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Supplementary information

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# Reducing the cost of capital to finance the energy transition in developing countries

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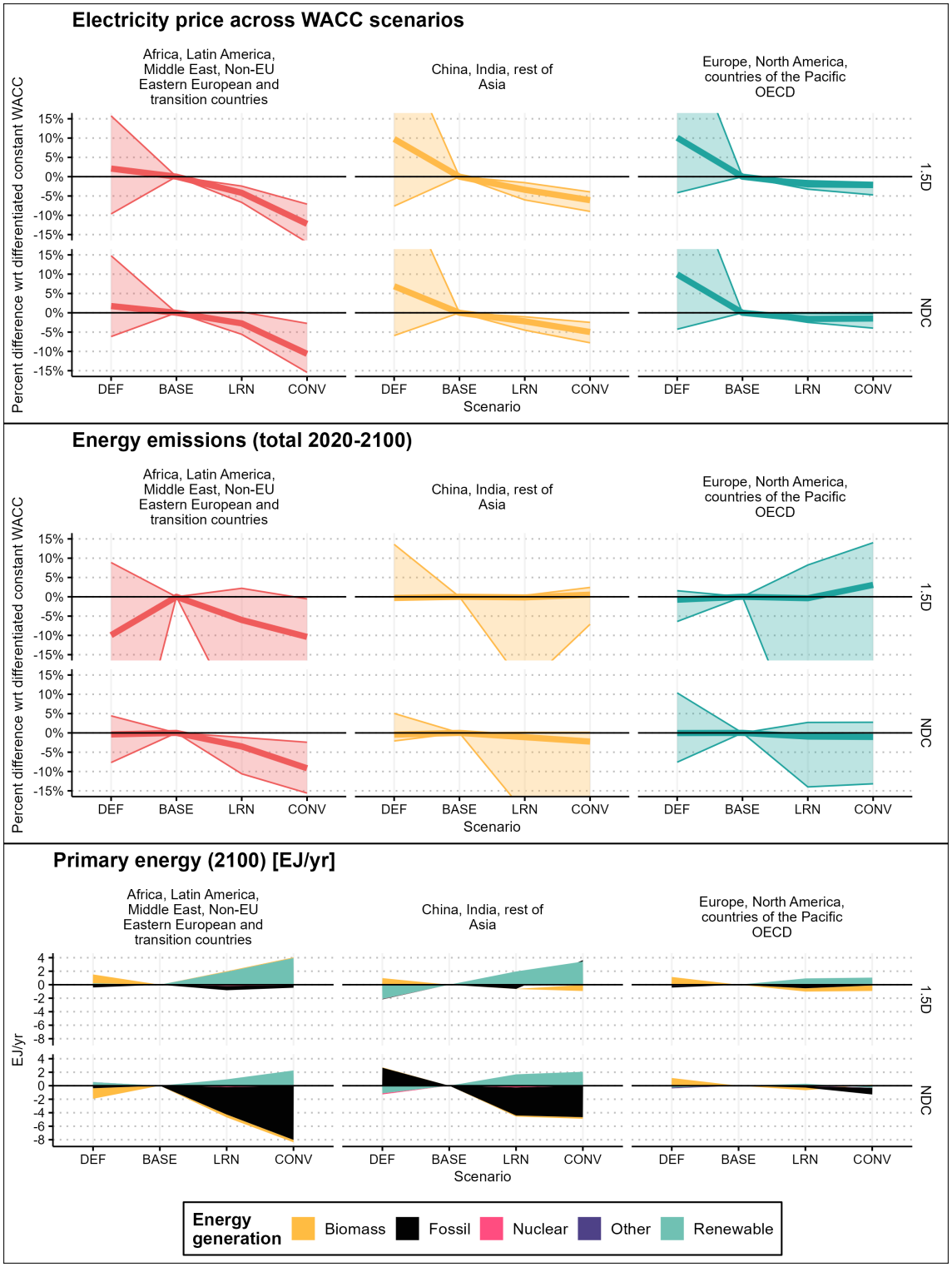


Figure 1: **Panel A**

Table 1: **Empirically calibrated WACC values by technology and country.** (*) Note: Coal values are also used for Biomass and CCS. Indeed, cost of capital is driven primarily by risk. Both biomass- and coal-CCS produce electricity and face price risks from carbon pricing. Risks related to the technology are also similar, given comparable engineering challenges [1]. Moreover, both are typically financed on balance sheet by large utilities and a lot of biomass projects either involve co-firing or converting coal to biomass installations. CoCs may differ between these technologies if policy makers decide to subsidise one rather than the other, but this is difficult to predict. We therefore assume similar empirical cost of capital for these three technologies.

| Countries | Gas plants | Nuclear plant | Hydro | Coal* | Solar PV | Onshore Wind | Offshore Wind |
|---|---|---|---|---|---|---|---|
| Algeria | 0.09 | 0.11 | 0.10 | 0.11 | 0.13 | 0.13 | 0.13 |
| Argentina | 0.13 | 0.15 | 0.14 | 0.15 | 0.15 | 0.16 | 0.16 |
| Australia | 0.03 | 0.05 | 0.04 | 0.05 | 0.04 | 0.05 | 0.06 |
| Austria | 0.03 | 0.05 | 0.04 | 0.05 | 0.05 | 0.04 | 0.07 |
| Azerbaijan | 0.05 | 0.07 | 0.06 | 0.08 | 0.09 | 0.09 | 0.09 |
| Bangladesh | 0.06 | 0.08 | 0.07 | 0.08 | 0.09 | 0.09 | 0.09 |
| Belarus | 0.08 | 0.10 | 0.09 | 0.11 | 0.12 | 0.12 | 0.12 |
| Belgium | 0.03 | 0.05 | 0.04 | 0.06 | 0.04 | 0.05 | 0.05 |
| Bolivia | 0.08 | 0.09 | 0.09 | 0.10 | 0.10 | 0.11 | 0.11 |
| Bosnia and Herzegovina | 0.08 | 0.10 | 0.09 | 0.11 | 0.12 | 0.12 | 0.12 |
| Brazil | 0.05 | 0.07 | 0.06 | 0.08 | 0.08 | 0.07 | 0.08 |
| Bulgaria | 0.04 | 0.06 | 0.05 | 0.06 | 0.07 | 0.07 | 0.08 |
| Burkina Faso | 0.08 | 0.09 | 0.09 | 0.10 | 0.08 | 0.11 | 0.11 |
| Canada | 0.03 | 0.05 | 0.04 | 0.05 | 0.06 | 0.05 | 0.06 |
| Chile | 0.03 | 0.05 | 0.05 | 0.06 | 0.05 | 0.05 | 0.07 |
| China | 0.03 | 0.05 | 0.05 | 0.06 | 0.04 | 0.05 | 0.07 |
| Colombia | 0.04 | 0.06 | 0.06 | 0.07 | 0.07 | 0.08 | 0.08 |
| Costa Rica | 0.08 | 0.09 | 0.09 | 0.10 | 0.10 | 0.08 | 0.10 |
| Croatia | 0.05 | 0.07 | 0.06 | 0.07 | 0.08 | 0.06 | 0.09 |
| Cuba | 0.10 | 0.12 | 0.12 | 0.13 | 0.13 | 0.14 | 0.14 |
| Cyprus | 0.05 | 0.07 | 0.06 | 0.08 | 0.08 | 0.08 | 0.09 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Czech Republic | 0.03 | 0.05 | 0.04 | 0.06 | 0.05 | 0.07 | 0.07 |
| Denmark | 0.03 | 0.05 | 0.04 | 0.05 | 0.05 | 0.04 | 0.04 |
| Dominican Republic | 0.06 | 0.08 | 0.07 | 0.08 | 0.07 | 0.09 | 0.09 |
| Ecuador | 0.11 | 0.13 | 0.12 | 0.13 | 0.14 | 0.14 | 0.14 |
| Egypt | 0.08 | 0.09 | 0.09 | 0.10 | 0.11 | 0.11 | 0.11 |
| El Salvador | 0.08 | 0.10 | 0.09 | 0.11 | 0.08 | 0.11 | 0.11 |
| Estonia | 0.03 | 0.05 | 0.05 | 0.06 | 0.07 | 0.05 | 0.07 |
| Ethiopia | 0.09 | 0.11 | 0.10 | 0.11 | 0.10 | 0.08 | 0.10 |
| Finland | 0.03 | 0.05 | 0.04 | 0.05 | 0.07 | 0.04 | 0.07 |
| France | 0.03 | 0.05 | 0.04 | 0.06 | 0.05 | 0.04 | 0.07 |
| Germany | 0.03 | 0.05 | 0.04 | 0.05 | 0.04 | 0.04 | 0.05 |
| Ghana | 0.08 | 0.10 | 0.09 | 0.11 | 0.11 | 0.11 | 0.11 |
| Greece | 0.06 | 0.08 | 0.07 | 0.08 | 0.06 | 0.07 | 0.09 |
| Guatemala | 0.05 | 0.07 | 0.06 | 0.07 | 0.08 | 0.08 | 0.08 |
| Honduras | 0.07 | 0.09 | 0.08 | 0.09 | 0.07 | 0.08 | 0.09 |
| Hungary | 0.05 | 0.07 | 0.06 | 0.07 | 0.07 | 0.09 | 0.09 |
| India | 0.05 | 0.07 | 0.06 | 0.07 | 0.06 | 0.06 | 0.08 |
| Indonesia | 0.04 | 0.06 | 0.06 | 0.07 | 0.08 | 0.08 | 0.08 |
| Iran | 0.08 | 0.09 | 0.09 | 0.10 | 0.13 | 0.13 | 0.13 |
| Iraq | 0.09 | 0.11 | 0.10 | 0.11 | 0.11 | 0.12 | 0.12 |
| Ireland | 0.04 | 0.05 | 0.05 | 0.06 | 0.07 | 0.05 | 0.07 |
| Israel | 0.03 | 0.05 | 0.05 | 0.06 | 0.05 | 0.07 | 0.07 |
| Italy | 0.05 | 0.07 | 0.06 | 0.07 | 0.05 | 0.07 | 0.08 |
| Jamaica | 0.08 | 0.09 | 0.09 | 0.10 | 0.09 | 0.09 | 0.11 |
| Japan | 0.03 | 0.05 | 0.05 | 0.06 | 0.04 | 0.07 | 0.07 |
| Jordan | 0.07 | 0.09 | 0.08 | 0.09 | 0.07 | 0.09 | 0.10 |
| Kazakhstan | 0.05 | 0.07 | 0.06 | 0.07 | 0.08 | 0.08 | 0.08 |
| Kenya | 0.08 | 0.09 | 0.09 | 0.10 | 0.10 | 0.08 | 0.10 |
| Korea | 0.03 | 0.05 | 0.04 | 0.06 | 0.05 | 0.07 | 0.07 |
| Kuwait | 0.03 | 0.05 | 0.05 | 0.06 | 0.07 | 0.07 | 0.07 |
| Latvia | 0.04 | 0.06 | 0.05 | 0.06 | 0.07 | 0.07 | 0.07 |
| Lebanon | 0.21 | 0.23 | 0.22 | 0.23 | 0.23 | 0.23 | 0.23 |
| Lithuania | 0.04 | 0.05 | 0.05 | 0.06 | 0.07 | 0.05 | 0.08 |
| Luxembourg | 0.03 | 0.05 | 0.04 | 0.05 | 0.05 | 0.05 | 0.06 |
| Malaysia | 0.04 | 0.06 | 0.05 | 0.06 | 0.07 | 0.07 | 0.07 |
| Malta | 0.04 | 0.05 | 0.05 | 0.06 | 0.04 | 0.07 | 0.07 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mauritius | 0.04 | 0.06 | 0.06 | 0.07 | 0.06 | 0.08 | 0.08 |
| Mexico | 0.04 | 0.06 | 0.05 | 0.06 | 0.07 | 0.06 | 0.07 |
| Mongolia | 0.08 | 0.10 | 0.09 | 0.11 | 0.10 | 0.09 | 0.11 |
| Montenegro | 0.07 | 0.09 | 0.08 | 0.09 | 0.10 | 0.08 | 0.11 |
| Morocco | 0.05 | 0.07 | 0.06 | 0.07 | 0.08 | 0.06 | 0.08 |
| Myanmar | 0.13 | 0.15 | 0.14 | 0.15 | 0.11 | 0.11 | 0.11 |
| Namibia | 0.06 | 0.08 | 0.07 | 0.08 | 0.06 | 0.09 | 0.09 |
| Netherlands | 0.03 | 0.05 | 0.04 | 0.05 | 0.04 | 0.04 | 0.06 |
| New Zealand | 0.03 | 0.05 | 0.04 | 0.05 | 0.06 | 0.05 | 0.06 |
| Nicaragua | 0.08 | 0.10 | 0.09 | 0.11 | 0.11 | 0.08 | 0.11 |
| Norway | 0.03 | 0.05 | 0.04 | 0.05 | 0.06 | 0.06 | 0.06 |
| Pakistan | 0.08 | 0.10 | 0.09 | 0.11 | 0.11 | 0.11 | 0.11 |
| Panama | 0.04 | 0.06 | 0.06 | 0.07 | 0.06 | 0.06 | 0.08 |
| Peru | 0.04 | 0.06 | 0.05 | 0.06 | 0.07 | 0.07 | 0.07 |
| Philippines | 0.04 | 0.06 | 0.06 | 0.07 | 0.07 | 0.08 | 0.08 |
| Poland | 0.04 | 0.05 | 0.05 | 0.06 | 0.07 | 0.05 | 0.07 |
| Portugal | 0.05 | 0.07 | 0.06 | 0.07 | 0.08 | 0.06 | 0.08 |
| Romania | 0.05 | 0.07 | 0.06 | 0.07 | 0.07 | 0.06 | 0.08 |
| Russia | 0.05 | 0.07 | 0.06 | 0.07 | 0.08 | 0.08 | 0.08 |
| Rwanda | 0.08 | 0.09 | 0.09 | 0.10 | 0.08 | 0.10 | 0.10 |
| Saudi Arabia | 0.03 | 0.05 | 0.05 | 0.06 | 0.08 | 0.08 | 0.08 |
| Senegal | 0.06 | 0.08 | 0.07 | 0.08 | 0.06 | 0.09 | 0.09 |
| Singapore | 0.03 | 0.05 | 0.04 | 0.05 | 0.06 | 0.07 | 0.07 |
| Slovakia | 0.04 | 0.05 | 0.05 | 0.06 | 0.06 | 0.07 | 0.07 |
| Slovenia | 0.04 | 0.06 | 0.05 | 0.06 | 0.06 | 0.08 | 0.08 |
| South Africa | 0.05 | 0.07 | 0.06 | 0.08 | 0.07 | 0.09 | 0.09 |
| Spain | 0.04 | 0.06 | 0.05 | 0.06 | 0.07 | 0.05 | 0.08 |
| Sri Lanka | 0.09 | 0.11 | 0.10 | 0.11 | 0.12 | 0.12 | 0.12 |
| Sweden | 0.03 | 0.05 | 0.04 | 0.05 | 0.06 | 0.04 | 0.06 |
| Switzerland | 0.03 | 0.05 | 0.04 | 0.05 | 0.04 | 0.07 | 0.07 |
| Thailand | 0.04 | 0.06 | 0.05 | 0.06 | 0.06 | 0.08 | 0.08 |
| Tunisia | 0.08 | 0.10 | 0.09 | 0.11 | 0.11 | 0.11 | 0.11 |
| Turkey | 0.08 | 0.09 | 0.09 | 0.10 | 0.09 | 0.09 | 0.11 |
| Uganda | 0.08 | 0.09 | 0.09 | 0.10 | 0.10 | 0.10 | 0.10 |
| Ukraine | 0.08 | 0.10 | 0.09 | 0.11 | 0.12 | 0.12 | 0.12 |
| United Arab Emirates | 0.03 | 0.05 | 0.04 | 0.06 | 0.07 | 0.08 | 0.08 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| United Kingdom | 0.03 | 0.05 | 0.04 | 0.06 | 0.04 | 0.05 | 0.05 |
| Uruguay | 0.04 | 0.06 | 0.06 | 0.07 | 0.06 | 0.05 | 0.08 |
| USA | 0.03 | 0.05 | 0.04 | 0.05 | 0.06 | 0.05 | 0.06 |
| Venezuela | 0.21 | 0.23 | 0.22 | 0.23 | 0.20 | 0.21 | 0.21 |
| Vietnam | 0.06 | 0.08 | 0.07 | 0.08 | 0.09 | 0.09 | 0.09 |
| Yemen | 0.21 | 0.23 | 0.22 | 0.23 | 0.19 | 0.23 | 0.23 |

Table 2: **RE technology maturity level by country and technology**

| | Country | Solar PV | Onshore wind | Offshore wind |
|---|---|---|---|---|
| 1 | Algeria | Immature market | Immature market | Immature market |
| 2 | Argentina | Immature market | Immature market | Immature market |
| 3 | Australia | Mature market | Intermediate market | Immature market |
| 4 | Austria | Intermediate market | Mature market | Immature market |
| 5 | Azerbaijan | Immature market | Immature market | Immature market |
| 6 | Bangladesh | Immature market | Immature market | Immature market |
| 7 | Belarus | Immature market | Immature market | Immature market |
| 8 | Belgium | Mature market | Intermediate market | Intermediate market |
| 9 | Bolivia | Immature market | Immature market | Immature market |
| 10 | Bosnia and Herzegovina | Immature market | Immature market | Immature market |
| 11 | Brazil | Immature market | Intermediate market | Immature market |
| 12 | Bulgaria | Intermediate market | Intermediate market | Immature market |
| 13 | Burkina Faso | Mature market | Immature market | Immature market |
| 14 | Canada | Immature market | Intermediate market | Immature market |
| 15 | Chile | Intermediate market | Intermediate market | Immature market |
| 16 | China | Mature market | Mature market | Immature market |
| 17 | Colombia | Immature market | Immature market | Immature market |
| 18 | Costa Rica | Immature market | Mature market | Immature market |
| 19 | Croatia | Immature market | Mature market | Immature market |
| 20 | Cuba | Immature market | Immature market | Immature market |
| 21 | Cyprus | Intermediate market | Intermediate market | Immature market |
| 22 | Czechia | Intermediate market | Immature market | Immature market |
| 23 | Denmark | Intermediate market | Mature market | Mature market |
| 24 | Dominican Republic | Intermediate market | Immature market | Immature market |
| 25 | Ecuador | Immature market | Immature market | Immature market |
| 26 | Egypt | Immature market | Immature market | Immature market |
| 27 | El Salvador | Mature market | Immature market | Immature market |
| 28 | Estonia | Immature market | Mature market | Immature market |
| 29 | Ethiopia | Immature market | Mature market | Immature market |
| 30 | Finland | Immature market | Mature market | Immature market |
| 31 | France | Intermediate market | Mature market | Immature market |
| 32 | Germany | Mature market | Mature market | Intermediate market |

| | | | | |
|---|---|---|---|---|
| 33 | Ghana | Immature market | Immature market | Immature market |
| 34 | Greece | Mature market | Mature market | Immature market |
| 35 | Guatemala | Immature market | Immature market | Immature market |
| 36 | Honduras | Mature market | Intermediate market | Immature market |
| 37 | Hungary | Intermediate market | Immature market | Immature market |
| 38 | India | Intermediate market | Intermediate market | Immature market |
| 39 | Indonesia | Immature market | Immature market | Immature market |
| 40 | Iran | Immature market | Immature market | Immature market |
| 41 | Iraq | Immature market | Immature market | Immature market |
| 42 | Ireland | Immature market | Mature market | Immature market |
| 43 | Israel | Intermediate market | Immature market | Immature market |
| 44 | Italy | Mature market | Intermediate market | Immature market |
| 45 | Jamaica | Intermediate market | Intermediate market | Immature market |
| 46 | Japan | Mature market | Immature market | Immature market |
| 47 | Jordan | Mature market | Intermediate market | Immature market |
| 48 | Kazakhstan | Immature market | Immature market | Immature market |
| 49 | Kenya | Immature market | Mature market | Immature market |
| 50 | Korea | Intermediate market | Immature market | Immature market |
| 51 | Kuwait | Immature market | Immature market | Immature market |
| 52 | Latvia | Immature market | Immature market | Immature market |
| 53 | Lebanon | Immature market | Immature market | Immature market |
| 54 | Lithuania | Immature market | Mature market | Immature market |
| 55 | Luxembourg | Intermediate market | Intermediate market | Immature market |
| 56 | Malaysia | Immature market | Immature market | Immature market |
| 57 | Malta | Mature market | Immature market | Immature market |
| 58 | Mauritius | Intermediate market | Immature market | Immature market |
| 59 | Mexico | Immature market | Intermediate market | Immature market |
| 60 | Mongolia | Intermediate market | Mature market | Immature market |
| 61 | Montenegro | Immature market | Mature market | Immature market |
| 62 | Morocco | Immature market | Mature market | Immature market |
| 63 | Myanmar | Immature market | Immature market | Immature market |
| 64 | Namibia | Mature market | Immature market | Immature market |
| 65 | Netherlands | Mature market | Mature market | Immature market |
| 66 | New Zealand | Immature market | Intermediate market | Immature market |
| 67 | Nicaragua | Immature market | Mature market | Immature market |
| 68 | Norway | Immature market | Immature market | Immature market |

| | | | | |
|---|---|---|---|---|
| 69 | Pakistan | Immature market | Immature market | Immature market |
| 70 | Panama | Intermediate market | Intermediate market | Immature market |
| 71 | Peru | Immature market | Immature market | Immature market |
| 72 | Philippines | Immature market | Immature market | Immature market |
| 73 | Poland | Immature market | Mature market | Immature market |
| 74 | Portugal | Immature market | Mature market | Immature market |
| 75 | Romania | Intermediate market | Mature market | Immature market |
| 76 | Russia | Immature market | Immature market | Immature market |
| 77 | Rwanda | Mature market | Immature market | Immature market |
| 78 | Saudi Arabia | Immature market | Immature market | Immature market |
| 79 | Senegal | Mature market | Immature market | Immature market |
| 80 | Singapore | Immature market | Immature market | Immature market |
| 81 | Slovakia | Intermediate market | Immature market | Immature market |
| 82 | Slovenia | Intermediate market | Immature market | Immature market |
| 83 | South Africa | Intermediate market | Immature market | Immature market |
| 84 | Spain | Immature market | Mature market | Immature market |
| 85 | Sri Lanka | Immature market | Immature market | Immature market |
| 86 | Sweden | Immature market | Mature market | Immature market |
| 87 | Switzerland | Mature market | Immature market | Immature market |
| 88 | Taiwan | Intermediate market | Immature market | Immature market |
| 89 | Thailand | Intermediate market | Immature market | Immature market |
| 90 | Tunisia | Immature market | Immature market | Immature market |
| 91 | Turkey | Intermediate market | Intermediate market | Immature market |
| 92 | Uganda | Immature market | Immature market | Immature market |
| 93 | UK | Mature market | Mature market | Mature market |
| 94 | Ukraine | Immature market | Immature market | Immature market |
| 95 | United Arab Emirates | Immature market | Immature market | Immature market |
| 96 | Uruguay | Intermediate market | Mature market | Immature market |
| 97 | USA | Immature market | Intermediate market | Immature market |
| 98 | Venezuela | Immature market | Immature market | Immature market |
| 99 | Vietnam | Immature market | Immature market | Immature market |
| 100 | Yemen | Mature market | Immature market | Immature market |

Table 3: **Variables used in Utility WACC calculations**. With explanations adapted from Thomson Reuters

| **Variable** | **Explanation** |
|---|---|
| Total Debt | Represents total debt outstanding, which includes: Notes Payable/Short-Term Debt, Current Portion of Long-Term Debt/Capital Leases and Total Long-Term Debt. |
| Total Equity | Consists of the equity value of preferred shareholders, general and limited partners, and common shareholders, but does not include minority shareholders' interest. |
| Interest Expense | For Industrial, Utility and Insurance companies, this represents the sum of Operating and Non-Operating Interest Expense, Net of Capitalized Interest for the fiscal year. |
| Total Cash Dividends Paid | Represents all cash dividends paid to common and preferred stockholders. This amount may be different from the dividends declared in the same period. Although the distribution of stock to shareholders as stock dividends or bonus shares is a non-cash activity, certain companies may report the stock dividend as a cash distribution and an increase in common stock. In such cases, Refinitiv follows what was reported by the company. |
| Revenue | Used for industrial and utility companies. It consists of revenue from the sale of merchandise, manufactured goods and services, and the distribution of regulated energy resources, depending on a specific company's industry. |
| Effective Tax Rate | Represents Provision for Income Taxes divided by Income Before Tax. Includes all taxes on the basis of profits that may be owed to federal, state and/or foreign government. These taxes do not include regressive taxes, such as sales taxes or excise taxes to state and federal government. |

Table 4: **Regression analysis output determining the technology component of the country-level utility WACCs**

| Dependent variable: $WACC_{ct} - rf_t - p_c$ | |
|---|---|
| **ShareCoal** | **0.02*** (0.00)** |
| **ShareGas** | **0.02** (0.00)** |
| ShareOil | 0.29*** (0.05) |
| **ShareNuclear** | **0.02*** (0.00)** |
| **ShareHydro** | **0.01 (0.01)** |
| ShareBiomass | 0.22*** (0.05) |
| ShareSolar | 0.09 (0.09) |
| ShareWind | 0.09** (0.04) |
| ShareOther | 0.55** (0.27) |
| R-squared | 0.62 |
| F-statistic (df1/df2) | 30.90*** (9.181) |
| N | 190 |

Notes: **(1)** The coefficients in bold were used in the research. We decided to use the point estimate for Hydro despite it being statistically insignificant as the point estimate still reflects the average risk premium paid on hydro in our sample. The estimated coefficient can be driven towards zero and insignificance because for this mature technology, risks are low and geography and weather, that are uncorrelated with risk, are more important drivers of the hydro share in total utilities' portfolios. Our results are not sensitive to setting this technology risk premium to 0 instead. **(2)** The point estimate for Biomass is mainly driven by a few Scandinavian countries with very high shares of Biomass in the electricity mix. Overall there is a low share of Biomass in the electricity mix which may have also inflated the values. We reverted to the point estimate for Coal plant as both are typically financed on balance sheet by large utilities and a lot of biomass projects either involve co-firing or converting coal to biomass installations. We therefore feel it is justified to assume the capital costs are similar in our empirical estimates.