SDG 7: Affordable and Clean Energy

Policy Insights

By Marijn van Rees

Policy efforts currently fall short of all SDG 7 targets. Progress on clean cooking and renewable energy is lagging behind. Progress on electricity and energy efficiency is better, but more efforts are needed to meet the targets.[1] Based on the latest IPCC special report on the impacts of global warming of 1.5˚C, energy-related emissions need to be reduced by 3.5% annually until 2050 and continue thereafter.[2] The accelerated deployment of renewable energy, combined with increases in energy access and energy efficiency, can achieve 90% of the energy-related CO_2 emissions reductions needed to reach the well-below 2˚C aim of the Paris Agreement. Hence, energy access, renewable energy and energy efficiency are key components for a successful global energy transition. Although their importance is a generally agreed upon insight, the synergy between these targets is often overlooked by policy-makers. Solutions will therefore need to be further improved for long-term strategy development and policy-making purposes.[3]

Energy access

Achieving universal access by 2030 requires a fundamental paradigm shift.[4] However, there is no one-size-fits-all strategy for increasing access to electricity. The centralized power grid remains the primary means for electrification as it is the most cost-effective option. In recent decades, the increasing concentration of those without access and the continued challenges associated with extending the grid to remote locations has resulted in decentralized solutions with demand served by mini-grids and off-grid systems (box 1). Whereas mini-grids tend to be the most cost-effective solution for remote areas far from existing power grids with high population densities, off-grid solutions tend to be the most cost-effective for areas with low population densities. Although off-grid solutions make up the largest part, the role for mini-

[1] World Bank. (2019). *Tracking SDG 7: The Energy Progress Report 2019.* Washington: IEA, World Bank Group, IRENA, UNSD, WHO. p. 102. Retrieved 2019, from https://trackingsdg7.esmap.org/data/files/download-documents/2019-Tracking%20SDG7-Full%20Report.pdf. UN DESA. (2019). *The Sustainable Development Goals Report 2019.* pp. 36-37. Retrieved 2019, from United Nations Department of Economic and Social Affairs: https://unstats.un.org/sdgs/report/2019/The-Sustainable-Development-Goals-Report-2019.pdf.

[2] IPCC. (2018). *Special Report: Global Warming of 1.5˚C Summary for Policymakers.* Retrieved 2019, from Intergovernmental Panel on Climate Change: https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf.

[3] IRENA. (2019). *Global Energy Transformation: A Roadmap to 2050 (2019 Edition).* pp. 24-28. Retrieved 2019, from International Renewable Energy Agency: https://www.irena.org/publications/2019/Apr/Global-energy-transformation-A-roadmap-to-2050-2019Edition.

[4] Ibid. 1. World Bank. (2019). *Tracking SDG 7: The Energy Progress Report 2019.* p. 104.

grids is expected to increase. However, electricity demand will have to provide an acceptable return on investment for mini-grids to be viable. Hence, they need a supportive enabling environment, including a grid extension plan and a regulatory framework on how to integrate mini-grids.[5]

Box 1: pathways to electricity access

On-grids typically draw their power from centralized systems. They provide electricity to households through a connection to a local network (or through grid extension) that is linked to a transmission network. Decentralized systems consist of mini-grids and off-grid solutions as opposed to centralized systems. **Mini-grids** are an option in areas not served by main grids. They are localized power networks that provide electricity at a higher cost and require certain demand thresholds to justify the initial investment. Mini-grids can be scaled up in line with rising demand and eventually be connected to a centralized grid. **Off-grids** are stand-alone systems that are not connected to a centralized grid and typically power single households through solar home systems. They may be the most cost-effective option in sparsely populated and remote areas, yet the cost of stand-alone systems can be a barrier.[6]

Decentralized systems are thus an essential part of efforts to bring electricity access to under-served populations, yet they are not without challenges. First, they are typically more expensive than power grid extension. Secondly, they bring technical and maintenance challenges and need support in the form of capacity training and subsidies to support their deployment. Finally, the limited amount of energy supplied can make it difficult to deliver energy services, requiring additional capital investments. Affordability in particular remains a critical barrier to scaling up these solutions. Pay-As-You-Go (PAYG) models[7] that couple energy services and efficiency appliances may overcome these cost barriers. Governments can further help by lowering the cost through de-risking investment (for example with soft-loans) and streamlining regulations for where and how mini-grids can be deployed. Targeted subsidies also help with affordability.[8]

Access to clean cooking

The two least-cost solutions for providing access to clean cooking are Liquefied Petroleum Gas (LPG) for urban areas and improved biomass cookstoves for rural areas.[9] However, many of

[5] Ibid. 1. World Bank. (2019). *Tracking SDG 7: The Energy Progress Report 2019.* IEA. (2017). *Energy Access Outlook 2017: From Poverty to Prosperity.* pp. 44-45. Retrieved 2019, from International Energy Agency: https://www.iea.org/publications/freepublications/publication/WEO2017SpecialReport_EnergyAccessOutlook.pdf.

[6] Ibid. 5. IEA. (2017). *Energy Access Outlook 2017: From Poverty to Prosperity.* pp. 40-41.

[7] In a Pay-As-You-Go model, an energy company rents consumers a solar home system. Consumers use basic mobile phones to make payments on a daily, weekly or monthly basis. Through this model, customers get immediate access to basic electricity for small appliances such as lights, phones, radios or TVs without having to take out a loan to buy a solar home system. Energypedia. (2018). *Pay-as-you-go Approaches (PAYGO)*. Retrieved 2019, from Energypedia: https://energypedia.info/wiki/Pay-as-you-go_Approaches_(PAYGO).

[8] Ibid. 5. IEA. (2017). *Energy Access Outlook 2017.* pp. 46-47.

[9] Ibid. 1. World Bank. (2019). *Tracking SDG 7: The Energy Progress Report 2019.* p. 105.

the programmes aimed at mitigating the harmful effects of cooking with biomass have been less successful than anticipated, often because they have not taken sufficient account of cultural and affordability factors. First, no biomass cookstove currently on the market meets WHO standards for exposure to household or indoor air pollution. Only cookstoves that use fuels like LPG or electricity meet these standards. Secondly, even the cheapest improved cookstoves can cost a poor household several weeks of income. Finally, many households do not have access to alternative fuels. When they do, they may not use them for reasons of affordability as solid biomass is often free. However, there are some best practices that help deliver access to clean cooking. Governments could built on an evaluation of local needs and social characteristics to adapt stove and fuel type to local circumstances. Furthermore, people need to be informed of the benefits and importance of clean cooking, thereby contributing to increased awareness. If necessary, subsidies can be used to lower costs and boost adoption rates. Overall, the success or failure of these projects seem to depend on the design and circulation of improved cookstoves to local communities, together with the effective design and delivery of education on clean cooking.[10]

Renewable energy

Renewable energy plays an important role in achieving a sustainable energy sector as it is a cost-effective means to increase energy access and enable economic development. Renewable electricity is the most encouraging due to declining costs of wind and solar PV, making them more competitive. However, growing shares of Variable Renewable Energy (VRE) require new approaches to the design of the energy sector. Moreover, while growth in renewable electricity is encouraging, fossil fuels still account for the vast majority of electricity generation globally. A more rapid decarbonization of the electricity sector is thus needed. Furthermore, greater efforts are needed in the transport and heating and cooling (for buildings and industry) sectors. In particular, the use of renewables in transport and for heat in buildings and industry represents a significant opportunity to increase the share of renewables in Total Final Energy Consumption (TFEC).[11]

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[10] Ibid. 5. IEA. (2017). *Energy Access Outlook 2017.* pp. 63-66.

[11] Ibid. 1. World Bank. (2019). *Tracking SDG 7: The Energy Progress Report 2019.* pp. 106-108. UN DESA. (2019). *The Sustainable Development Goals Report 2019.* pp. 36-37. IRENA, IEA, REN21. (2018). *Renewable Energy Policies in a Time of Transition.* Retrieved 2019, from International Renewable Energy Agency (IRENA): https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Apr/IRENA_IEA_REN21_Policies_2018.pdf.

Box 2: Renewable energy concepts

Variable Renewable Energy captures renewable technologies that have a degree of daily or seasonal variability. The impact of this variability depends on the characteristics of the energy system.[12] **Feed-In Tariffs** (or FITs) and **Auctions** are a type of support mechanism for renewable energy technologies. FITs provide renewable energy producers with a fixed price for each unit of energy generated. FITs increase stability and allow for long-term planning which encourages investment. In the case of auctions, a government specifies the capacity (kW) or the electricity generation (kWh) and the generation technology which is up for auction. Project developers can submit their project proposal and stating the price per unit of electricity. The government evaluates the offers, selecting the best proposals that form the basis for **Power Purchasing Agreements (PPAs)**.[13] **Net-metering** is a system of **Distributed Power Generation** in which the electricity generated by consumers in a decentralized system is offset with the metered consumption. It allows private electricity producers to export surplus electricity from variable energy sources and use the exported electricity to balance-out deficit, allowing households or investors to meet their own electricity demand with their own production. **Net-billing** is based on the difference between the amount of electricity consumed and the amount produced. A household can usually carry over the surplus in electricity.[14]

Electricity sector

Regulatory and non-regulatory policies enable the translation of renewable energy targets into concrete actions. As to **regulatory** policies, quotas and obligations mandate that a percentage of electricity must be generated from renewables supported by tradable renewable certificates. However, while they help make the targets more binding, their effectiveness depends on a solid monitoring and enforcement framework. Power Purchase Agreements (PPAs), feed-in tariffs and auctions are useful to reflect the value of specific renewables (such as location and ability to generate at specific times) and enable real-price discovery based on external costs (see box 2). These instruments can be combined, typically auctions for large-scale and feed-in tariffs for small-scale installations, thereby improving integration of VRE into the system. Due to falling costs of renewable energy sources, distributed power generation can further complement the grid through the promotion of net-metering and net-billing, providing cost reductions to the end-consumer and the overall system. Decentralized solutions like mini-grids and off-grids are opportunities for providing electricity to previously underserved areas. Besides these options, thorium-based nuclear energy is an often overlooked but potentially important and viable way for generating long-term sustainable electricity (box 3). **Non-regulatory** policies also play an

[12] IEA. (2018). *20 Renewable Energy Policy Recommendations.* p. 20. Retrieved 2019, from International Energy Agency: https://webstore.iea.org/download/direct/2327?fileName=20_Renewable_Energy_Policy_Recommendations.pdf.
[13] Energypedia. (2018). *Renewable Energy Support Mechanisms: Feed-In Tariffs and Auctions*. Retrieved 2019, from Energypedia: https://energypedia.info/wiki/Renewable_Energy_Support_Mechanisms:_Feed-In_Tariffs_and_Auctions.
[14] Energypedia. (2018). *Net-Metering and Net-Billing*. Retrieved 2019, from Energypedia: https://energypedia.info/wiki/Net_Metering.

important role. Financial and fiscal instruments such as loans, grants, subsidies, tariffs and taxation, including for providing risk guarantees, can facilitate investments. This is needed at the early stages since the costs of initial deployment tend to be higher as investment is riskier.[15]

Box 3: Thorium and nuclear energy

Thorium has been considered an excellent nuclear energy alternative for decades as it offers a less dangerous and environmentally friendly path to electricity generation than uranium.[16] Thorium is a radioactive metal that is more abundant in nature than uranium and is fertile rather than fissile, meaning it cannot split to make a nuclear chain reaction like uranium. Furthermore, it can be converted into fissile material (uranium-233) through exposure to recycled fissile fuels such as uranium-235 and plutonium-239. This process creates energy and is self-sustaining as fission of uranium-233 turns more thorium into the same nuclear fuel.[17] Due to its self-sustaining properties, thorium fuel cycles result in lower levels of waste generation while offering energy security benefits, providing a diversification option for nuclear fuel supply.[18] Thorium works particularly well in combination with molten salt reactors, nuclear power plants that use liquid salt as primary coolant. They have many favourable characteristics for nuclear safety and sustainability. Molten salt reactors operate at higher temperatures, making them much more efficient in generating electricity. In addition, their low operating pressure can reduce the risk of coolant loss, which could otherwise result in an accident. Moreover, molten salt reactors conserve fuel resources and reduce the volume, radiotoxicity and lifetime of high-level radioactive waste.[19] In 2013, privately owned Norwegian company Thor Energy began using thorium to produce electricity at its Halden test reactor in Norway, showing that thorium can be considered a very important and potentially viable way of building credible, long-term nuclear energy scenarios.[20]

Heating and cooling sector

Renewable energy plays a key role in decarbonising and cleaning up heat supply. However, the heating and cooling sector is complex and fragmented, and generally less well understood than the electricity sector. As a result, policy-makers are primarily focussing their renewable energy

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[15] Ibid. 11. IRENA, IEA, REN21. (2018). *Renewable Energy Policies in a Time of Transition.* pp. 60, 75. Ibid. 12. IEA. (2018). *20 Renewable Energy Policy Recommendations.* pp. 18-22.

[16] IAEA. (2016). *CRP T12026 on Near Term and Promising Long Term Options for Deployment of Thorium Based Nuclear Energy (2011-2016)*. Retrieved 2019, from International Atomic Energy Agency: https://www.iaea.org/newscenter/news/crp-t12026-on-near-term-and-promising-long-term-options-for-deployment-of-thorium-based-nuclear-energy-2011-2016. It addresses how thorium fuel types may be deployed, and what hinders progress toward such goals with the objective to develop strategies for the timely deployment of thorium-based nuclear energy systems.

[17] WNA. (2017). *Thorium*. Retrieved 2019, from World Nuclear Association: http://www.world-nuclear.org/information-library/current-and-future-generation/thorium.aspx. THOR ENERGY. (2018). *Towards more Sustainable Nuclear Energy*. Retrieved 2019, from Thor Energy: http://thorenergy.no/.

[18] Ibid. 16. IAEA. (2016). *CRP T12026 on Near Term and Promising Long Term Options for Deployment of Thorium Based Nuclear Energy (2011-2016)*. Ibid. 17. WNA. (2017). *Thorium*.

[19] IAEA. (2016). *Molten Salt Reactors: IAEA to Establish New Platform for Collaboration*. Retrieved 2019, from International Atomic Energy Agency: https://www.iaea.org/newscenter/news/molten-salt-reactors-iaea-to-establish-new-platform-for-collaboration.

[20] Ibid. 18. IAEA. (2016). *CRP T12026 on Near Term and Promising Long Term Options for Deployment of Thorium Based Nuclear Energy (2011-2016)*. Ibid. 16. THOR ENERGY. (2018). *Towards more Sustainable Nuclear Energy*.

policies on the electricity sector. Still, heating and cooling is the most important energy end-use sector and is a significant contributor to global CO_2 emissions as it is primarily produced by fossil fuels. Progress in this domain can be slow due to high capital costs, low prices of and subsidies for fossil fuels, low building renovation rates and a slow turnover of efficiency appliances.[21] As solutions are often complex, policies need to be carefully designed. First, slow renovation rates and turnover of heating appliances in the building stock requires a long-term strategy for heat decarbonization. Secondly, policy instruments need to be combined that take into account local authorities since policy approaches vary from country to country due to differences in demand, infrastructure and other contextual factors. Thirdly, due to the difficulty for renewable heat options to compete with cheap fossil fuels, carbon and energy taxation are useful tools to address this issue. Finally, renewable heat and efficiency policies could be aligned more closely through the use of performance certificates to ensure that waste heat is minimised.[22]

District heating

Many countries with above-average climate-related demand for heat have extensive district heating networks that developed over time. District heating offers promising opportunities for integrating renewable and waste sources of heat. District heating can therefore be an enabler for renewables, and as such, policies that promote it can have a positive impact. A shift to renewables can be achieved through a variety of combined policy instruments. Energy and carbon taxes are an important driver in making fossil fuels uncompetitive with other sources who can be exempted from taxation. Furthermore, countries can deploy financial incentives such as feed-in tariffs and investment grants for individual renewable heat installations. Setting targets are important for the expansion of district heating, specifically for renewable heat or carbon reduction, whereas regulatory measures can put bans on fossil fuels for space heating. In addition, renewable heat could be coupled with high efficiency standards in new buildings.[23]

Transport sector

Transport is the second largest energy end-use sector and, like the heating and cooling sector, is almost entirely produced by fossil fuels. Decarbonizing the transport sector therefore involves a fundamental change in the nature and structure of transport demand, improvements in energy

[21] Ibid. 11. IRENA, IEA, REN21. (2018). *Renewable Energy Policies in a Time of Transition.* p. 26. Ibid. 12. IEA. (2018). *20 Renewable Energy Policy Recommendations.* p. 23.
[22] Ibid. 11. IRENA, IEA, REN21. (2018). *Renewable Energy Policies in a Time of Transition.* p. 37. Ibid. 12. IEA. (2018). *20 Renewable Energy Policy Recommendations.* pp. 24-25.
[23] Ibid. 11. IRENA, IEA, REN21. (2018). *Renewable Energy Policies in a Time of Transition.* pp. 28-30.

efficiency and changes in the energy mix. This requires policies that address three dimensions in an integrated way. First, the availability of both energy carriers and fuels[24] produced from renewable energy sources. Secondly, the deployment of vehicles that can use renewable energy fuels. Finally, the development of infrastructure for energy and fuel distribution. Governments could focus on policy instruments like financial de-risking measures and fiscal incentives such as carbon and energy taxes based on the life-cycle of GHG emissions. Furthermore, attention needs to be paid to strengthening low-carbon fuel and vehicle emission standards, setting quotas and obligations for the share of renewables in fuel, as well as implementing fossil fuel subsidy reform (box 4).[25]

Box 4: Fossil fuel subsidy reform

Given the high dependence of the building and transport sector on fossil fuel, fossil fuel subsidy reform is essential for decarbonizing these sectors. Subsidies are an important obstacle to delivering a sustainable energy system. However, despite repeated pledges to end fossil fuel subsidies, G7 countries continue to provide support for the production and consumption of fossil fuels. As a result, no G7 country has delivered on their fossil fuel phase-out commitment and continued to provide new public finance since 2016.[26] Fossil fuel subsidy reform and increasing investments in renewable energy and energy efficiency therefore remains essential. A so-called SWAP is where governments undergo fossil fuel subsidy reform and (re)allocate some of the resulting savings toward sustainable energy.[27] The Global Subsidies Initiative (GSI) has recommended two additional approaches to accelerate energy access. First, to completely remove or phase-out fossil fuel subsidies that have little or no potential for energy access. Secondly, to use targeted subsidies only to incentivize the use of technologies for which there is no short-term sustainable alternative, aimed at those who really need them, in particular poor households.[28] In this regard, the Overseas Development Institute (ODI) points out that governments should establish plans for fossil fuel subsidy phase-out, starting with key subsidies that have negative social and environmental impacts. As such, governments should ensure that subsidies related to energy transition do not support fossil fuels and that any remaining support is (re)allocated to facilitating a just transition and to vulnerable communities and households.[29]

[24] Any system or substance that contains energy for conversion as usable energy at a different time and place. ISO. (2018). *ISO 13600: Technical Energy Systems - Basic Concepts*. Retrieved 2019, from International Organization for Standardization: https://www.iso.org/obp/ui/#iso:std:iso:13600:ed-1:v1:en.

[25] Ibid. 11. IRENA, IEA, REN21. (2018). *Renewable Energy Policies in a Time of Transition.* pp. 44, 54-55. Ibid. 12. IEA. (2018). *20 Renewable Energy Policy Recommendations.* pp. 27-28.

[26] ODI. (2018). *G7 Fossil Fuel Subsidy Scorecard: Tracking the Phase-Out of Fiscal Support and Public Finance for Oil, Gas and Coal.* p. 2. Retrieved 2019, from Overseas Development Institute: https://www.odi.org/sites/odi.org.uk/files/resource-documents/12222.pdf.

[27] NCM. (2017). *Making the Switch: From Fossil Fuel Subsidies to Sustainable Energy.* p. 9. Retrieved 2019, from Nordic Council of Ministers: http://norden.diva-portal.org/smash/get/diva2:1094676/FULLTEXT02.pdf.

[28] IISD/GSI. (2018). *Getting on Target: Accelerating Energy Access through Fossil Fuel Subsidy Reform.* p. vi. Retrieved 2019, from International Institute for Sustainable Development / Global Subsidies Initiative: https://www.iisd.org/sites/default/files/publications/getting-target-accelerating-energy-access.pdf.

[29] Ibid. 22. ODI. (2018). *G7 Fossil Fuel Subsidy Scorecard: Tracking the Phase-Out of Fiscal Support and Public Finance for Oil, Gas and Coal*. p. 2.

Currently, the principle options for using renewable energy in the transport sector involve the use of biofuels and renewable electricity. While biofuels can play a useful role, they require careful policy development that takes into account potential land-use and sustainability impacts. Policies therefore need to promote a shift to advanced biofuels over time. Advanced biofuels are derived from waste and residue materials that have little or no GHG emissions. Combining low-level blends with conventional energy infrastructure and vehicle fleets, advanced biofuels can power the existing transport system. However, high-level blends are necessary for deep decarbonization, requiring adjustments in vehicle engines and fuel distribution infrastructure. Governments could introduce specific mandates for advanced biofuels and put in place direct financial incentives, coupled with the imposition of carbon taxes on fuels based on their GHG emissions. Given the high investment costs of adjusting engines and infrastructure, financial de-risking measures such as soft loans are also important. Electric vehicles may play a crucial role as well, although they are only truly clean when operating on electricity that is produced from renewable sources. In this respect, governments could make sure that the electrification of transport is integrated with measures that stimulate the use of renewable electricity. Hence, it requires long-term policy planning combining electric mobility with renewable electricity production and distribution while considering measures that stimulate the use of renewable electricity.[30]

Energy efficiency

Government policies are essential for realizing improved energy efficiency across the major end-use sectors (building, industry, transport). The energy intensity improvement rate will need to increase from 1.7% (in 2018) to 3.2% annually. However, only one-third of global energy consumption is currently covered by mandatory efficiency codes and standards.[31] Setting goals and targets is thus an important way of keeping focus on improving energy efficiency, energy intensity being the most commonly used benchmark. Energy efficiency requires a broad range of efficiency measures across all end-uses. In many respects, the types of solutions needed are well-known, generally consisting of both regulatory and non-regulatory policies. In terms of **regulatory** policies, quotas and obligations such as Minimum Energy Performance Standards

[30] Ibid. 11. IRENA, IEA, REN21. (2018). *Renewable Energy Policies in a Time of Transition.* pp. 45-48. Ibid. 12. IEA. (2018). *20 Renewable Energy Policy Recommendations.* pp. 29-30.

[31] Ibid. 1. World Bank. (2019). *Tracking SDG 7: The Energy Progress Report 2019.* p. 112. IRENA. (2019). *Global Energy Transformation: A Roadmap to 2050 (2019 Edition).* p. 25. UN DESA. (2019). *The Sustainable Development Goals Report 2019.* pp. 36-37.

(MEPS) are important instruments for increasing energy efficiency. Information programmes can raise public awareness and provide the infrastructure for incentives aimed at increasing the uptake of the most efficient products and services. **Non-regulatory** policies play an equally important role. Financial and fiscal instruments such as loans, grants, subsidies, tariffs and taxation can be used to penalise inefficient goods and services and to provide advantages on more favourable or efficient products. In addition, as energy prices influence investment and consumer behaviour, measures will need to be supported by prices that reflect the true cost of production, including external costs associated with GHG emissions and the removal of fossil fuel subsidies.[32]

Building sector

Two-thirds of the energy consumed in the building sector is not covered by energy efficiency standards. While many countries have implemented building codes and standards, achieving efficiency requires codes to be strengthened and expanded to cover new and existing buildings. Minimum Energy Performance Standards (MEPS) for key equipment not currently covered, such as electric heat pumps and air conditioners, also need to be strengthened and expanded.[33]

Building space and equipment

Building codes and performance standards are necessary measures for the construction of new buildings. Importantly, failure to tackle the thermal properties in building envelopes at the time of construction risks the loss of a significant proportion of the most cost-effective potential. This means that policy-makers need to prioritise the coverage of building codes and standards and strengthen them towards near-zero emissions. While renovating the *existing* building stock is key to achieve energy efficiency, codes and performance standards have a more limited role to play. Financial support and fiscal measures could therefore be employed to drive renovations, accompanied by training and accreditation schemes for consistency and quality.[34] The main policy approach for delivering more efficient equipment could be to set performance standards

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[32] IEA. (2018). *Perspectives for the Energy Transition: The Role of Energy Efficiency.* pp. 82-88. Retrieved 2019, from International Energy Agency: https://www.iea.org/publications/freepublications/publication/Perspectives%20for%20the%20Energy%20Transition%20-%20The%20Role%20of%20Energy%20Efficiency.pdf. Ibid. 1. World Bank. (2019). *Tracking SDG 7: The Energy Progress Report 2019.* p. 112.

[33] Ibid. 1. World Bank. (2019). *Tracking SDG 7: The Energy Progress Report 2019.* p. 112. Energy end-use in the building sector consists of two categories. Heating and cooling appliances for building space are installed during construction or renovation and are long-lived types of equipment that typically remain with the building. Lighting and appliances (including cooking and office equipment) are installed by the owners or tenants and resemble short-lived technologies that can be readily upgraded. Ibid. 36. IEA. (2018). *Perspectives for the Energy Transition: The Role of Energy Efficiency.* pp. 88-89.

[34] Ibid. 1. World Bank. (2019). *Tracking SDG 7: The Energy Progress Report 2019.* p. 112. Ibid. 31. IEA. (2018). *Perspectives for the Energy Transition: The Role of Energy Efficiency.* pp. 89-92.

supported by energy labels. These can be very effective instruments for improving efficiency of new lighting and appliances. The main challenges lie in setting standards at a sufficiently stringent level and ensuring compliance. Importantly, beginning with policy intervention early in the supply chain (for example at the point of manufacture) is more cost-effective than forcing early replacement. Other approaches may include the provision of information to promote the best available equipment and practices, as well as funding the installation of new equipment.[35]

Industry sector

In the industry sector, policy efforts should focus on increasing the adoption and strengthening of Energy Management Systems (EMS).[36] This includes improving the efficiency of industrial equipment and shifting industrial activity as a whole towards less energy-intensive production routes. Improving materials efficiency is an additional step that can enable a shift in industrial activity.[37]

Equipment en production routes

The adoption and strengthening of MEPS for electric motors within a well-designed EMS is an important policy measure. This may include financial support for Energy Service Companies (ESCOs) who can facilitate more widespread adoption. Importantly, industry could increase the installation of Variable Speed Drives (VSDs) which allow motor electricity demand to be varied depending on the service provided. Furthermore, gains can be made through improved design, maintenance and efficiency of end-use devices. In addition, increased adoption of electric heat pumps as an alternative to gas- or oil-fired boilers can improve efficiency and reduce GHG emissions. Hence, with the support from ESCOs, installing VSDs and heat pumps for electric motors are opportunities for industrial efficiency that can be replicated at scale.[38] Furthermore, improvements in resource efficiency can also be an important driver. In contrast to primary production routes, secondary production routes (production from scrap or waste products) are less energy-intensive. However, their use is limited by the availability of recyclable products.

[35] Ibid. 32. IEA. (2018). *Perspectives for the Energy Transition: The Role of Energy Efficiency.* pp. 92-95. IEA. (2018). *Energy Efficiency 2018: Analysis and Outlooks to 2040.* pp. 81-95. Retrieved 2019, from International Energy Agency: https://webstore.iea.org/download/direct/2369?fileName=Market_Report_Series_Energy_Efficiency_2018.pdf.

[36] Energy Management Systems (EMS) provide the procedures and practices for an industrial firm to ensure the systematic planning, analysis, control and monitoring of energy use in order to improve efficiency. Since 2011, the global EMS standard is ISO 50001. Regulations provide the most likely degree of certainty that an EMS will be implemented. However, without incentives to go beyond formal legal requirements, regulatory policies can see focus switch to minimum compliance rather than the improvements needed in energy efficiency. ISO. (2018). *ISO 50001: Energy Management Systems*. Retrieved 2019, from International Organization for Standardization: https://www.iso.org/standard/69426.html.

[37] Ibid. 1. World Bank. (2019). *Tracking SDG 7: The Energy Progress Report 2019.* p. 112. Ibid. 32. IEA. (2018). *Perspectives for the Energy Transition: The Role of Energy Efficiency.* p. 96.

[38] Ibid. 32. IEA. (2018). *Perspectives for the Energy Transition: The Role of Energy Efficiency.* pp. 97-99.

Policy-makers could therefore aim at increasing scrap collection and recycling rates that contribute to less energy-intensive production. The consumption of recycled products can be encouraged through labelling or setting standards as it increases demand. Improvements in materials efficiency can further contribute to resource efficiency by using improved product designs, thereby reducing raw material input and thus limiting energy-intensive production routes.[39]

Box 5: CO_2-Methane reforming and biomass

Capturing and reforming CO_2 for the production of methane is a cost-effective way to limit GHG emissions that builds upon the existing natural gas infrastructure. Methane can be used not only as a combustible fuel but also as a means to store surpluses of renewable energy such as wind and solar as it can be used to produce new energy carriers suitable for such storage.[40] However, this solution is not without challenges. First, using methane to store renewable energy sources is still expensive. Secondly, it may be important that CO_2 originates from biomass (such as plants and trees who absorb CO_2) so as to prevent further emissions into the atmosphere, thereby enabling CO_2 to be naturally recycled. However, the use of biomass is limited with regard to land-use and sustainability considerations. Therefore, advanced forms of biomass (such as scrap or waste products) should be considered and preferably be used only where there are no or limited sustainable alternatives available.[41] Thirdly, reformed CO_2 may need to be kept in a close circuit, for example circulating between industry (sectors such as chemicals, steel, paper and food who are large emitters of CO_2) and power plants, rather than using it for households through the existing pipeline infrastructure (where it gets emitted again in the atmosphere). Despite these challenges, CO_2-reforming is considered an important and promising solution in switching from fossil-based fuels to sustainable energy.[42]

Transport sector

A series of policy measures are needed to bring forward efficiency improvements across the various modes of transport. Policy-makers could focus on efficiency standards for cars and trucks, incentives for electrification and global targets and measures for aviation and shipping as important policy tools. Furthermore, consumers and fleet managers need to be well-informed on running costs and efficiency to support efficient vehicle uptake. Financial incentives can

[39] Ibid. 32. IEA. (2018). *Perspectives for the Energy Transition: The Role of Energy Efficiency.* pp. 99-101. Ibid. 35. IEA. (2018). *Energy Efficiency 2018: Analysis and Outlooks to 2040.* pp. 99-117.

[40] Aan de Brugh, M. (2019, March 11). *Nieuwe Energieopslag met Oude Chemie*. Retrieved 2019, from NRC: https://www.nrc.nl/nieuws/2019/03/11/nieuwe-energieopslag-met-oude-chemie-a3952821.

[41] ECN-TNO. (2018). *Making Industrial Heat Management More Sustainable*. Retrieved 2019, from ECN-TNO: https://www.tno.nl/en/focus-areas/ecn-part-of-tno/roadmaps/towards-co2-neutral-industry/making-industrial-heat-management-more-sutainable/. ECN-TNO. (2018). *Biomass & Energy Efficiency*. Retrieved 2019, from ECN-TNO: https://www.tno.nl/en/focus-areas/ecn-part-of-tno/expertise/biomass-energy-efficiency/.

[42] Kragten, T. (2019, March 11). *Broeikasgas kan ook nuttig zijn, stellen wetenschappers: zet CO2 om in gas voor je fornuis*. Retrieved 2019, from De Volkskrant: https://www.volkskrant.nl/wetenschap/broeikasgas-kan-ook-nuttig-zijn-stellen-wetenschappers-zet-co2-om-in-gas-voor-je-fornuis~bc008322/?referer=https%3A%2F%2Fwww.google.nl%2F.

further stimulate a switch to higher efficiency options at the point of purchase or lease and operation.[43]

Road and non-road transport

To improve efficiency for both Light Duty Vehicles (LDVs: passenger cars, light trucks) and Heavy Duty Vehicles (HDVs: trucks, freights), the key policy tool is fuel efficiency standards coupled with energy labelling and zero-emission mandates. For LDVs these policy measures could be supported by information on the running costs of cars, for example by energy labels, and by supporting public transportation. As to HDVs, while differentiated vehicle taxation can have a role in improving efficiency, low-interest loans may be more suitable to stimulate the purchase of more efficient trucks and freights. Wider logistical measures will also be needed such as appropriate infrastructure and restricting access to urban areas based on vehicle GHG emissions.[44] Public procurement to support electric vehicle competitiveness, as well as the construction of electric road systems, may be a longer-term option but is not yet viable as electricity production is primarily still dependent on fossil fuels. Non-road transport generally consists of aviation, rail and shipping. Increasing the efficiency in these sectors represents a significant challenge for policy-makers. This is largely due to their transnational nature and participation in international agreements, which may limit the scope for action of national governments. Generally, policies could aim at improving performance standards, codes and information; at including national governments in international agreements not currently participating; and reducing dependency on traditional biofuels and carbon offsetting schemes.[45]

Conclusions

Policy efforts currently fall short of all SDG 7 targets. Solutions therefore need to be further improved if the world is to achieve a modern, affordable and sustainable energy sector for all. This will require policy-makers to show greater commitment to scaling-up sustainable energy policies and financing, as well as the willingness to embrace new technologies. While energy access, renewable energy and energy efficiency are key components for a successful energy transition, policy-makers need to take into consideration the synergy between these targets and

[43] Ibid. 1. World Bank. (2019). *Tracking SDG 7: The Energy Progress Report 2019.* p. 112. Ibid. 32. IEA. (2018). *Perspectives for the Energy Transition: The Role of Energy Efficiency.* p. 102.
[44] Ibid. 32. IEA. (2018). *Perspectives for the Energy Transition: The Role of Energy Efficiency.* pp. 103-107.
[45] Ibid. 32. IEA. (2018). *Perspectives for the Energy Transition: The Role of Energy Efficiency.* pp. 107-108. Ibid. 35. IEA. (2018). *Energy Efficiency 2018: Analysis and Outlooks to 2040.* pp. 51-72.

the needs of local communities. This overview attempts to identify several regulatory and non-regulatory policy measures across the major end-use sectors needed to achieve SDG 7 by 2030.