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Morocco's Decarbonization Pathway - Part IV:
Policy Recommendations[1]

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I. Introduction

As decarbonization is a long-term process and requires significant investments, specific financial and non-financial measures will need to be implemented, both in the short and long term, to facilitate this transition.

In Part II of Morocco's decarbonization pathway Policy Brief series, an update of the decarbonization scenarios was presented. It revealed that the Increased Ambition and Green Development scenarios achieve higher decarbonization targets than current policy. It showed that decarbonization targets will be achieved mainly through extensive electrification of end sectors and increasing renewable energy sources in the generation mix. Specifically, transportation, power generation, and the residential sector will be key sectors for decarbonizing Morocco's energy consumption.

In Part III of the aforementioned Policy Brief series, a cost-benefit analysis of this transition was conducted. This brief argues that this shift will generate full economic benefits in the hundreds of billions of dollars, even with the additional capital expenditures needed to modernize the sectors covered, namely the transport, residential, industry and services, agriculture, and power sectors.

Achieving this vision and reducing decarbonization costs will therefore require some incentives for the five sectors covered. In this sense, Part IV will address the remaining barriers to energy transition in each sector and propose short and long-term recommendations to support decarbonization, including financial and non-financial policy measures while considering distributional concerns and impacts.

II. Policy Recommendations

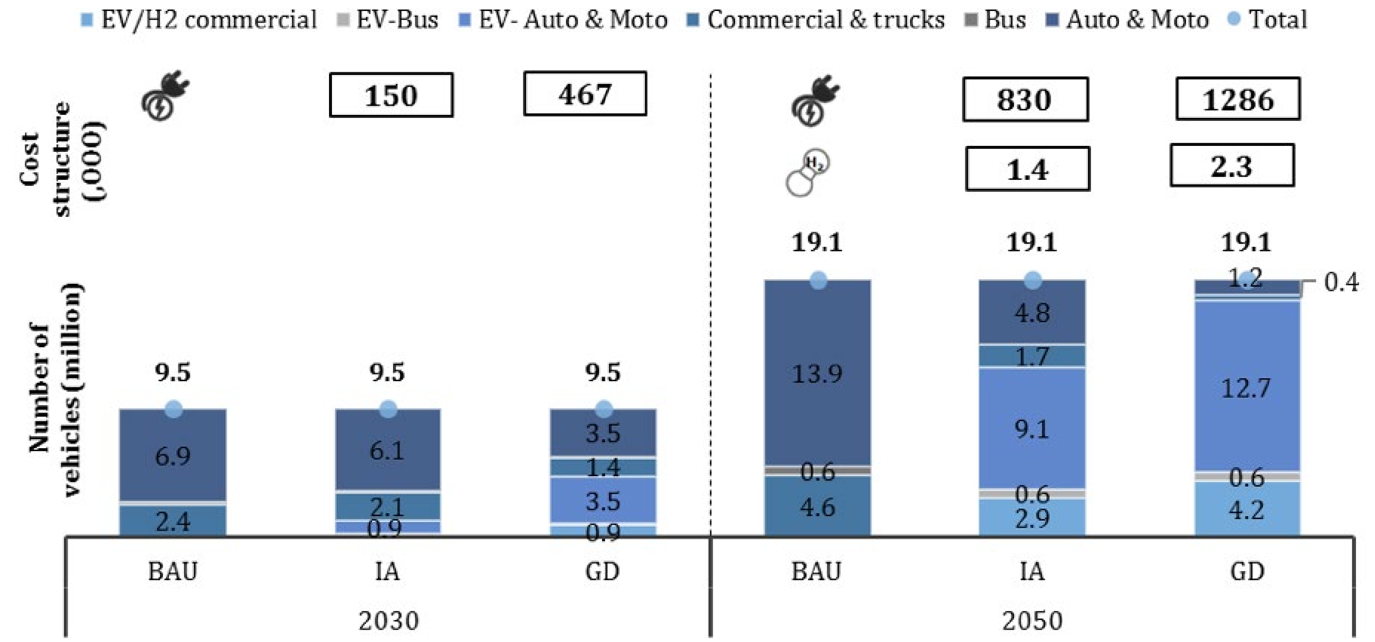
1. Transport Sector

Part II and III of Morocco's Decarbonization Pathway Policy Brief series indicate that the transport sector is

1. The technical component of the study pertaining to modeling was carried out by AFRY, under the strategic and policy directions of the Policy Center for the New South and Enel Green Power Morocco. The study was conducted in 2020, prior to the release, in June 2021, of Morocco's new Nationally Determined Contribution (NDC). Therefore, the NDCs in this study refer to those of 2016.

critical to decarbonizing Morocco's energy consumption. It shows that decarbonizing the transport sector is practical because it leads to lower total economic costs compared to the Business as Usual (BAU) scenario, thus generating net benefits. Decarbonizing the transport sector will be possible through electrification, diesel and gasoline phase-out, and hydrogen technology. However, several barriers must be overcome in order to achieve the ambitious penetration rate for electric vehicles (EVs) and unlock these benefits. The deployment of EVs is therefore expected to be gradual (Figure 1). In the medium term, by 2030, EVs will account for only 11% of the vehicle fleet in the Increased Ambition scenario and 47% of the total vehicle fleet in the Green Development scenario. In the long term, by 2050, the share of EVs will increase significantly and represent 66% and 92% of the vehicle fleet in the Increased Ambition and Green Development scenarios respectively.

Figure 1 : Number and Breakdown of Vehicle Fleet by 2030 and 2050



Source: Authors' calculations. Note: BAU: Business as usual. IA: Increased Ambition. GD: green Development.

The technology switch from fossil-fueled mobility to electric mobility is hindered by four types of barriers:

- Economic: EVs have higher upfront costs compared to internal combustion engines (ICE), which leads to higher investments to be sustained by the private sector;
- Technical: Electric mobility development is strictly dependent on Battery Energy Storage Systems (BESS) technology cost improvement and charging infrastructure development;
- Managerial: Procurement and tendering models typically focus on upfront costs without taking into account the whole cost structure and benefits of EVs;
- Financing: Uncertainties about long-term performance of BESS and a market that is not mature can limit the attractiveness of EVs for public and private investors.

Policy measures must therefore be identified to mitigate these barriers. EVs need to be supported with financial incentives and the development of an appropriate value chain, with specific actions for the short and long term (Figure 2).

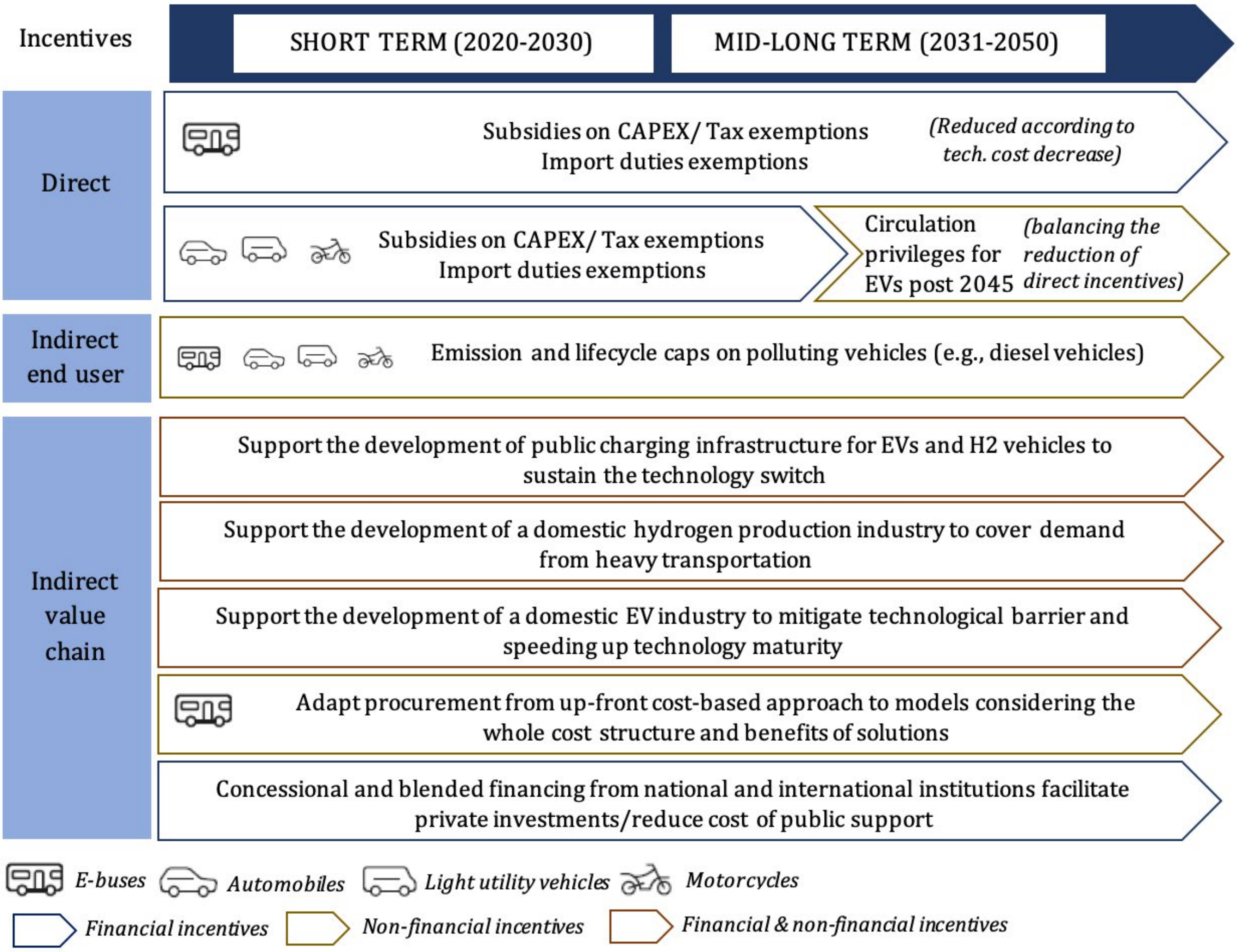
1.1. In the Short Term (2020-2030)

In the short term, significant financial incentives will be needed to cover the higher initial cost of EVs, particularly for electric buses (e-buses) (Figure 2). Assuming that EVs will be introduced from 2025 onwards to replace fossil-fuel vehicles and meet EV penetration targets, a combination of policies to phase out polluting vehicles and gradually introduce low-carbon technologies should then be implemented. These policies can take the form of either: (i) indirect incentives, such as emission and life-cycle caps for polluting vehicles (e.g., diesel); or (ii) direct financial incentives to reduce the higher upfront investment costs of EVs and stimulate private sector purchases through measures such as:

- Subsidies for capex or tax exemptions, in the form of reduced VAT and corporate income tax or exemption from annual vehicle tax and registration fees;
- Import duty exemptions[2] on vehicles and components. However, these aspects can generate technological dependence until the development of a domestic market.

Direct financial incentives will be needed in particular for e-buses, as this technology must close the levelized cost of energy (LCOE) gap with diesel buses, which have effectively lower direct system costs. If we recall Morocco's Decarbonization Pathway Part III[3], e-buses were the only technology that experienced an increase in total direct system cost over the 2020-2050 period, making diesel or gasoline buses more attractive over the period in question due to a lower LCOE if no incentives for electric technology are provided. Furthermore, to support transition to EVs, an appropriate charging infrastructure will also need to be developed, starting with public charging stations.

Figure 2: Short and Long-Term Policy Incentives to Mitigate Barriers to Electric Mobility



Source: Authors.

2. Import duty exemptions can be adopted until a domestic market has developed.

3. Berahab Rim, Chami Abdelilah, Derj Atar, Hammi Ibtissem, Morazzo Mariano, Naciri Yassine, Zarkik Afaf, with the technical support of AFRY. 2021. Morocco's Decarbonization Pathway - Part III: The Costs and Benefits of the Energy Transition, Policy Center for the New South, Enel Green Power, July 2021.

1.2. In the Mid-Long Term (2031-2050)

In the mid-long term, direct financial incentives for EVs can be replaced by indirect incentives, while e-buses will still require financial support (Figure 2). Over the period 2031-2050, the initial cost of EVs is expected to become even lower due to lower technology costs. Direct investment incentives for EVs (Auto, Motorcycle, LUV) can then be replaced by indirect incentives, such as driving privileges (special driving lanes, preferential or free parking, and waiving of toll fees). While e-buses will achieve an LCOE close to that of ICE technology, the initial investment cost will remain higher (up to +$100 k/vehicle)[4]. Continued subsidies on the CAPEX with reduced values as the cost of the technology decreases and continued exemptions from import duties if a domestic market has not developed will have to continue.

From 2035 onwards, heavy hydrogen mobility is expected to replace heavy diesel trucks. By that time, H2 technology would be already advantageous in terms of LCOE and initial investment costs, and no direct financial support would be needed. However, specific policy measures must be put in place to stimulate the development of a domestic hydrogen industry. Charging infrastructure development should be supported on an ongoing basis and extended to hydrogen charging stations.

1.3. Additional Policies

In addition to short and long-term measures, further policies will be needed to mitigate the barriers to e-mobility and develop the value chain through indirect incentives, especially for e-buses.

On the technology side, the main drivers for the development of e-mobility (especially e-buses) are the improvement of technology costs, both for vehicles and charging infrastructure, and the identification of technical standards. However, technological dependence on China and Europe for e-buses slows down technological expertise on components and associated maintenance. Thus, a national industry could foster the adoption of e-mobility by facilitating the monitoring of technological maturity and accelerating the improvement of costs and skills. Achieving this will then require the creation of a domestic market through a foreign manufacturer, e.g., through in-kind incentives, as well as R&D subsidies to foster technological improvement and identify the best technical standards and business models (e.g., smart charging).

4. Upfront cost increases up to 200 k$ if we consider also battery replacement during the bus lifetime. as done in the LCOE calculation.

On the procurement and management side, most procurement and tendering models favor a low-cost, low-risk approach, focusing on the upfront cost of solutions. However, technological change will require the allocation of responsibilities among many actors along the value chain. Therefore, procurement models should be adapted to take into account the full cost and benefit structure of the assets and assign responsibilities for the new tasks that arise from e-mobility business models, namely:

- BESS maintenance and replacement for public e-buses;
- Development and operation of the network infrastructure (e.g., public or private development and operation).

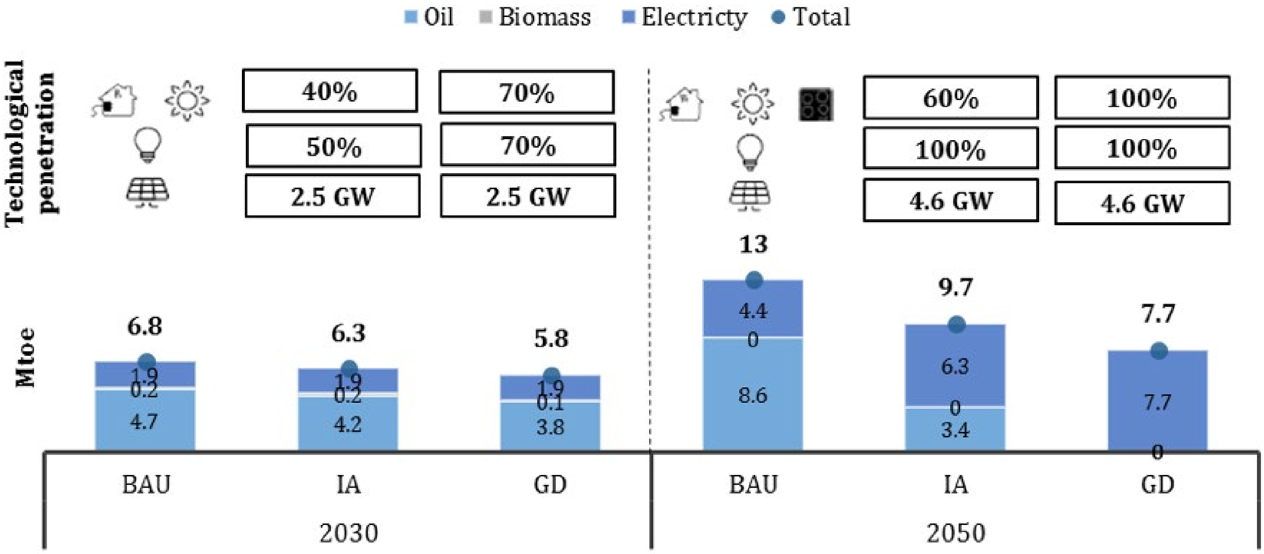
On the financial side, the e-mobility sector is characterized by high initial investment costs, both for vehicles and for charging infrastructure. Uncertainties about the long-term performance of BESS and an emerging market without economies of scale may, however, represent a barrier for investors. Concessional and blended financing from national and international banks and development agencies can therefore be used to facilitate private investment and reduce the cost of public support. Such financing can take the form of lower than market interest rates, longer terms and grace periods and subsidies for investments.

2. Residential Sector

For Moroccan households, electrification of heat and cooking appliances is centered around the adoption of electric appliances: heat pumps for space heating, solar thermal for water heating and induction cooktops, instead of liquefied petroleum gas (LPG) boilers and stoves. Reaching the transition goals by mid-century will require mass mobilization of markets and households, with different penetration rates depending on the defined scenario. However, this technology switch is hindered by an economic barrier since electric technologies have higher upfront and commodity costs. Fossil fuel technologies are made even more convenient by the current butane subsidy. Reaching electrification targets will also require replacing all or some of the existing appliances in 8.2 million Moroccan households (as of 2019)[5]. Policy measures must be identified to mitigate these economic barriers from proper distributional and budget perspectives (Figure 3).

5. Source: Euromonitor International, 2019.

Figure 3 : Residential Energy Consumption by 2030 and 2050



Source: Authors' calculations. Technological penetration on final demand.

A hybrid approach combining economic and regulatory policies in the short (2020-2030) and long term (2031-2050) is explored (Figure 4).

2.1. In the Short Term (2020-2030)

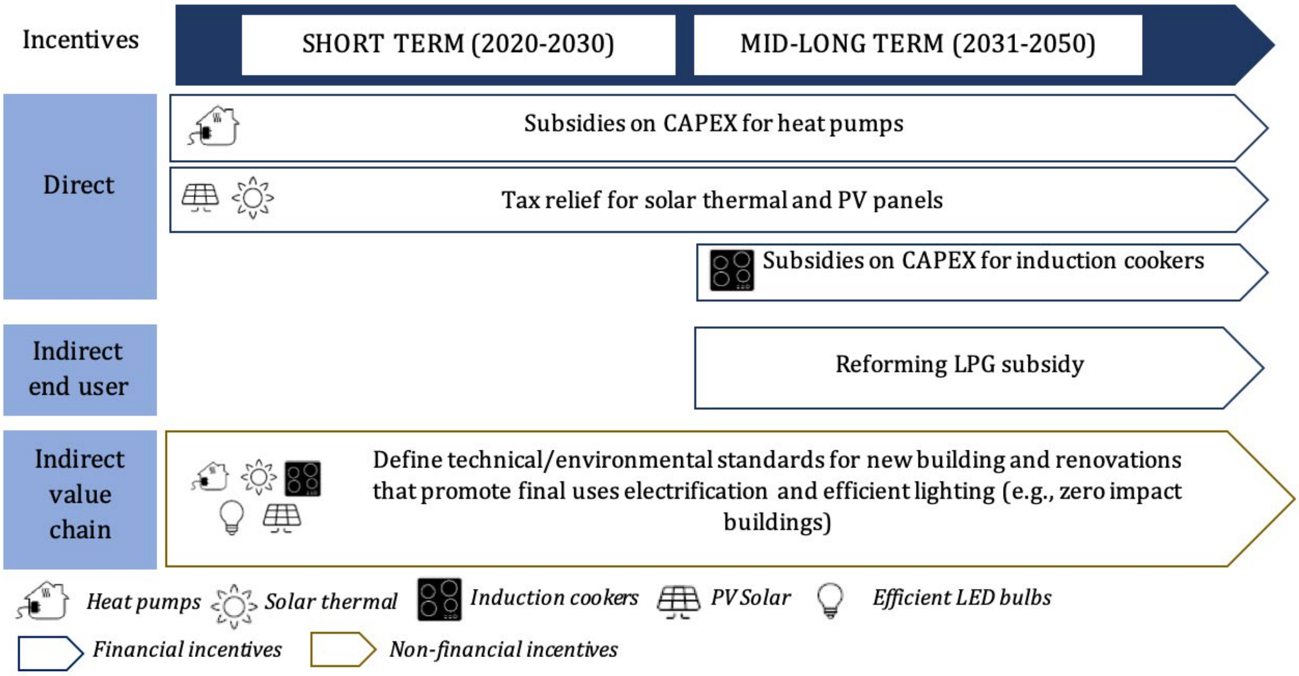
In the short term, economic incentives (subsidies and tax breaks) are strategic in correcting consumers' behavior, while traditional regulatory approaches (defining technology and environmental standards for new buildings and renovations) will also help foster the technology switch. Economic policy measures must be aimed at reducing the LCOE of the low carbon configuration up to the point of reaching LPG appliances' value (considering LPG subsidies). Direct financial incentives are needed to fill the gap with boilers' LCOE and to reduce the purchasing price through subsidies on CAPEX for heat pumps and a tax relief scheme for solar thermal panels, in order not to burden the final users with increased costs. Maintaining LPG subsidies in the short term and LPG stoves, will deter distributional effects and social unrest from the transitional shock, even if financial support will make the low carbon configuration attractive.

2.2. In the Mid-Long Term (2031-2050)

In the mid-long term (2030-2050), economic incentives on CAPEX for heat pumps and solar thermal power must be maintained to keep the cost of heating and domestic hot water (DHW) for the private sector at the same level as the previous LPG subsidized configuration. From 2040 onwards, direct financial incentives must be extended to include induction cookers and should be complemented with a butane subsidy reform and proper financial incentives in the form of subsidies, tax relief, and an LPG subsidy phase out[6]. Similarly, financial incentives need to be coupled with indirect 'top-down' or 'command and control' approaches such as obligations regarding technical/environmental standards for new buildings and promoting electrification of end uses (including cooking).

6. Given social sensitivity of removing butane subsidies, butane subsidy reform might benefit from international reform experience, for instance of Iran and/or India.

Figure 4 : Residential Policy Recommendations

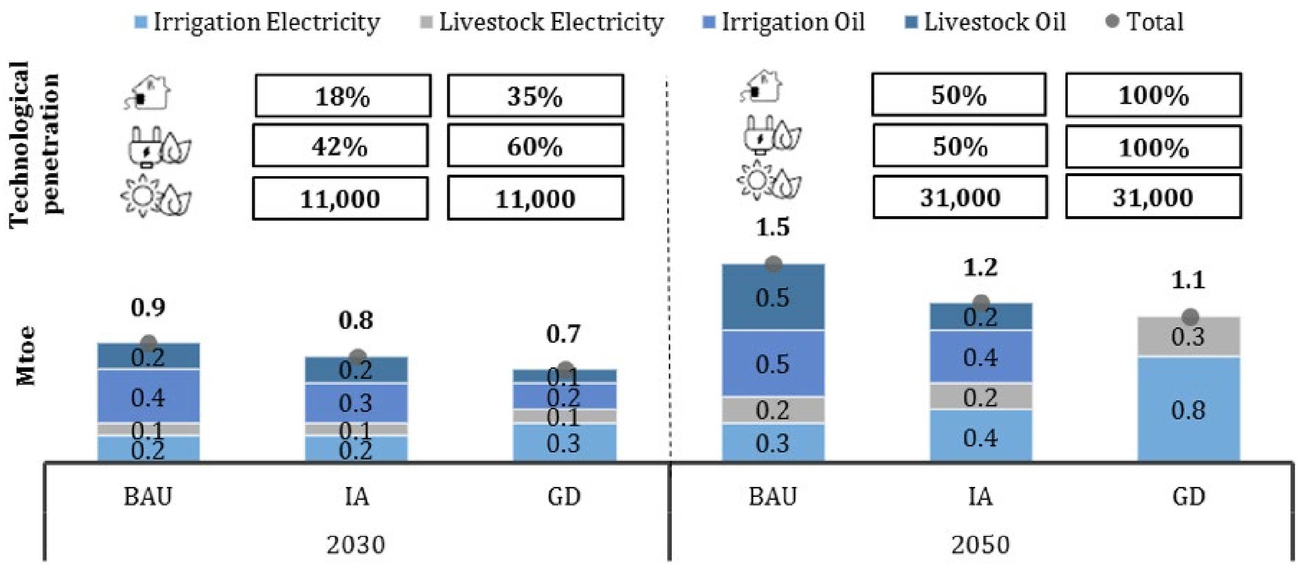


Source: Authors.

3. Agriculture Sector

To reach greenhouse gas (GHG) abatement targets in the agricultural sector, electric technologies - mainly in the form of heat pumps for sustainable farm climatization and electric and solar pumps for field irrigation - need to be embraced (Figure 5). Currently, fossil fuels (mostly diesel and LPG) are the main energy sources adopted for this purpose, yet introducing renewables and efficient heating, ventilating, and air conditioning systems (HVAC) would reduce energy consumption and improve sustainability. The switch from fossil fuels will also reap energy savings due to the higher efficiency of electric appliances. Fortunately, with Morocco's universal access to electricity - even in rural areas, which is seldom the case for African countries – and the country's solar energy potential with excellent conditions for solar thermal pumps, this target is technically achievable.

Figure 5 : Agricultural Energy Consumption by 2030 and 2050



Source: Authors' calculations. Technological penetration on final demand.

However, the technology switch to heat pumps is hindered by economic barriers since this technology is characterized by higher upfront costs compared to traditional LPG boilers that also benefit from a commodity discount (butane subsidy). On the upside, the technology switch for irrigation is not penalized, since electric and solar technologies already have lower upfront CAPEX and LCOE compared to diesel pumps. Therefore, policy measures must be identified to mitigate the economical barrier for livestock heating (Figure 6).

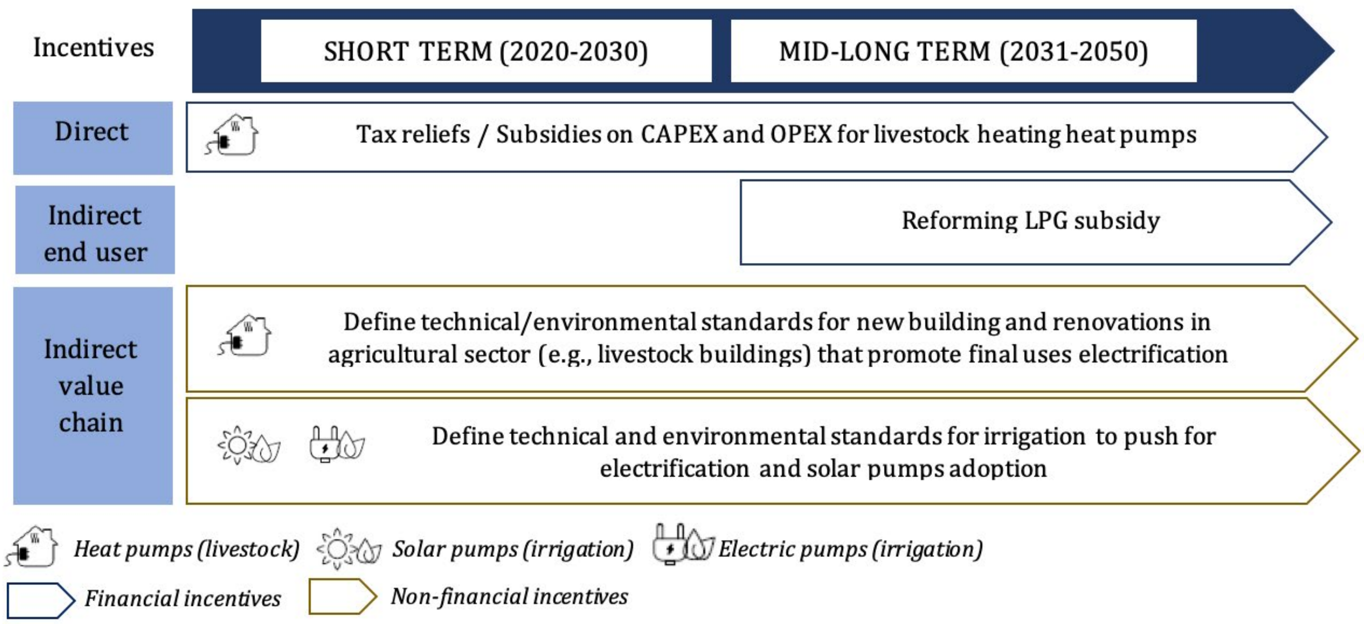
3.1. In the Short Term (2020-2030)

In the short term (2020-2030), policy measures must aim to reduce the LCOE of heat pumps to reach the value for LPG boilers (considering LPG subsidies). Therefore, direct economic incentives such as tax relief or subsidies on CAPEX and maintenance are needed to bridge the gap with boilers' LCOE and lower the higher upfront cost. LPG subsidies can be maintained in the short term as broader social implications shall be factored in. No financial support is needed to encourage electric and solar pumps for irrigation due to the convenience of these technologies. Finally, defining new technological and environmental standards for both farm heating and field irrigation can be gradually introduced in the short term to encourage the technology switch.

3.2. In the Mid-Long Term (2031-2050)

In the longer term (2031-2050), financial incentives on CAPEX and/or maintenance for heat pumps should be maintained. However, LPG subsidies must be reformed to bolster the transition and end current practices. Financial incentives for livestock heat pumps need to be coupled with indirect non-financial incentives, such as technical/environmental standards requirements to promote electrification of end uses. Similarly, no financial support shall be required for irrigation due to the convenience of electric and solar technologies. However, some technical and environmental obligations should be continued to encourage their adoption.

Figure 6 : Agricultural Sector Policy Recommendations



Source: Authors.

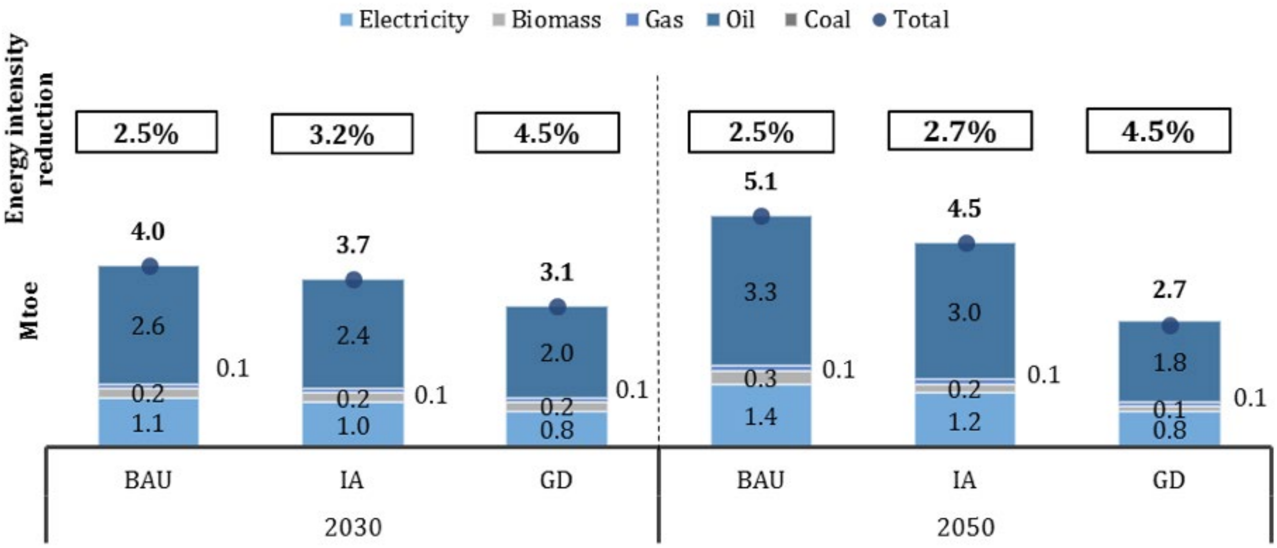
4. Industry and Tertiary Sector

The main driver of decarbonization in the industrial and tertiary (Figures 7 and 8) sectors is energy intensity reduction[7]. Industrial end-use intensity reduction or energy efficiency (EE) includes a broad range of energy-efficient technologies and management practices that

7. Energy intensity is a measure of the energy inefficiency of an economy. It is calculated as units of energy per unit of GDP (Mtoe/GDP)

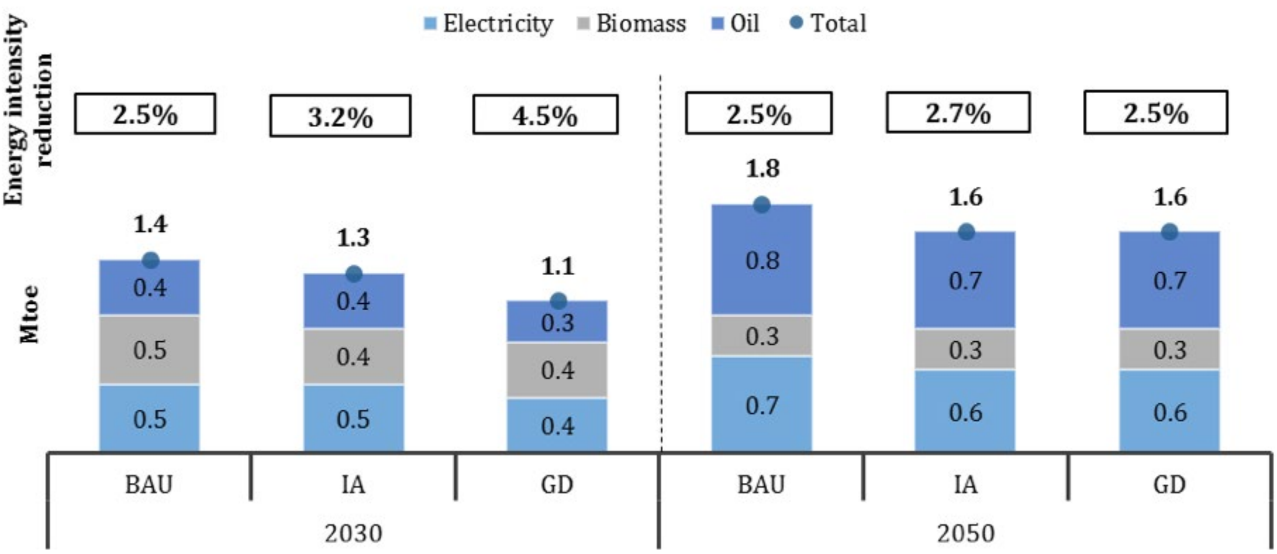
can be implemented in the manufacturing sector to reduce energy consumption. Examples that illustrate the diversity of technologies and practices include waste heat recovery, high-efficiency combined heat and power (CHP) systems, energy efficient lamps and lighting controls, modernization or replacement of process equipment, the use of sensors and controls etc. Similarly, targets to reduce energy intensity through EE interventions are necessary to cut GHG in the tertiary sector. This can be achieved by retrofitting heating, cooling, and air conditioning systems. There are barriers, however, to the adoption of energy-efficient technologies and practices in the industrial and tertiary sectors which limit opportunities to capture energy savings. Unmistakably, the upfront costs of these heavy EE interventions constitute a big economic barrier. Businesses and manufacturers often have limited capital available for efficiency projects, and require short-term payback periods compared to the estimated long-term payback period of EE plans. Moreover, in the absence of clear EE legislation and/or environmental standards that stimulate change, some simply fail to capture the value of cost-effective energy savings that can be achieved. Therefore, policies in the form of financial and non-financial incentives must be implemented to foster this positive transition.

Figure 7: Energy Consumption in the Industrial Sector by 2030 and 2050



Source: Authors' calculations. Note: Yearly reduction of energy intensity (Mtoe /GDP).

Figure 8 : Energy Consumption in the Tertiary Sector by 2030 and 2050



Source: Authors' calculations. Note: Yearly reduction of energy intensity (Mtoe /GDP).

Similar to other sectors, EE shall be sustained in the industrial and tertiary sectors with some financial incentives, given the additional upfront costs for commercials and industrials (C&Is), combined with energy intensity and environmental obligations to encourage change (Figure 9).

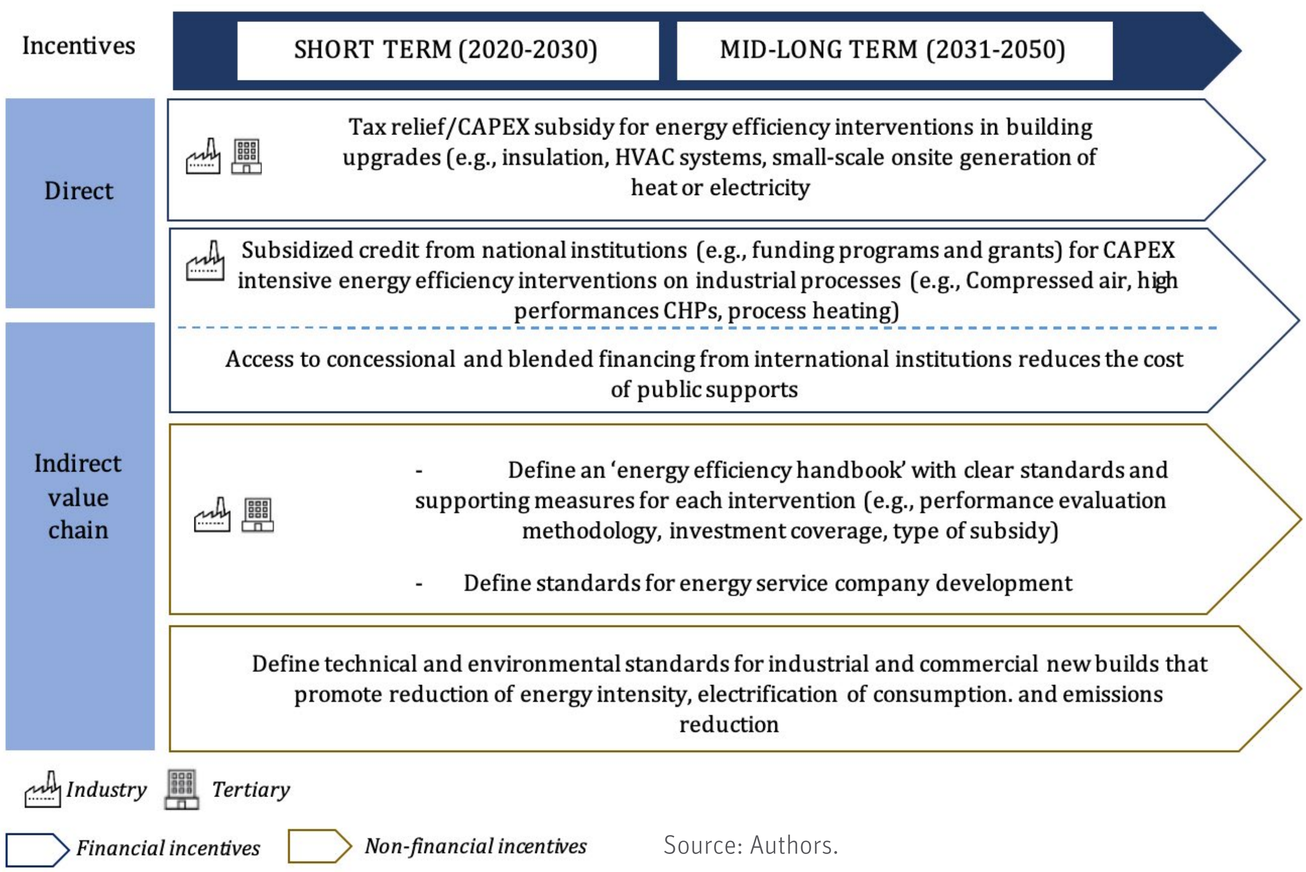
4.1. In the Short Term (2020-2030)

Policy measures in the short term (2020-2030), must aim to reduce these upfront capital investments and stimulate private investments by the means of tax relief and subsidies on CAPEX for building upgrade solutions (e.g., heating, cooling, small on-site generation), or subsidized credit from national institutions (e.g., funding programs and grants) for higher CAPEX intensive interventions related to industrial processes (e.g., compressed air, high performances CHPs, process heating). These financial incentives can be modulated on the basis of the expected payback time/internal rate of return (IRR) of each sector of application[8]. In order to foster an effective transition, these financial subsidies must be backed by a clear 'energy efficiency handbook' (detailing performance evaluation methodology, investment coverage, type of subsidy etc.) to facilitate and reduce uncertainty of investments, a definition of energy service companies' (ESCOs) standards to ease the development of such operators on the market and facilitate project financing, and finally, a definition of technical and environmental standards for new buildings in industry and services.

4.2. In the Mid-Long Term (2031-2050)

In the mid-long term (2031-2050), direct financial incentives should be maintained to sustain the higher penetration of EE measures, which will in turn lead to a greater decrease in direct system costs. Investments must be sustained during this period due to the additional up-front costs they represent for C&Is. In the long run, CAPEX coverage of investments can be reduced thanks to EE sector maturity and increased awareness of EE benefits on the user side.

Figure 9 : Industrial and Tertiary Sector Policy Recommendations



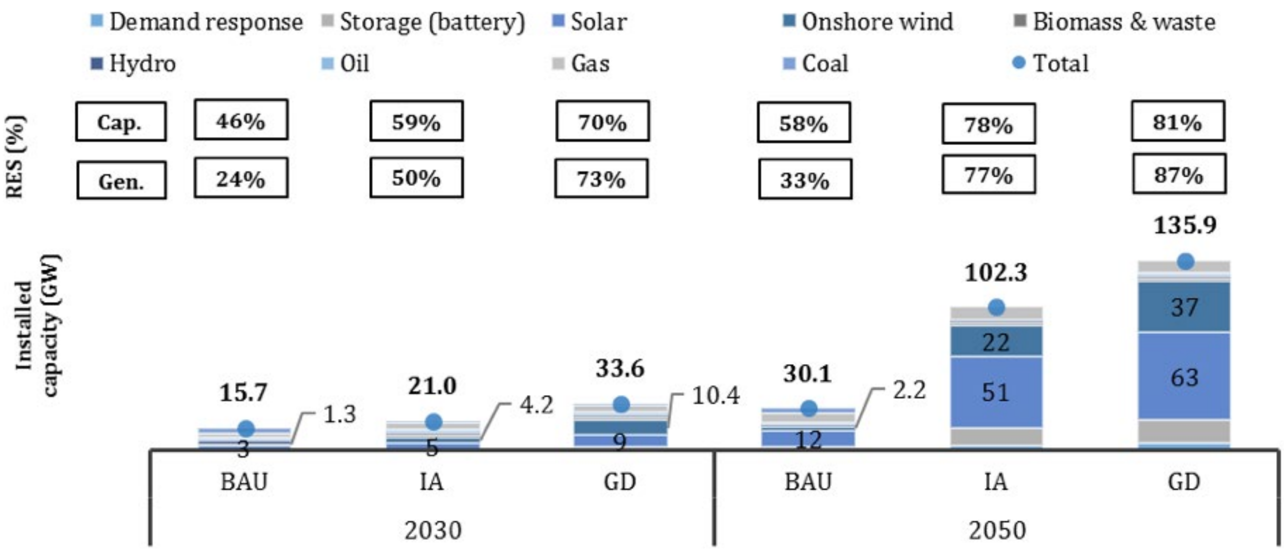
Source: Authors.

8. Financial incentives can cover only a part of the additional CAPEX to reduce the payback time of the investment. A full CAPEX coverage is not needed since interventions already represent profitable investments for C&Is.

5. Power Sector

Decarbonizing the electricity sector will require increased penetration of renewable energy sources to support growing household demand as well as to ensure the electrification of other sectors of the economy, such as the transport sector. Achieving a high level of decarbonization of the electricity sector therefore requires ambitious targets for renewable energy penetration, combined with demand response (DR) and storage to better manage the electricity grid (Figure 10).

Figure 10 : Power Capacity Mix by 2030 and 2050



Source: Authors' calculations

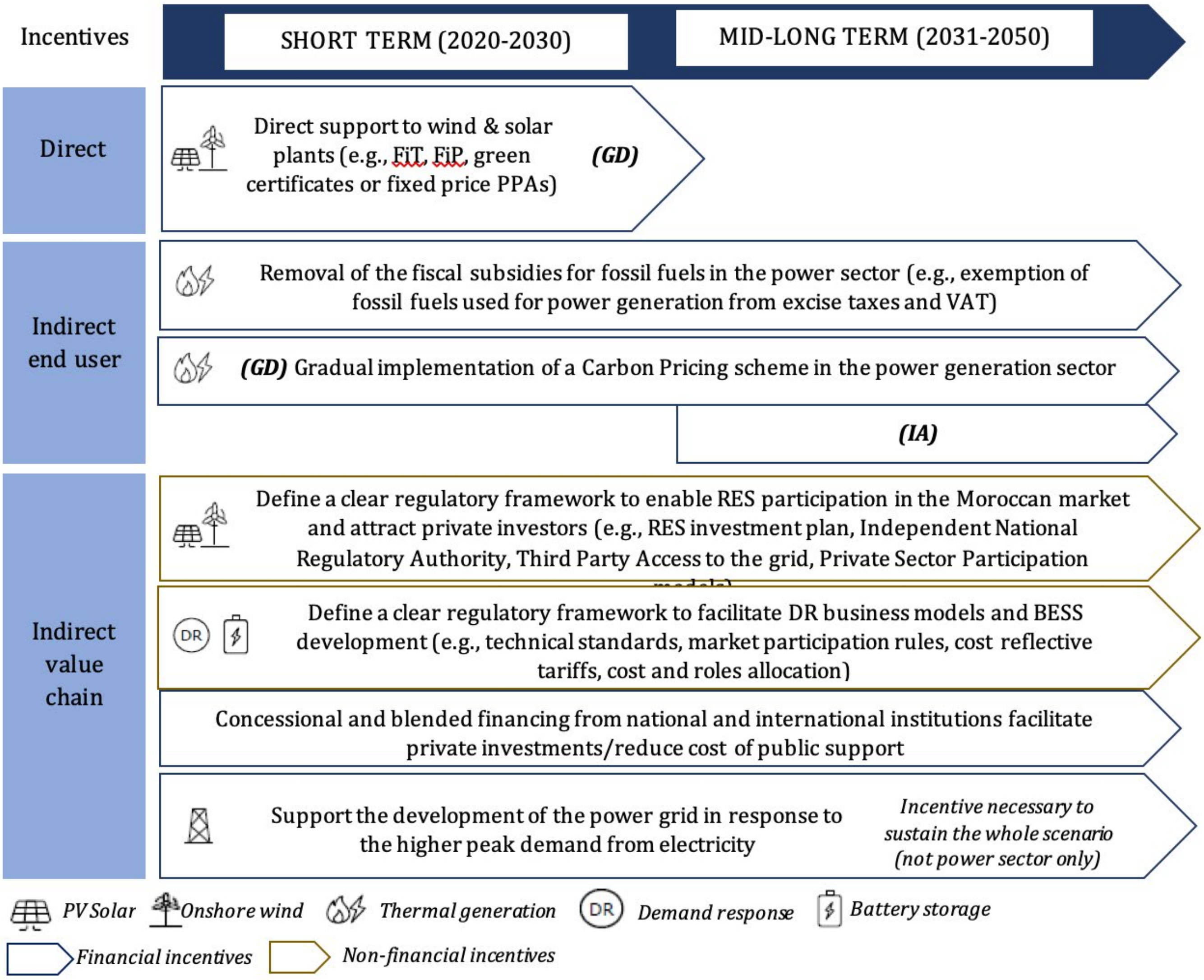
However, several obstacles to the development of renewable energy sources remain. They can be summarized as follows:

- Economic: The profitability of renewable energy projects is affected by the low production cost of fossil fuels, which have a low marginal price. In addition, the increase in renewable electricity generation can be subject to a price cannibalization effect, which may result from a supply-demand imbalance: on sunny or windy days, the grid may be overwhelmed by too much low-cost electricity generated from these sources, and if not absorbed by consumer demand, may drive down wholesale market prices. In the extreme case where wholesale market prices fall to zero or less, electricity suppliers must pay their wholesale customers to purchase electricity.
- Technical: Additional renewable electricity capacity to meet increased electricity demand must be supported by adequate grid enforcement. Moreover, high levels of variable renewable energy sources require significant and costly enhancement of system integration measures, which include demand-side measures, electricity storage, strong, smart transmission and distribution grids and flexible power sources.
- Regulatory: A clear and supportive regulatory framework is needed to enable renewable energy market participation and attract private investment.

With regard to DR and batteries, they are mainly hindered by a lack of clear regulations allowing DR and BESS business models.

Therefore, policy measures need to be identified to mitigate these barriers. In particular, national policies should support investment through carbon pricing and provide a clear and supportive regulatory framework for renewable energy sources, DR and BESS. These policies require profound change and are for the most part mid-long term in scope (Figure 11).

Figure 11 : Power Sector Policy Recommendations



Source: Authors. Note: Taxes refer to excise taxes imposed on fuel consumptions. FiT: Feed-in Tariff FiP: Feed-in Premium.

5.1. Policy Recommendations to Foster Renewable Energy

The economic barriers to renewable energy sources outlined above can be addressed by introducing carbon pricing in the electricity sector. Indeed, carbon pricing can increase the internal rate of return (IRR) for renewable energy projects, thus allowing for greater penetration of such projects. In Part III of Morocco's Decarbonization Pathway, we established that carbon pricing makes all renewable energy investments economically advantageous without further financial incentives in the Increased Ambition scenario. However, in the Green Development scenario, certain direct financial incentives will be needed for plants built before 2030 to cover the shortfall in the minimum rate of return.

These direct short-term incentives can take the form of feed-in tariffs, green certificates, or fixed-price power purchase agreements (PPAs).

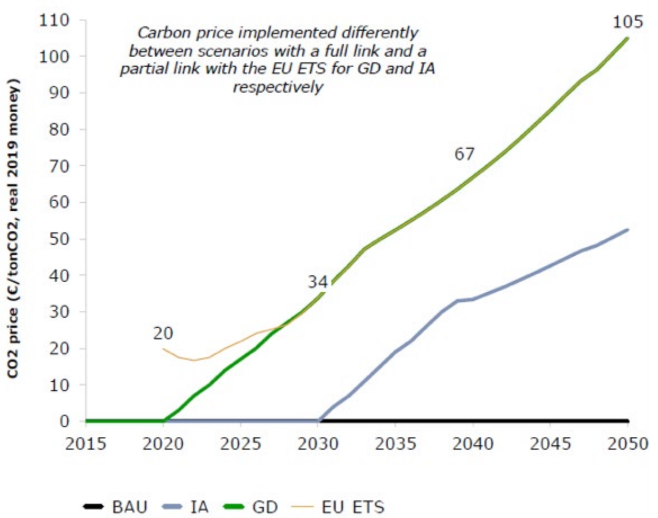
In addition to international moves towards a more restrictive carbon policy (e.g., the EU carbon border adjustment mechanism), investments will need to be facilitated by an adequate regulatory framework that mitigates project risks and allows for private sector participation through the provision of an energy strategy and investment plan, the entry into operation of the independent national regulatory authority, clear grid connection (third-party access), operating and dispatch rules, market competition and private sector participation models, and procurement processes (e.g., tendering, public private partnerships). Grid infrastructure also needs to be strengthened to accommodate renewable energy sources and meet additional electricity demand from the electrified sectors. For these purposes, concessional and blended financing from national and international banks and development agencies can be used to facilitate private investment/reduce the cost of public support.

The development of a comprehensive regulatory framework is the key challenge for the country in the coming years. Laws and regulations are currently in place, but the real challenge lies in overcoming the implementation gap. Furthermore, the national regulatory body for electricity will play a key role in catalyzing the process once operational.

5.2. Carbon Pricing Implementation

Carbon pricing can be an effective and efficient way to drive decarbonization, as it ensures the cost is borne by those who generated the emissions, in order to reduce them. A carbon price can then be introduced into the electricity sector in different ways over time via: (i) a short-term carbon tax which puts a price on emissions; and (ii) a medium to long-term emissions trading scheme (ETS [9]), by first adopting it at national level, and then developing it and linking it to international carbon markets, such as the EU ETS (Figure 12).

Figure 12 : Carbon Price Value in Decarbonized Scenarios



Source: Authors' calculations. Note: BAU: Business as Usual. IA: Increased Ambitions. GD: Green Development.

9. An emissions trading scheme (ETS) is a tool that puts a quantity limit and a price on emissions. Its 'currency' is emission units issued by the government.

This will generate government revenues that can be used to improve welfare, reduce other taxes (e.g., on low-income households), decrease trade deficit, or support investments in emissions reductions. According to the World Bank's 2020 states and trends of carbon pricing[10], governments raised more than $45 billion from carbon pricing in 2019. Almost half of the revenues were dedicated to environmental or broader development projects, and more than 40% went to the general budget. The remaining share was dedicated to tax cuts and direct transfers.

Tax reforms and a phasing out of fossil fuel subsidies also seem like a natural starting point before introducing a carbon pricing mechanism, so as not to distort the price signal. For the electricity sector, this can take the form of phasing out tax exemptions on fossil fuels (TIC[11] and VAT) and better aligning TIC rates with the social cost of pollution.

Carbon pricing may also be extended to other energy sectors, in particular the industrial sector, in anticipation for the new EU carbon border adjustment mechanism. However, such carbon pricing schemes must be accompanied by comprehensive studies that assess their impact on individuals and households, and possibly include compensation mechanisms to cushion the blow for the most vulnerable. Indeed, social assistance and support must be ensured for people who may be negatively affected by the energy transition in order to guarantee equal access to the benefits and avoid unfair distribution of costs.

5.3. Policy Recommendations for Demand Response

As renewable energy sources develop, the need for system flexibility increases, thus creating favorable conditions for DR and batteries to increase system reliability by reducing peak demand[12], which will simultaneously also reduce electricity cost and volatility. DR can be provided in the form of network services and/or market participation in response to wholesale price signals (front of the meter, FTM) or in the form of load shifting in response to cost-reflective retail rates (behind the meter, BTM).

10. World Bank, 2020.

11. TIC (Taxation Information and Communication) are the excise taxes imposed on fuel consumption.

12. Peak demand reduction leads to cost savings for grid infrastructure and flexible generation units needed for maintaining the acceptable reserve margin.

To support DR, certain policies need to be introduced or adapted for the electricity sector to:

- Revise retail tariffs to provide price signals (e.g., time-of-use, electricity consumption bands etc.);
- Facilitate DR business models through a clear regulatory framework that provides for:
  - → The ability for loads to provide network services and wholesale energy alongside generators (short-term pilot);
  - → Technical standards and cost allocation (for smart meters);
  - → Coordination along the value chain (necessary in a liberalized market to regulate balancing service provider (BSP) and balancing responsible party (BRP) /distribution network operator (DSO) interaction).
- Enable market liberalization, which facilitates the development of DR through market competition, further enhanced by third-party aggregators.

5.4. Policy Recommendations for BESS

Similar to renewable energy sources and DR, battery storage should be facilitated by a clear regulatory framework providing, among others, the following:

- Clear rules for grid connection, operation and dispatching (for BTMs, stand-alone BESS, and BESS coupled to renewable energy sources);
- The ability for BESS to provide grid services and wholesale power alongside the generators;
- Procurement processes (e.g., tendering, PPP).

In addition, a revision of the retail tariff to a cost-reflective scheme would allow positive synergies between DR and BESS on the customer side by enhancing load shifting capabilities.

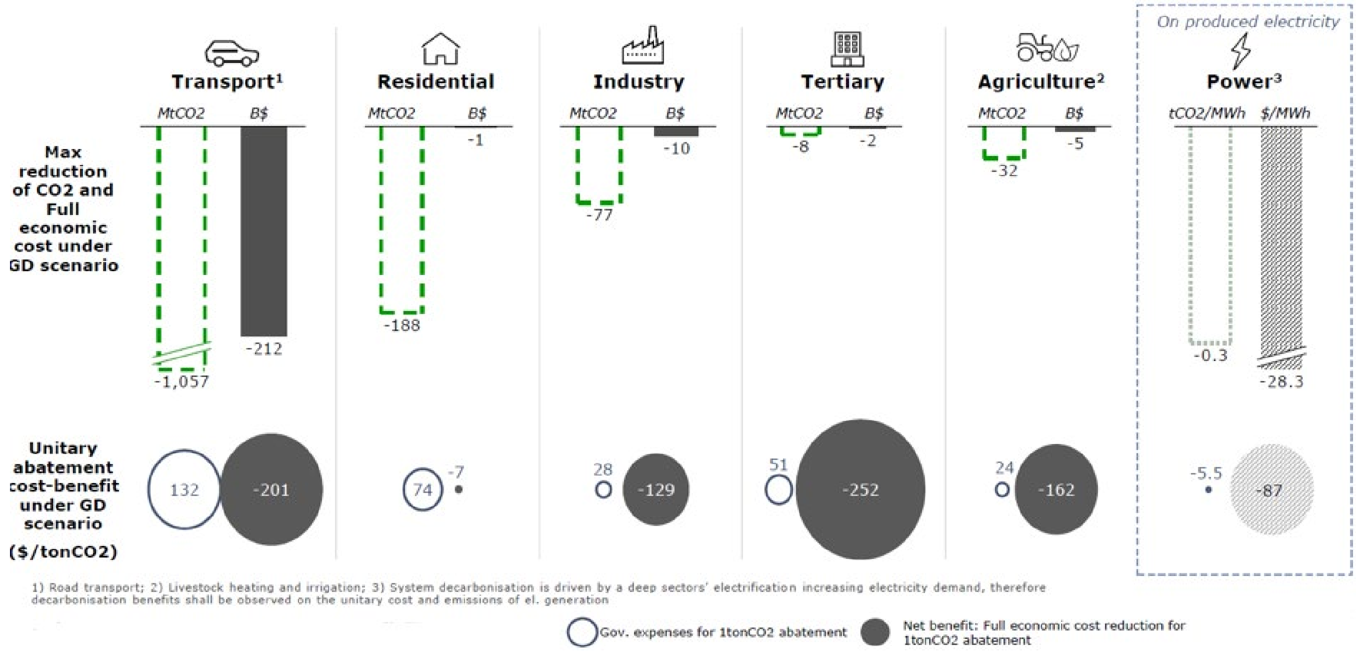
6. Public Spending Sensitivity Analysis

To support the financial measures to decarbonize the Moroccan economy, significant and efficient public spending will be required, with a relevant impact on welfare and the economy. Over the 2020-2050 period, estimated public spending is valued at $108 billion in the Increased Ambition scenario and $198 billion in the Green Development scenario. In both scenarios, the transport sector accounts for the majority of this spending—up to 65% in the Increased Ambition scenario and 70% in the Green Development scenario. By sector, the following financial incentives will be needed, according to our study:

- Road transport: Nearly 93% of additional CAPEX will need to be incentivized in the short to medium term (2020-2045). But EVs will require reduced financial incentives beyond 2045.
- Industry and tertiary: Around 50% of additional CAPEX from energy efficiency interventions needs to be incentivized and modulated according to the expected payback time/IRR of each sector of application.
- Residential: Full subsidization of CAPEX gap between the low-carbon configuration and LPG boilers will be needed, and an LPG subsidy considered to not increase the cost for end users.
- Livestock and irrigation: Full subsidization of CAPEX and OPEX gap of heat pumps for livestock heating with LPG boilers will be required.
- Power: Carbon pricing implies government revenues (limited costs in the Green Development scenario up to 2030 to sustain renewable energy sources IRRs).
- Grid infrastructure: Public development will be needed to sustain sectors decarbonization.

A public spending sensitivity analysis was conducted to determine the cost of reducing carbon dioxide (CO2) emissions as well as the net benefit to the state. The results of the Green Development scenario show that public spending results in emission reductions and cost benefits for all sectors over the 2020-2050 period (Figure 13).

Figure 13 : Public Spending Sensitivity Analysis for the 2020-2050 Period for the GD Scenario



Source: Authors' calculations

The transport and residential sectors, in particular, exhibit remarkable results: the largest reduction in CO2 emissions, estimated at a maximum of 1057 MtCO2 over the 2020-2050 period, comes from the transport sector, while public spending to reduce a ton of CO2 reaches $132/metric ton of CO2. Overall, the total economic cost for this sector in an ambitious decarbonization scenario (i.e. Green Development) will be reduced by $212 billion over the 2020-2050 period, while the reduction in the full economic cost for reducing one ton of CO2 is estimated at $201/ton of CO2. The residential sector also has great potential to reduce CO2 emissions. Total CO2 reduction over the period 2020-2050 is estimated at 188 MtCO2, while reducing one ton of CO2 will require $74/ton of CO2 in public spending. The total economic cost reduction, both over the entire period and for the reduction of one ton of CO2, however, will be small ($1 billion and $7/ton of CO2 respectively).

For the tertiary sector, while the maximum CO2 reduction and full economic cost reduction are minimal compared to the other sectors ($8 MtCO2 and $2 billion respectively), the reduction in total economic cost per 1 tonCO2 reduction is the highest, estimated at $252/tonCO2. For the electricity sector, electricity generated under the Green Development scenario will generate a maximum reduction of 0.3 tCO3/MWh, while the total economic cost will be reduced by $28.3/MWh over the 2020-2050 period and by of $87/ton of CO2 for the abatement of one ton of CO2.

III. Conclusion

The Policy Center for the New South and Enel Green Power Morocco, with the technical support of consult group AFRY and in collaboration with local stakeholders including government, regulators, business and civil society, carried out an energy transition study, aiming to contribute to the ongoing NDC work on reducing GHG emissions by 52%[13] in 2050. This is also consistent with his Majesty's Royal vision of 52% RE penetration in the country's power mix by 2030. The argument made in this study is that rather than developing abstract high-level national strategies, it is more important to focus on specific sectors working together toward a single end point: decarbonizing the economy.

Beyond NDCs, clear long-term strategies aligned with the Paris agreement goals are key to avoid locking in high-carbon technologies and losses associated with climate-related stranded assets. Our 2050 pathway established short and long-term objectives and asked what steps

13. According to the new NDC (Contribution Déterminée au Niveau National- Actualisée, Juin 2021).

are needed to get there in a way that will provide global economic benefits in a way that also accounts for the social costs of carbon. This ultimately helped to indicate transformational decisions and significant barriers.

Our review showed that the key drivers for decarbonization differ for each of the six sectors covered: for the residential sector, a technology switch toward the use of more renewables in cooking, heating, domestic hot water and lighting; for the transport sector, a switch to EVs and exploring hydrogen technology for trucks as substitutes of conventional private vehicles and full electric public transportation; for agriculture, progressive electrification thanks to the deployment of electric pump for irrigation and heat pump for heating in the livestock sector; for industry and the tertiary sector, the reduction of energy intensity and improving energy efficiency; and finally, for the power sector, increased penetration of renewable energy sources (RES) in the power generation mix, including green hydrogen possibilities with grid infrastructure reinforcement.

Nonetheless, the introduction of such a decarbonization package entails some risks and may encounter certain regulatory, technical, managerial, financial, and, above all, economic and social barriers that may erode business competitiveness, especially if pricing hurts their market share. It may also result in social cleavages and distributional effects if these costs are passed on to end consumers. Planning and implementing a socially-inclusive green transition plan requires coordination across sectors, complex laws and policies, new sources of finance, and sophisticated monitoring and evaluation. Finally, in order to achieve this vision, Morocco needs to step in and act quickly in the following five main policy areas. First, continue with more ambitious renewable energy and energy efficiency targets, accompanied by development of the infrastructure needed to sustain decarbonization. Second, establish a clear carbon pricing system and phase out fossil fuel subsidies plan while introducing possible economic incentives (subsidies and tax breaks). These economic instruments are strategic in sending the right price signals to investors and all value chain stakeholders including consumers while being mindful to distributional concerns. Third, introduce new regulatory policies able to follow the development at sectorial and sub-sectoral levels and the encourage technology switch, for instance by defining environmental and performance standards. Fourth, include an attractive policy framework encouraging private investment, boosting domestic technological innovation, making concessional finance available, supporting private investment and adapting policies on the procurement and management side to assign responsibilities for the tasks that arise from new business models. Finally, it is vital to highlight the importance of the private-public partnership model as an enabler for the scale investments coupled with a monitoring system that includes green transition indicators.

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About Enel Green Power Morocco

Enel Green Power was founded in December 2008 inside the Enel Group to develop and manage power generated from renewable resources worldwide.

The company is present in 32 countries across 5 continents and has over 1,200 plants. It has around 49 GW of installed renewable capacity generated from a mix of resources, including wind, solar, hydroelectric and geothermal. Enel Green Power is playing a fundamental role in the energy transition, as it is one of the world's leading renewable energy companies. Its goal is to accompany the planet into a new era in which everyone has access to sustainable, decarbonized energy.

Enel Green Power is also a founding member of RES4MED, Renewable Energy Solutions for the Mediterranean and Beyond, an association created in 2012 to promote renewable energy and the infrastructures needed to deliver the generated electricity throughout the Mediterranean area.

About the Policy Center for the New South

The Policy Center for the New South: A public good for strengthening public policy. The Policy Center for the New South (PCNS) is a Moroccan think tank tasked with the mission of contributing to the improvement of international, economic and social public policies that challenge Morocco and Africa as integral parts of the Global South.

The PCNS advocates the concept of an open, responsible and proactive « new South »; a South that defines its own narratives, as well as the mental maps around the Mediterranean and South Atlantic basins, within the framework of an open relationship with the rest of the world. Through its work, the think tank aims to support the development of public policies in Africa and to give experts from the South a voice in the geopolitical developments that concern them. This positioning, based on dialogue and partnerships, consists in cultivating African expertise and excellence, capable of contributing to the diagnosis and solutions to African challenges.

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