supply together, with circularity

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Coupling demand and supply together, with circularity

Choice of tools for promoting open data and open source: where can we see observe and explore circularity?

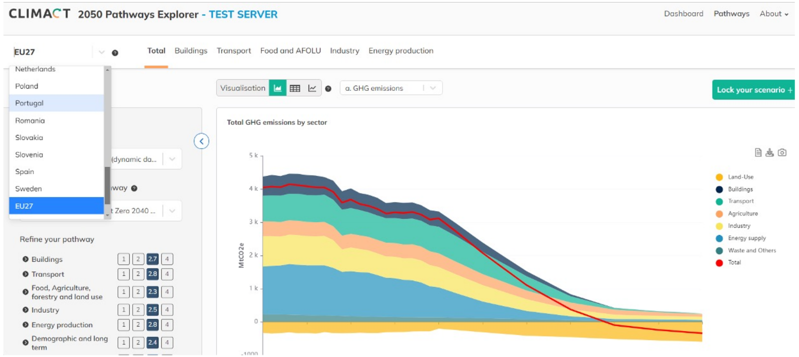
Aim to visualise results in a user-friendly manner. Allow anyone to access, explore and interact with the scenario, assumptions, enablers, perspectives, and referenced data in traceable and transparent manner (i.e. promoting "FAIR principles").

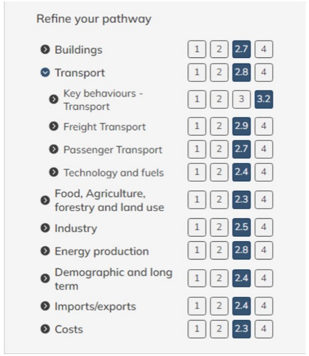
Climate and energy pathways 2040 nationally and for EU27 *(demand and supply)*

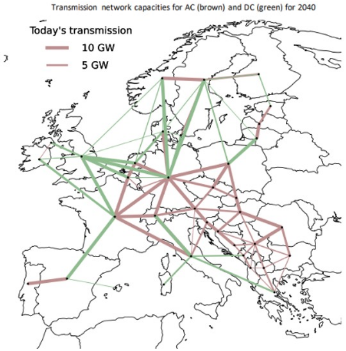
An open data software tool called Pathways Explorer 2050. Any European citizen can explore the levers, the ambition levels, the findings of their country and the EU27, as a visual playground.

The road towards a 100% RES system *(supply)*

Energy supply and associated infrastructure, illustrated with Python for Power Systems Analysis (PyPSA-Eur), as an open source tool. For anyone to explore, findings in a dedicated GitHub data repository.







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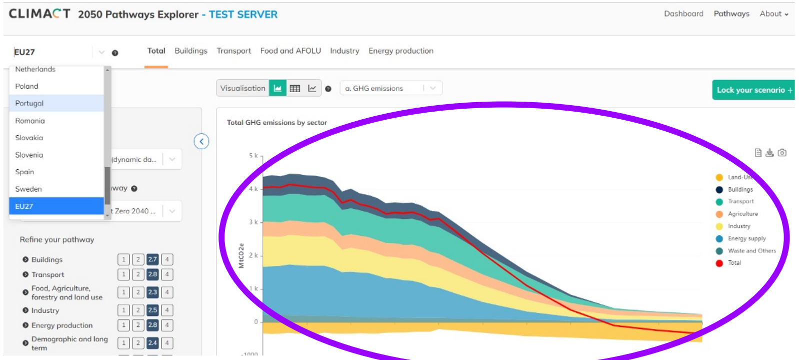
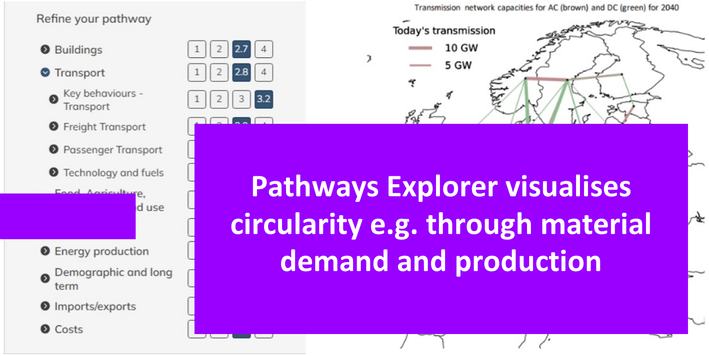
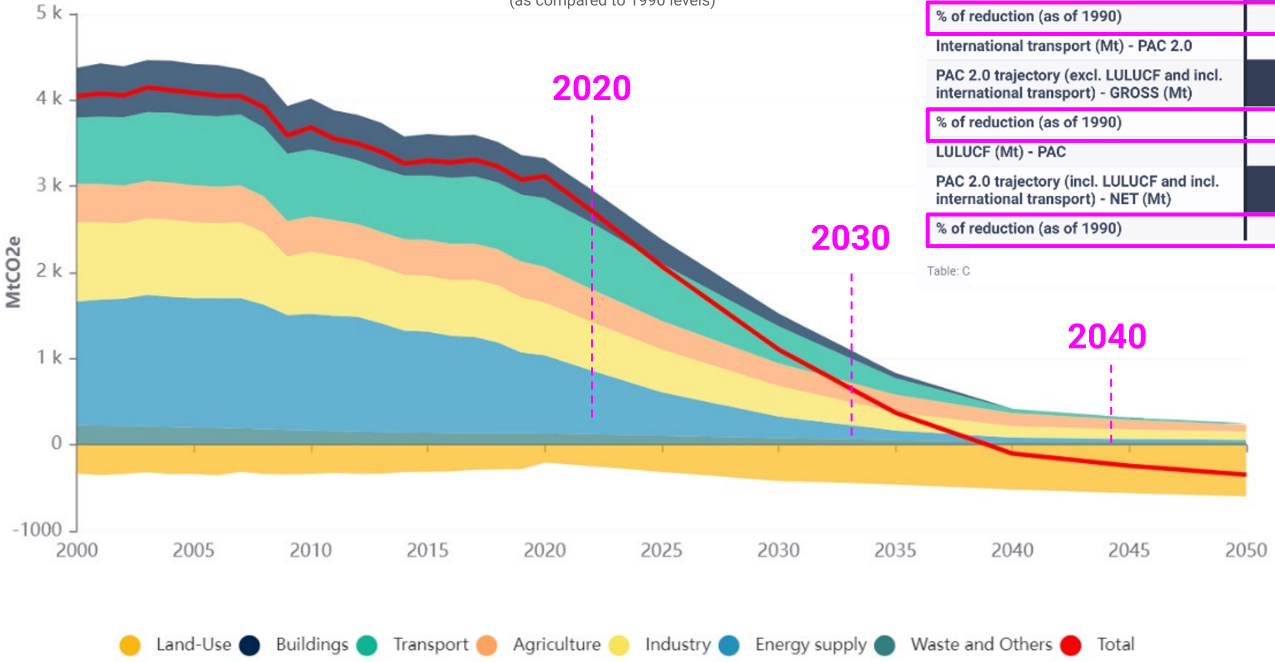




Pathways Explorer visualises circularity e.g. through material demand and production

Our emissions pathway as a 2040 net-zero scenario

PAC 2.0 scenario
GHG emissions for EU27 by 2040



Explanation of the key figures

-91% reduction (*excl.* LULUCF, *excl.* int. transport)
-92 % gross reduction (*excl.* LULUCF, *with* int. transport)
-102% net reduction (*with* LULUCF, *with* int. transport)

(as compared to 1990 levels)

PAC 2.0 emission reduction trajectory (based on EEA most updated data)

PAC 2.0 achieves climate neutrality (EU 27) by 2040

Year	1990 (EEA)	2020	2025	2030	2035	2040
PAC 2.0 trajectory (excl. LULUCF and excl. international transport)	4,897	3,324	2,386	1,525	833	419
% of reduction (as of 1990)		-32	-51	-69	-83	-91
International transport (Mt) - PAC 2.0		280	256	232	66	0
PAC 2.0 trajectory (excl. LULUCF and incl. international transport) - GROSS (Mt)	5,023	3,604	2,642	1,758	900	419
% of reduction (as of 1990)		-28	-47	-65	-82	-92
LULUCF (Mt) - PAC		-207	-313	-419	-460	-519
PAC 2.0 trajectory (incl. LULUCF and incl. international transport) - NET (Mt)	4,814	3,398	2,329	1,339	440	-100
% of reduction (as of 1990)		-29	-52	-72	-91	-102

Table: C

- According to the ESABCC, more efforts will be needed across all sectors to achieve the EU climate objectives, and particularly in buildings, transport, agriculture and forestry.

- Considerable climate ambition will also need to be assisted by diverse supportive measures and policies

Halving energy demand across by 2040 to remain within +1.5 C

*“Energy demand reduction scenarios prioritise energy savings and efficiency as the main driver of the transition. These types of scenarios **minimise the use of resources and materials**, since they aim to reduce the energy demand across sectors drastically.” (ESABCC 2023)*

ESABCC (2023): Scientific advice for the determination of an EU-wide 2040 climate target and a greenhouse gas budget for 2030–2050

- In PAC 2.0, final energy consumption (FEC) falls by -25% by 2030, and -51% by 2040 (as per 2020 reference)
- A higher ambition is socio-technical (and even socio-cultural), and is **helped by changes in how societies, different sectors, and their interactions are organised**, as is clear from scientific analyses
- As most experts agree, **energy transition is not only about fuel switches.** Changing fuels is ‘easy’. For societies to be circular and also sustainable takes more.

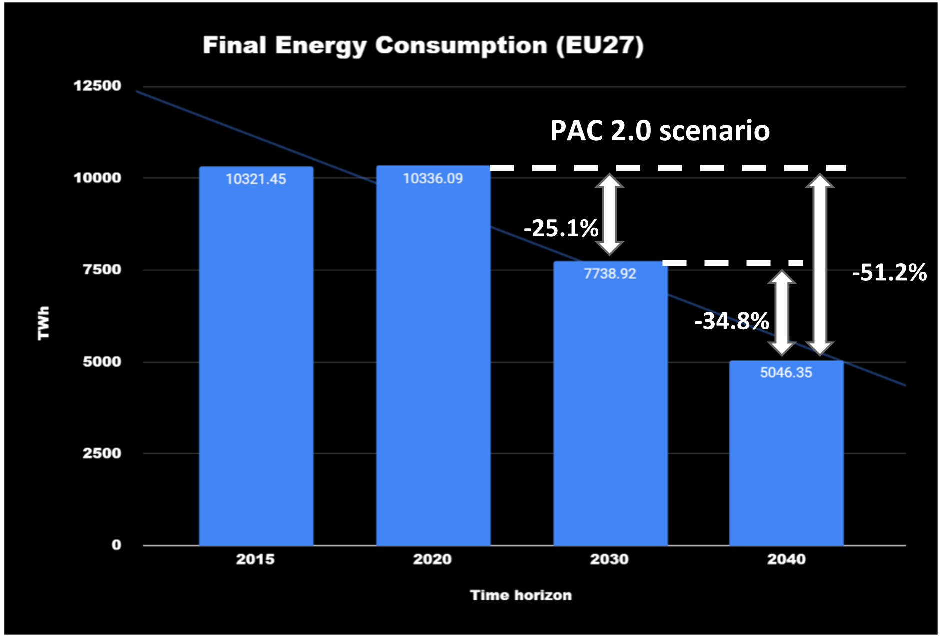


Figure. PAC 2.0 - Final Energy Consumption (EU27) - CAN Europe preliminary analysis. Note: FEC calculation will be updated against new Eurostat methodology (EED 2023).

PAC 2.0 as a systems change scenario 2040

The PAC 2.0 scenario...

Encourage and inspire sustainable lifestyles in Europe

Achieving net zero requires a considerable reduction of the energy demand. This is achieved through changes in social patterns and societal organization, our use of technologies, also going towards circularity.

Perform energy and process improvements to transform buildings, industry and transport for far higher efficiency

Energy efficiency measures coupled with technological progress and process improvements will allow to reduce energy demand and a more sustainable economy.

Accelerate renewables-based electrification for a 100% RES system

Electrification of the processes across all sectors is necessary and needs to be coupled with renewable power production.

Decarbonise what is left

- Fuel switch (bio or e-fuels): for processes that cannot be electrified
- Carbon capture only for limited industrial activities with process emissions (cement,...)
- Reverses land-use change, as natural carbon removal potential is limited

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PAC 2.0 as a systems change scenario 2040

The PAC 2.0 scenario… models socio-technical change, with technology switches as well as material switches, and also reflects on their underlying sustainability criteria.

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Deep renovations in buildings require access to relevant building materials and talented workforce

Role of less energy consuming buildings

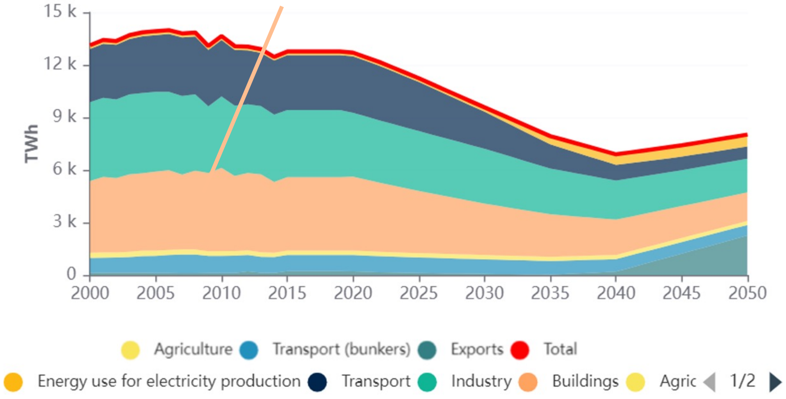

Fig. Role of buildings, within FEC and exports - PAC 2.0

Buildings energy demand (cf. 2020)	-24% (2030)	-41% (2040)	-53% (2050)

GHG emissions	2020	2025	2030	2035	2040
Buildings	461	284	150	59	4
Net total (Mt)	**3,120**	**2,070**	**1,110**	**373**	**-100**

Annual renovation rate up to 3% for far more energy-efficient buildings, as deep renovations, with heat pump installations. 75% buildings renovated between now and 2050 (average saving -78%). Electrification from ~35% to ~60%.

PAC 2.0 - Non-residential floor area

Evolution of renovated, non-renovated and new constructed area of the non-residential sector

Categories	2020	2025	2030	2035	2040	2045	2050
Renovated area (mio. sq.m.)	186	1,083	2,015	2,967	3,911	4,846	5,772
% of increase		481	982	1,492	1,999	2,500	2,997
Existing area/non-renovated (mio. sq.m.)	7,579	6,639	5,655	4,646	3,639	2,635	1,635
% of decrease		-12	-25	-39	-52	-65	-78
Constructed area (mio. sq.m.)	46	68	98	134	176	224	277
% of increase		49	115	194	286	390	507
Total	7,811	7,789	7,768	7,747	7,726	7,704	7,683
% of change		-0	-1	-1	-1	-1	-2

Table: CAN Europe analysis • Source: Pathways Explorer • Created with Datawrapper

Supply chain implications:

- ➢ Available of skilled workforce
- ➢ Funding renovations, EU and national funds to
- ➢ Increased costs, inflation (e.g. for building materials)
- ➢ More than shallow renovations
- ➢ Addressing energy poverty, quality of renovation plans

Beyond EVs – Transforming the way we move, also with properly dimensioned and lighter vehicles

A well-organised transport sector has also a smaller, electrified car fleet

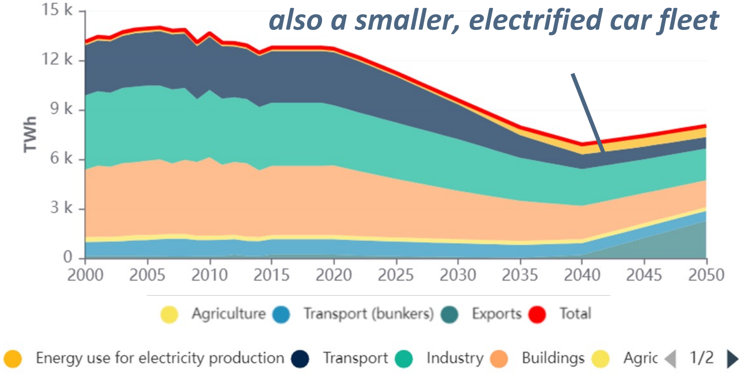

Fig. Role of transport, within FEC and exports - PAC 2.0

Transport energy demand (cf. 2020)	-11% (2030)	-24% (2040)	-36% (2050)

GHG emissions	2020	2025	2030	2035	2040
Transport	799	663	430	192	45
Net total (Mt)	3,120	2,070	1,110	373	-100

Shift in social patterns and critical infrastructure. Modal shifts, access to good public transport. Rail, marine and aviation sector will be transformed. Higher car-sharing and car-pooling. Support shifts away from ICE vehicles.

PAC 2.0 - Long distance (freight)

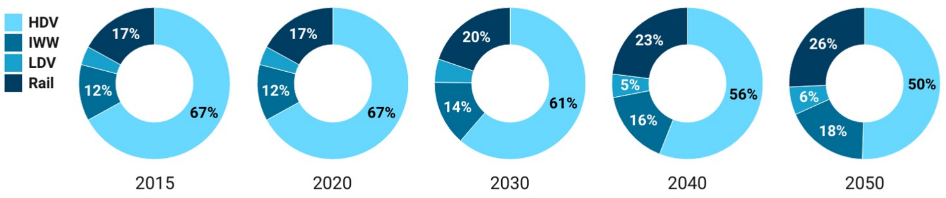

Chart: CAN Europe • Source: Pathways Explorer • Created with Datawrapper

As freight shifts slightly from trucks to rail and shipping, it becomes more environmentally friendly.

Supply chain implications:

- ➢ Slightly lower volumes of goods transported
- ➢ Increased focus on catenary and rail infrastructure
- ➢ Droughts could challenge higher use of inland waterways
- ➢ Car industry innovation might not favour lighter vehicles

Circularity for industry renewal – generating new value

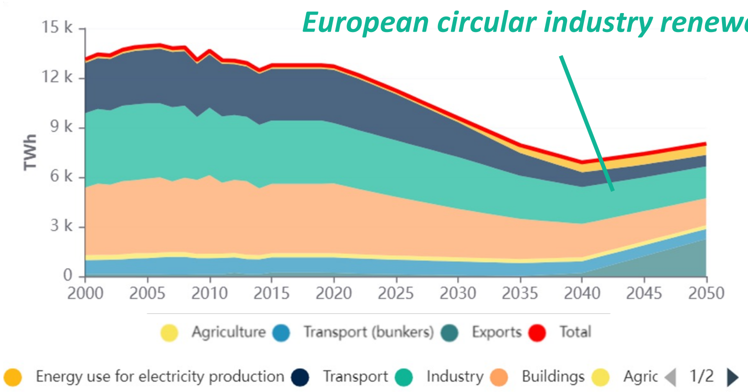

Fig. Role of industry , within FEC and exports - PAC 2.0

Industry energy demand (cf. 2020)	-15% (2030)	-39% (2040)	-47% (2050)

GHG emissions	2020	2025	2030	2035	2040
Industry	611	484	356	213	131
Net total (Mt)	3,120	2,070	1,110	373	-100

Lower waste costs per product, less primary material needed per product, as a rising ecosystem for circularity. Secondary-use shares reach 50% for steel, almost 50% for aluminium, and 60% for paper.

- **Circularity and sharing economy for resource efficiency** in 100% RES + demand-reduction scenario.
- Circularity emerges as a key feature of Europe's industrial logic by 2040, which implies an increase of secondary, or recycled materials and that fewer primary resources will be needed, as an industrial transformation.

Supply chain implications:

- ➢ Substitutes to energy-intensive materials, immediately sourced within EU (wood in construction instead of steel, aluminium and cement, biomass as feedstock for plastics replacing oil
- ➢ H2 as RE H2. Wariness of H2 imports of any origin
- ➢ A need to produce less new materials, as creation of new value from circular and sharing patterns
- ➢ Anticipate any supply chain disruptions

Towards 100% RES-based electrification with flexible grids

Estimated modelled RES capacities *with* demand reduction (EU27)

RES	Now: 449GW	2030: 0.92 - 1.25TW	2035: 1.76 - 2.04TW	2040: 2.28 - 2.53TW

Note: Our EU27 and national RES capacities are to be taken into account ONLY when the final energy consumption is also reduced (with around 50% by 2040)

RES = Renewable energy sources (supply)

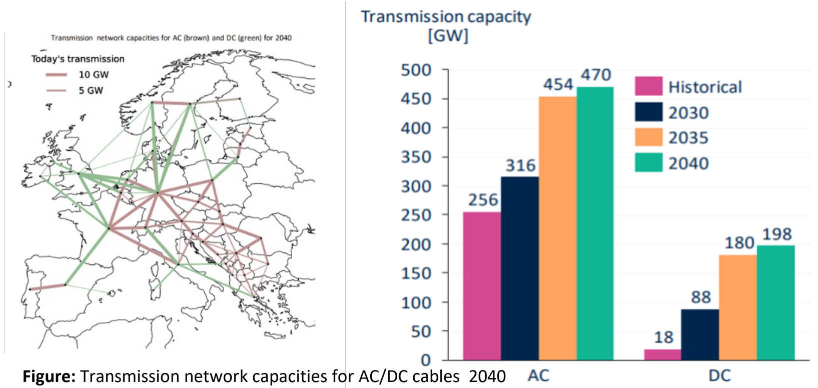

Figure: Transmission network capacities for AC/DC cables 2040
Source: CAN Europe, Climact, PyPSA-Eur analysis

https://caneurope.org/content/uploads/2024/05/Wired-for-Climate-Neutrality_A-Paris-Agreement-Compatible-roadmap-for-power-grids.pdf

- **100-120GW annual RES deployment needed (also higher than in proposed EC 2040 targets).** Annual RES deployment in EU27 +38-59% compared to 2023 record - or 3x against 2020-2022 average

- **Existing power grids to be improved, and more grids needed**, as enhanced transmission capacities that accelerate RES deployment and their integration, and address storage needs.
  - 2030: 404 GW (316 GW in AC, 88 GW in DC cables) +47% **(blue)**
  - 2035: 634 GW (454 GW in AC, 180 GW in DC) +131% **(yellow)**
  - 2040: 668 GW (470 GW in AC, 198 GW in DC) +144% **(green)**

- Newest studies suggest EV batteries to present a high potential to replace large utility-scale batteries. **EV batteries could be repurposed for the grid, rather than recycling them**, lowering the pressure on minerals, especially at the end of their lifecycle, as the IEA also recently suggested, which in turn might make economic sense.

Every kilowatt hour saved also means lower capacities for energy production, power transmission, and lower material needs.

Integrating circularity considerations for avoiding resource waste – also with energy transition

As a cross-cutting element to the 2040 pathway, circularity means lower demand for primary materials and resources.

PAC 2.0 - Material production by material

Evolution of material production per time horizon (kt)

	2020	2030	2035	2040	2045	2050
Aluminium	5,697	4,857	4,391	3,925	3,458	2,992
Cement	170,881	140,762	125,702	110,643	95,583	80,523
Ceramic and others	99,071	90,179	85,733	81,287	76,841	72,395
Chemical (Ammonia)	12,528	10,764	9,881	8,999	8,117	7,235
Chemical (Olefin)	64,977	56,915	52,883	48,852	44,821	40,790
Chemical (Other)	112,888	116,259	117,945	119,630	121,316	123,001
Food processing	341,681	320,991	310,645	300,300	289,955	279,609
Glass	34,647	31,427	29,817	28,207	26,597	24,987
Lime	31,536	31,783	31,906	32,029	32,152	32,275
Non Ferrous	7,596	6,495	5,945	5,394	4,844	4,293
Other Industries	10,323	10,215	10,161	10,108	10,054	10,000
Paper	78,507	71,560	68,087	64,614	61,141	57,668
Steel	137,476	134,305	132,719	131,133	129,547	127,962
Wood	103,479	99,325	97,247	95,170	93,092	91,015
Total	1,211,289	1,125,836	1,083,063	1,040,289	997,516	954,743

PAC 2.0 - Material demand by material

Evolution of material demand per time horizon (kt)

	2020	2030	2035	2040	2045	2050
Aluminium	10,569	16,231	20,885	21,300	17,582	15,466
Cement	165,262	335,165	307,094	234,244	226,869	232,829
Ceramic and others	92,331	305,797	292,572	251,064	238,768	234,483
Chemical (Ammonia)	14,995	10,766	8,841	7,105	5,903	4,920
Chemical (Olefin)	61,883	66,812	53,536	34,955	27,919	24,113
Chemical (Other)	113,456	114,051	91,942	65,100	54,637	47,563
Food processing	353,708	333,037	300,083	249,543	232,905	223,415
Glass	36,015	41,695	40,321	37,802	36,181	35,422
Lime	30,827	51,530	55,354	53,268	49,026	46,553
Non ferrous	8,064	14,661	16,947	16,633	15,176	14,831
Other industries	10,480	12,794	13,768	13,296	12,207	11,562
Paper	62,805	61,798	56,123	50,529	42,799	34,701
Steel	142,758	223,358	235,337	210,811	193,324	188,872
Wood	98,085	186,167	240,257	309,078	317,940	315,210
Total	1,201,239	1,773,863	1,733,060	1,554,727	1,471,234	1,429,937

Charts - CAN Europe - Source: Pathways Explorer - Created with Datawrapper

As a further frontier, we are interested in describing in more detail, how more circular European economies and societies can substitute to **more sustainable materials; and a higher use of secondary materials, and to address the needs of the energy transition**, to build the new energy infrastructure of the future.

Thank you for your attention!

Closing the Circle: Supply chains and circularity approaches for delivering a decarbonised energy system

PAC Modellers' Exchange
Brussels, Belgium, June 26, 2024

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