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G7 POWER SYSTEMS SCORECARD

METHODOLOGY¹

May 2024

Why track G7 countries' progress towards a 2035 net zero power systems goal?

The G7 countries committed to reach “fully or predominantly decarbonised power systems by 2035”, the first iteration of the commitment agreed upon during the 2021 Climate and Environment Ministerial.² With this commitment, the G7 are the first group of countries to aim for a milestone that the IEA has identified³ as mission critical to a 1.5 °C compatible pathway. All OECD countries will however need to achieve this goal, and it is now essential for G7 countries to demonstrate they are making progress in delivering on this commitment.

In tracking G7 countries' progress towards reaching a net zero power systems target, this Scorecard aims to:

- > **Show the real steps undertaken by the G7** to decarbonise their electricity systems and adapt them to higher shares of variable renewable energy. This enables us to understand which countries and which policy and governance areas require more action. G7 countries have about ten years left to reach net zero power systems – a very short timeframe, given that it takes time to adjust policy frameworks, build a skilled workforce to drive the delivery, and deploy the infrastructure on the ground. Keeping track of the key policy and financial decisions, and the effect they have on the power systems themselves, is key to understanding whether the current pace of change is sufficient.
- > **Provide lessons learned from the G7 countries** on power systems decarbonisation. These are useful for other OECD countries, which also need to aim for 2035 net zero power systems, and for the rest of the world, which

¹ To see the whole Scorecard, including the scoring methodology, visit <https://www.e3g.org/g7-power-systems-scorecard>

² **G7 Climate and Environment: Ministers' Communiqué**, London, 21 May 2021 (Website, last visited May 2024).

³ IEA, September 2023, **Net Zero Roadmap: A Global Pathway to Keep the 1.5C Goal in Reach** (Report, last visited May 2024)



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needs to reach net zero power systems by 2045 at the latest to be on track for climate neutrality by mid-century or shortly thereafter.

What does this Scorecard measure?

The Scorecard considers two key aspects:

1. **G7 countries' progress towards decarbonising their power systems so far.** This is reflected by their current electricity mix and plans for future power capacity deployment (project pipeline). The first section of the Scorecard (Infrastructure/Energy mix) scores this aspect against two benchmarks (1. Reducing fossil fuel reliance and 2. Ramping up renewables).
2. **G7 governments' policy framework, governance and global leadership** to create the necessary frameworks and conditions for reaching the 2035 net zero power systems commitment. The second section of the Scorecard (Policies/Targets) scores this aspect against three benchmarks (3. Adapting the power systems to high RES share; 4. Governance / International leadership; 5. Reducing energy waste).

This section includes not only domestic policies and targets, but also G7 countries' international leadership to bring forward global power sector decarbonisation. As a group of advanced economies claiming global climate and energy transition leadership, the G7 need to not only go faster to set a global precedent but also create the right global signals for the transition to take off in other parts of the world, particularly emerging markets and developing economies.

How are we measuring progress?

Speed and cost-effectiveness guide our assumptions about technology mix

The Scorecard assumes that the most cost-effective low-carbon electricity and solutions that can be realistically deployed within this decade (by 2035) will dominate the power mix in G7 countries. The Scorecard therefore looks primarily at the pace and scope of variable renewable energy (VRE) capacity deployment and the policies that enable faster VRE integration in the power system.

Solar and wind have reached full market maturity and are more cost-competitive than any other low-carbon technology (and more cost-competitive than new



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fossil-based generation⁴). These technologies are prioritised in the Scorecard as they have the highest potential to transform the power systems at the speed needed and in a sustainable way, including addressing new electricity demand coming from electrification of end use across other sectors including heating, transport, and industry. Most prominent decarbonisation scenarios (IEA WEO, IRENA WETO, IEA G7 NZP2035) see these technologies growing significantly in the next ten years while the growth of other renewable capacity (hydropower, geothermal) and nuclear is limited.

G7 countries with a historically high share of low-carbon electricity derived from hydropower and nuclear power generation will have to focus primarily on enabling deployment of VRE technologies if they are to achieve fully net zero power systems by 2035. Not only is the capacity for growing nuclear and hydropower generation in these countries limited, the long lead times will also not get this new generation online in time for the 2035 target.

Focus on policies to adapt power systems to net zero

The IEA estimates an 80% growth in electricity demand in G7 countries by 2050 under a net zero emissions scenario, due to electrification of key sectors and additional capacity required for hydrogen production.⁵ All G7 countries are expected to rely on 50–100% VRE sources in their power mix in the long term, the rest largely covered by hydropower and nuclear. Even where the power mix is currently largely decarbonised (France, Canada), the share of VRE is expected to grow dramatically by 2035.

Systemic transformation is needed to secure the benefits of high shares of renewable electricity and to ensure reliability of generation, transmission, distribution and energy services. Benchmark 3 of the Scorecard therefore assesses policies in areas beyond renewables capacity, including flexibility, digitalisation, grid deployment and electrification of end use.

Reducing energy waste and boosting energy efficiency is another of the five benchmarks used in this Scorecard. Enhanced energy efficiency is crucial for making high levels of end use electrification feasible and affordable, and is therefore an enabler of net zero power systems by 2035.

⁴ IRENA, August 2023, **Renewable Power Generation Costs in 2022** (Report, accessed in May 2024)

⁵ IEA, October 2021, **Achieving Net Zero Electricity Sectors in G7 Members** (Report, accessed in May 2024)



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Approach to various non-renewable generation technologies

Some G7 countries rely on nuclear energy for large shares of their power generation. As a carbon-free source, nuclear has historically contributed to the decarbonisation of those countries' power systems, before the upscale and massive cost reduction of VRE technologies meant that they started to dominate new generation capacity additions worldwide.

The historic contribution of nuclear to power systems decarbonisation in the G7 countries is reflected in the Scorecard (indicators 1.3 and 1.4). Given that the existing nuclear pipeline in the G7 doesn't point to any significant growth within the group by 2035 (the new nuclear capacity in construction today in France, Japan, the UK and the US would add between 0.01% (US) and ~3% (UK) to the countries' existing capacity,⁶ while some of these plants are aimed at replacing the ageing existing nuclear fleet) it is not explicitly considered in the remainder of the scorecard.

Ambition to build new large-scale nuclear capacity beyond what's already in the pipeline is not relevant for 2035 ambition due to the very long lead times for nuclear projects. Any project not already in operation or under construction is unlikely to contribute to the 2035 net zero power systems target.

We consider the potential role of abatement⁷, H₂ to power and other "new/non-mature technologies", in particular in delivering the "last-mile" decarbonisation of power systems in the G7 countries. However, given the high costs, lack of demand signals and poor track record of applications such as CCS-equipped coal power, ammonia and H₂ co-firing, overreliance on these technologies in G7 countries' power systems decarbonisation policies is considered a liability and contributes to a poor scoring. Countries are considered as over-reliant on these technologies if they bet on high shares of CCS-equipped thermal generation by 2035 without a solid implementation plan and cost-effectiveness assessment, or if they plan to rely on ammonia or H₂ co-firing in the short term without a long-term plan to decarbonise the power mix by 2035.

⁶ Global Energy Monitor, October 2023, **Global nuclear power tracker**

⁷ For this iteration of the Scorecard, abated fossil fuel generation is defined in line with the definition put forward by the Intergovernmental Panel on Climate Change (IPCC): "fossil fuels produced and used with interventions that substantially reduce the amount of greenhouse gases emitted throughout the life cycle; for example, capturing 90% or more CO₂ from power plants, or 50–80% of fugitive methane emissions from energy supply". See IPCC, 2022, **Climate Change 2022: Mitigation of Climate Change. Summary for Policymakers**, p. 28).



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Clean (zero-carbon) H₂ as a storage medium and addition to power systems flexibility is considered in Benchmark 3 among other storage options.

The Scorecard structure

The Scorecard is divided into two main sections:

- > Section 1: Infrastructure/Energy mix reflects the current state of the power system in the G7 countries and makes up 30% of the available score. It comprises two benchmarks: Reducing fossil fuel reliance and Ramping up renewables, each contributing 15% to the total score.
- > Section 2: Policies/Targets reflects G7 countries' efforts to put the targets, policies and frameworks in place that should create enabling conditions for their power systems to reach net zero emissions by 2035. It makes up 70% of the total score and comprises three benchmarks: Adapting power systems to high RES share (30% of the total score); Governance / International leadership (20%); and Reducing energy waste (20%).

The benchmark weighting reflects their relative importance in the overall assessment. It ensures that the main focus of the Scorecard is on Section 2: Policies/Targets (Benchmarks 3,4,5). While the historic achievements of G7 countries towards decarbonising their power systems give them an important base, the scale and speed of the change needed within the next decade necessitates much more extensive policy action to enable not only the rollout of new capacity, but also all the measures required to facilitate the structural transformation of the power sector (grid deployment, end use flexibility, digitalisation, and so on).

Each benchmark is composed of a range of indicators, 32 in total.

Countries are scored against each indicator. The scores are combined to give overall scores for each benchmark, section and for the overall Scorecard.



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Section 1: Infrastructure/Energy mix

TOTAL SCORE 0–120

This section of the Scorecard reflects the current state of the power system in the G7 countries. It comprises two largely numerical benchmarks: Reducing fossil fuel reliance and Ramping up renewables.

The numerical indicators that reflect the share of different technologies in a country’s power generation (1.2, 1.3, 2.1, 2.2) do not imply that a certain share of generation must be met by any of these technologies. They merely reflect the current share of generation. Having said that, were a country to reach a net zero power mix, all these indicators would automatically be given the maximum score.

For example:

- > 2% nuclear generation in a country where the net zero target is not achieved = 0–1 points (reflects the current share of generation).
- > 2% nuclear generation in a country where the net zero target is achieved = 15 points (reflects the fact that, in the total net zero mix, 2% of nuclear generation is enough and no new nuclear is needed).

The scoring for Section 1 (benchmarks 1 and 2)

Indicator	Maximum score	Comments
Benchmark 1: Reducing fossil fuel reliance	60	0–20: Unacceptable 21–43: Insufficient 44–60: On track
1.1 New unabated coal and gas power plants in planning or construction	15	Unacceptable: 0 – new unabated coal in the pipeline Unacceptable: 1–4 – no new unabated coal but new unabated gas in the pipeline On track: 15 – no new unabated fossil fuel pipeline
1.2 Share in electricity generation: fossil fuels	15	>40% generation: 0–5 20–40% of generation: 6–10 <20% of generation: 11–15



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Indicator	Maximum score	Comments
1.3 Share in electricity generation: non-renewable low-carbon tech	15	Nuclear, abated coal and gas, H ₂ -powered power plants <20% of generation: 0–5 20–40% of generation: 6–10 >40% generation: 11–15
1.4 Carbon intensity of power index	15	>400 gCO ₂ e/kWh: 0–5 200–400 CO ₂ e/kWh: 6–10 <200 gCO ₂ e/kWh: ⁸ 11–15
Benchmark 2: Ramping up renewables	60	0–20: Unacceptable 21–43: Insufficient 44–60: On track
2.1 Share of variable RES in electricity generation	15	<20% of generation: 0–5 20–40% of generation: 6–10 >40% generation: 11–15
2.2 Share of other RES in electricity generation	15	Hydropower, geothermal power, bioenergy and other non-variable RES <20% of generation: 0–5 20–40% of generation: 6–10 >40% generation: 11–15
2.3 Variable RES pipeline capacity vs country’s announced target	15	Unacceptable: 0–5 – no target to match against, or the pipeline is significantly below announced target Insufficient: 6–10 – pipeline is below announced target On track: 11–15 – pipeline likely to deliver the announced RES target
2.4 Average permitting time for VRE ⁹	15	Unacceptable (>5 years): 0–5 Insufficient (3–5 years): 6–10 On track (<2 years): 11–15

⁸ Drawing on Ember’s **overview of carbon intensity worldwide**, where the global average is 480.7 gCO₂/kWh, and the OECD average (among which G7 should be leading on reducing CO₂ intensity of power) is 341.2 gCO₂/kWh

⁹ Ideally the timeframe should be the same for onshore and offshore RES. Where permitting times differed, scoring was based on the arithmetic average.



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Section 2: Policies/Targets

TOTAL SCORE 0–280

This section of the Scorecard reflects G7 countries' efforts to put the targets, policies and frameworks in place that should create enabling conditions for their power systems to reach net zero emissions by 2035. It comprises three benchmarks: Adapting power systems to high RES share; Governance / International leadership; and Reducing energy waste.

In this first iteration of the Scorecard, we assess the policies in a very simple way:

- > **Unacceptable:** no policy in place
- > **In development:** no policy in place but active discussions/consultations ongoing, or a white paper/policy draft existing.
- > **Insufficient:** policy adopted but doesn't address the problem/inhibits further progress
- > **On track:** effective policy announced and adopted.

The indicators reflecting targets (e.g. coal phase-out target) have three scoring categories:

- > **Unacceptable:** neither a target nor a trajectory towards reaching it
- > **Insufficient:** target/date adopted but no trajectory proposed to underpin delivery
- > **On track:** both target and implementation trajectory adopted

Similarly, the indicators reflecting G7 countries' global leadership have three scoring categories: unacceptable, insufficient, on track. For a detailed description of what these categories entail please refer to the individual indicators in the table below.

We recognise that the quality of the policies is often different between countries, and we will aim to enable a qualitative comparison across countries – as far as the national power system specific allows – in next year's iteration of the Scorecard.



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The Scorecard faces the additional challenge that there are both countries with centralised policymaking and countries where states/provinces have more authority (such as Canada and the US). This version of the scorecard primarily looks at central government efforts.

We are certain that it is possible to make the policy scores comparable across countries in the long term and aim to include this nuance in next year’s Scorecard.

The scoring for Section 2 (benchmarks 3–5)

Indicator	Maximum score	Comments
Benchmark 3: Adapting the power systems to high-RES share	120	0–40: Unacceptable 41–95: Insufficient 96–120: On track
3.1 Policies to limit curtailment to a minimum that ensures optimal RES capacity utilisation	15	No: 0 In development: 1–5 Insufficient: 6–11 On track: 12–15
3.2 Active steps by the national grid operator to plan for short spells of 100% RE power	15	No: 0 In development: 1–5 Insufficient: 6–11 On track: 12–15
3.3 Effective policies to ramp up electricity storage	15	No: 0 In development: 1–5 Insufficient: 6–11 On track: 12–15
3.4 Effective policies to increase end use flexibility	15	No: 0 In development: 1–5 Insufficient: 6–11 On track: 12–15
3.5 Effective policies to accelerate grid development	15	No: 0 In development: 1–5 Insufficient: 6–11 On track: 12–15
3.6 Effective policies to enable the required digitalisation of power systems	15	No: 0 In development: 1–5 Insufficient: 6–11 On track: 12–15



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Indicator	Maximum score	Comments
3.7 Effective mechanisms or frameworks to prevent preferential treatment for fossil fuel-based generation over RES on the market	15	No: 0 In development: 1–5 Insufficient: 6–11 On track: 12–15
3.8 Electrification rate target and roadmap to support delivery	15	No: 0 In development: 1–5 Insufficient: 6–11 On track: 12–15
Benchmark 4: Governance / International leadership	80	0–30: Unacceptable 31–64: Insufficient 65–80: On track
4.1 2035 carbon neutral power system commitment adopted in national legislation	10	No: 0 In development: 1–5 Insufficient: 6–9 On track: 10
4.2 Global leadership on supporting power systems decarbonisation in developing countries ¹⁰	10	Unacceptable: 0 – failed to contribute to global progress / actively inhibits global progress Insufficient: 1–6 – contributes to global progress but fails short of delivering what’s needed / what’s expected of the country given its overall role in the global economy and governance On track: 7–10 – shows strong delivery as a global partner
4.3 International commitments on power systems decarbonisation through alliances or networks such as the PPCA, Glasgow Coal to Clean Power Initiative etc.	10	Unacceptable: 0 – none of the global clean power alliances Insufficient: 1–6 – member of international initiatives supporting global targets (e.g. the 3×RES, 2×EE pledge), but not to alliances where they have to commit to national delivery (e.g. PPCA) On track: 7–10 – member of both international alliances supporting global targets and alliances where they have to commit to national delivery

¹⁰ Based on the overall expectations of a country as a global actor and its weight in the global economy as well as in the ability to shape global power systems decarbonisation.



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Indicator	Maximum score	Comments
4.4 Net zero power system roadmap to drive delivery of 2035 commitment	10	Unacceptable: 0 – no roadmap Insufficient: 1–6 – roadmap isn’t aligned with 2035 target / roadmap adopted only in parts of the country – for G7 countries with strong sub-national level entities On track: 7–10 – roadmap adopted and is aligned with 2035 target
4.5 Critical role of renewables, interconnection and demand side measures reflected in country’s energy security framework	10	Unacceptable: 0 – no Insufficient: 1–6 – only partially, e.g. role of RES deployment but not efficiency or flexibility On track: 7–10 – yes
4.6 Unabated coal phase-out date and roadmap to support delivery	10	No: 0 Insufficient: 5 On track: 10
4.7 Unabated gas phase-out date and roadmap to support delivery	10	No: 0 Insufficient: 5 On track: 10
4.8 2030 target for share of total RES in electricity generation	10	No: 0 Insufficient: 1–6 – there is a target but insufficient for the country to be at 80% clean electricity by 2030 On track: 7–10 – target amounts to 80% of RES in generation or, in countries with large share of non-RES low-carbon electricity, an equivalent of RES needed to reach 80% clean electricity by 2030 (e.g. with 20% nuclear expectation by 2030, RES must be at least 60%)
Benchmark 5: Reducing energy waste	80	0–30: Unacceptable 31–64: Insufficient 65–80: On track
5.1 Efficient policies to retrofit / renovate buildings	20	No: 0 In development: 1–10 Insufficient: 11–15 On track: 16–20
5.2 National energy / power savings target	20	No: 0 In development: 1–10 Insufficient: 11–15 On track: 16–20



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Indicator	Maximum score	Comments
5.3 Sufficient spending on energy efficiency programmes	20	No: 0 In development: 1–10 Insufficient: 11–15 On track: 16–20
5.4 High-quality appliance and equipment standards and labelling	20	No: 0 In development: 1–10 Insufficient: 11–15 On track: 16–20

Abbreviations

List of abbreviations used in the Scorecard and country profiles.

AB	Alberta (Canada)
ACER	Agency for the Cooperation of Energy Regulators (EU)
ADS	Association for Demand Response and Smart Grid (US)
AESO	Alberta Electric System Operator
ANRE	Agency for Natural Resources and Energy (part of METI, Japan)
APER	Renewable Energy Acceleration Law (France)
AZEC	Asia Zero Emissions Community
BC	British Columbia (Canada)
BEG	Federal Funding for Efficient Buildings (Germany)
BENEFIT	Buildings Energy Frontiers and Innovation Technologies (US)
BIL	Bipartisan Infrastructure Law (US)
BMWK	Federal Ministry for Economic Affairs and Climate Action (Germany)
BNetzA	Federal Network Agency (Germany)
BOGA	Beyond Oil and Gas Alliance
BSW	German Solar Industry Association
BVES	Energy Storage System Association (Germany)
CAISO	California’s Independent System Operator (US)
CC(US)	carbon capture (utilisation) and storage
CEC	California Energy Commission (US)
CfD	Contracts for Difference
CIP-ACT	Climate Investment Funds – Accelerating Coal Transition Program (Canada)
CPUC	California’s Public Utilities Commission (US)
DENA	German Energy Agency
DER	distributed energy resources
DoE	Department of Energy (US)
DPA	Defense Production Act (US)
DPE	Energy Performance Certificate (France; equivalent to EPC)
DRAI	Deep Retrofit Accelerator Initiative (Canada)



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DSM	demand side management
DSR	demand side response
DX	digital transformation
ECCE	Environment and Climate Change Canada
EE	energy efficiency
EED	Energy Efficiency Directive (EU)
EEG	Renewable Energy Sources Act (Germany)
EERS	Energy Efficiency Resource Standard (US)
EISA	Energy Independence and Security Act (US)
EnWG	Energy Industry Act (Germany)
EPA	Environmental Protection Agency (US)
EPBD	Energy Performance Buildings Directive (EU)
EPC	Energy Performance Certificate (EU/UK)
EPREL	European Product Registry for Energy Labelling
ERCOT	Electric Reliability Council of Texas (US)
ESO	electricity system operator
ESPR	Ecodesign for Sustainable Products Regulation (EU)
ETA	Energy Transition Accelerator (US)
ETC	Energy Transition Council
ETS	Emissions Trading System
EU	European Union
EV	electric vehicle
FERC	Federal Energy Regulatory Commission (US)
FIP	feed-in premium
FIT	feed-in tariff
G7	Group of Seven: Canada, France, Germany, Italy, Japan, UK, US
GBS	Green Buildings Strategy (Canada)
gCO ₂ /kWh	grams of carbon dioxide emitted per kilowatt hour of electricity generated
GDO	Grid Deployment Office (part of the DoE, US)
GEG	Buildings Energy Act (Germany)
GGI	Green Grids Initiative
GRIP	Grid Resilience and Innovation Partnership (US)
GW	gigawatt
GX	green transformation
H ₂	hydrogen
HVAC	high-voltage alternative current
IEA	International Energy Agency
IJA	Infrastructure Investment and Jobs Act (US)
IPG	International Partners Group
IRA	Inflation Reduction Act (US)
ISO-NE	System Operator New England (US)
ITC	Investment Tax Credit (US)
JETP	Just Energy Transition Partnership
KTF	Climate and Transformation Fund (Germany)
kWh	kilowatt hour
LDC	least developed countries



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LDES	long-duration energy storage
LNG	liquefied natural gas
MASCE	Electric Storage Capacity Procurement Mechanisms (Italy)
METI	Ministry of Economy, Trade and Industry (Japan)
MLF	Local Flexibility Markets (Italy)
MLIT	Ministry of Land Infrastructure and Tourism (Japan)
MoE	Ministry of Environment (Japan)
MoU	Memorandum of Understanding
MSA	Market Surveillance Administrator (Canada)
MSD	Ancillary Services Market (Italy)
Mtoe	million tons of oil equivalent
MW	megawatt
NABEG	Grid Expansion Acceleration Act for the Transmission Grid (Germany)
NDP	Network Development Plan
NECP	National Energy and Climate Plan
NEDRI	New England Demand Response Initiative (US)
NELEV	Electrotechnical Properties Verification Ordinance (Germany)
NEPA	National Environmental Policy Act (US)
NREL	National Renewable Energy Laboratory (US)
NWS	National Hydrogen Strategy (Germany)
OCCTO	Organisation for Cross-regional Coordination of Transmission Operators
OECD	Organisation for Economic Co-operation and Development
PLMA	Peak Load Management Alliance (US)
PPCA	Powering Past Coal Alliance
PPE	Programmations pluriannuelles de l'énergie / multiannual energy planning (France)
PREPAC	Programme for the Energy Requalification of Central Public Administration Buildings (Italy)
PV	photovoltaic
REC	Renewable Energy Certificate (US)
RES	renewable energy sources
RPS	renewable portfolio standard
RT2012	Thermal Regulations 2012 (France)
RTE	Réseau de transport d'électricité (TSO, France)
SACE	Italian Export Credit Agency
S3RenR	Regional grid plans (France)
SNBC	National Low-Carbon Strategy (France)
SREP	Smart Renewables and Electrification Pathways Program (Canada)
T&D	transmission and distribution
TOU	time of use
TSO	transmission system operator
UK	United Kingdom
ULO	Ultra-Low Overnight (price plan; Canada)
US	United States
UVAM	Virtual Mixed Aggregated Unit (Italy)
VRE	variable renewable energy



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About E3G

E3G is an independent climate change think tank with a global outlook. We work on the frontier of the climate landscape, tackling the barriers and advancing the solutions to a safe climate. Our goal is to translate climate politics, economics and policies into action.

E3G builds broad-based coalitions to deliver a safe climate, working closely with like-minded partners in government, politics, civil society, science, the media, public interest foundations and elsewhere to leverage change.

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