Sustainable Energy Pathways for Kosovo

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Abstract:

We have developed an analytic platform to analyze the energy options, costs, and impacts for Kosovo, a nation at the forefront of the global debates over energy access and the role of fossil fuels versus cleaner energy options to meet growing demands for power. We find that a range of alternatives exists to meet present supply constraints all at a lower cost than constructing a proposed 600 MW coal plant. The options include energy efficiency measures, combinations of solar PV, wind, hydropower, and biomass, and the introduction of natural gas. A $30/ton carbon price increases costs of coal generation by at least $330 million USD. The results indicate that financing a 600 MW coal plant is the most expensive pathway to meet future electricity demand.

1. Introduction

Kosovo faces serious energy challenges, and at the same time is a critical test case for the future financing of new coal-fired power plants worldwide. The power sector faces extreme electricity supply shortages and severe technical losses. In 2013, the World Bank issued a policy underscoring its commitment to no longer finance any new coal projects unless no financially feasible alternatives exist. The US Department of the Treasury has also ended U.S. support of public financing for new overseas coal projects as part of President Obama’s Climate Action Plan (CAP) with the exception of “very limited circumstances” (US Department of the Treasury, 2013). Additionally, the European Bank for Reconstruction and Development (EBRD) policy requires that the infrastructure being financed is the least carbon-intensive of the realistically available options, keeping in line with other multilateral development banks (EBRD, 2014). Kosovo currently utilizes brown lignite coal for 98% of its power generation, which directly threatens environmental and human health. Future coal-fired generation in a proposed 600 MW coal plant will undermine the goals of the US Department of Treasury and the World Bank without fully understanding the feasible alternatives to meet Kosovar power generation challenges.

We find that a range of technically and economically viable clean energy paths exists to meet Kosovo’s near and long-term energy needs. The scenarios that emphasize a variety of renewable energy resources – notably solar, wind, and hydropower, in concert with judicious use of fossil fuels that are
employed with a clear end game of a decarbonized and reliable energy system – afford Kosovo with an array of advantages. Significant in the cases examined is the consistently estimated lower overall cost relative to the business-as-usual fossil fuel pathway. In addition, each scenario emphasizing renewable energy provides more energy than the forecasted demand, opening the door for regional power trading and exports, which have significant capacity to build security, regional prosperity, and peace. We find that:

1. There is a diverse suite of low-cost, low-carbon paths that Kosovo and international investment and development partners could follow.

2. As a result of the above, a coal-dominated future is neither a resource, economic, nor political necessity. In ongoing work, the job creation and both human and environmental health benefits of these non-coal scenarios will be further detailed, which makes the case for a multi-billion dollar coal-based pathway unnecessary.

3. A diversity of low-carbon pathways requires further discussion and action; the range of options presented, in fact, may make the pathway to a decision challenging in a contentious environment.

2. The Energy Supply and Demand Picture for Kosovo

Kosovo’s power sector currently is not meeting the needs of its population. Furthermore, the combination of the existing resource and technology mix, and the high levels of lost or diverted energy means that the future supply and efficiency measures will not be sufficient to meet the country’s projected energy demand. The heavy dependence on lignite coal for power generation is coupled with outdated and insufficient transmission and distribution infrastructure. Electricity service remains unreliable, with frequent blackouts, extreme energy losses, and rising costs to consumers across the electricity system. This situation requires a fresh look at the energy mix for Kosovo. The reduced cost of solar PV and wind power over the past five years has expanded the range of options available to meet Kosovo’s energy supply (Fraunhofer, 2013). International perspectives on energy security and job creation have changed. Energy efficiency programs have been augmented by resource and technology improvements. The combination of improvements to energy efficiency programs, the declining cost of
renewable energy alternatives, and the potential inclusion of natural gas as a coal substitute have added richness to the technical and policy landscape.

As an example of the key role of technological change, the declining cost of renewable energy, including solar PV and wind power, provides an alternative development pathway for Kosovo’s electricity grid and economy, by meeting the electricity demand in a way that creates jobs and lowers the risk for public health disaster (Zheng and Kammen, 2014). This report demonstrates the viability of solar PV, wind, biomass, and hydroelectric resources to generate increased shares of electricity in Kosovo at a lower cost than constructing a new 600-MW coal-fired power plant by 2017, by updating an initial assessment (Kammen et al., 2012). Even in a variety of scenarios that estimate different cost structures for installing and utilizing solar PV on the grid, we observe a number of options that could meet projected future energy generation in Kosovo that eliminates the need to construct a 600-MW coal-fired power plant.

3. Regional Trends in the Cost of Energy

Across Southeastern Europe, the cost of solar PV and wind electricity generation has declined dramatically, with real-world costs falling by up to 70% over the past five years, increasing the cost competitiveness of solar PV and wind when compared with conventional energy sources. Furthermore, small rooftop PV systems are expected to become cost-competitive with all forms of coal power in the next decade due to the consolidation and progress in the PV marketplace. According to the Fraunhofer Institute, the LCOE of PV power plants dipped as low as 0.078 Euro/kWh in 2013, and reached parity with grid electricity in Germany (Fraunhofer, 2013). Learning in wind power development also has contributed to lower costs for intermittent renewables, motivating a new push to use renewables as a transition toward EU integration. The high cost of meeting environmental regulations as part of the proposed Energy Community Treaty for new coal-fired power plants inhibits their future competitiveness to provide low-cost and reliable electricity, especially considering the ambient air quality directive.

Given renewable energy’s slow start in Kosovo, many have posed the question of whether it is realistic to expect that the situation will change in the next few years. A 2013 GIZ study found that there
is at least 290 MW of confirmed wind capacity in Kosovo spread across at least seven sites (GIZ, 2013). Furthermore, a 2014 study by Economic Consulting Associates and Energy Institute Hrvoje Pozar has cited 246 MW of wind planned for 2020 (KOSTT, 2014).

According to a report by the External Expert Panel to the World Bank the LCOE of a new coal power plant in Kosovo will be approximately €81.42/MWh. By the time of completion such cost level will be clearly uncompetitive with both renewable generation and the price that electricity is traded within neighboring power exchanges. Figure 1 highlights the base market spot prices for electricity traded in nearby Austria, which represents a realistic option since Kosovo is part of the Energy Community and a shareholder in SEE CAO (Coordinated Auction Office in Southeast Europe). An open regional market could allow for trading of electricity at significantly less than the LCOE of coal based on 2014 prices.

![Figure 1. Base Electricity Market Spot Prices for Austrian Energy Exchange in 2014 (Energy Exchange Austria, 2014).](image-url)

Kosovo will inevitably move into the emerging open regional power market. In fact, KOSTT is already a shareholder in the Coordinated Auction Office for South East Europe. The existing and planned grid interconnections are giving Kosovo a very good position to become a regional power market player. The market however will expose the financial uncompetitiveness of the proposed power plant. Kosovo runs a serious risk to end up with a significant stranded asset that will either drain public resources through government subsidies or restrict the integration of the country within the broader European energy system.
4. Data and Methods

We created a spreadsheet model using a time-step of one year to estimate the cost of annual generation and supply. We incorporate previous analyses and parameters of Kosovo’s power sector. These models provide a framework to investigate the cost and generation of Kosovo’s power sector. The data are from the latest levelized cost of energy projections determined by Fraunhofer and represent prices within Southeast Europe. We base capacity factors for different technologies on previous reports that estimate resource availability for renewable technologies and historical generation from existing power plants using information from KOSTT. Each scenario represents a different alternative pathway that highlights the numerous opportunities for development in the region. The base case presents a business as usual approach if the World Bank approves financing for Kosovo C. Additionally we estimate the cost difference from the base scenario when introducing a $30/ton shadow price of carbon when using coal. The domestic lignite reserves amount to nearly 12.5 billion metric tonnes. Of this resource, approximately 10.5 billion metric tonnes are exploitable. Lignite coal is one of the lowest quality types of coal and could release 5.8 million tons of CO$_2$/year in Kosovo’s electricity sector (Kammen et al., 2012). In multiple scenarios, Kosovo B must close down by, as it will approach its end-of-life unless we apply retrofit investments. The base case scenario continues operation of Kosovo B beyond 2025.

Our model features one option where the global cost of solar reduces due to innovation and learning curves and reaches SunShot solar prices, which makes the increased deployment of solar photovoltaics an attractive option. We add a penalty of 10% of the total system cost to account for adding the necessary energy storage to backup solar, while remaining technology neutral. To estimate the annual generation of solar electricity, we use the range of incoming solar radiation within Kosovo. We find that solar radiation varies between 1550 kWh/m$^2$/year and 1650 kWh/m$^2$/year, therefore we use an average value for incoming solar radiation at 1600 kWh/m$^2$/year, since there is not much variation within the country for an ideally sited solar photovoltaic array.

The information on the potential for small hydropower developments comes from a previous feasibility study that highlights the potential for 63 MW of projects with projected annual production of nearly 300 GWh. The ERO office within Kosovo also foresees development of small-scale hydropower projects that could total up to 140 MW beyond 2020. We include this within our scenarios. We also
analyze the potential construction of Zhur, where the development is proposed between Prizren and Dragash. However, we scale back the capacity of Zhur from the previous analysis due to the concerns over feasibility and include a scenario with an operation Zhur at 45 MW, which is 15% of the originally proposed capacity of 300 MW.

We introduce natural gas as one scenario by including the construction of the Trans Adriatic Pipeline (TAP) by 2018. Though natural gas remains politically questionable, it remains an important energy source globally and could become a large regional player given the supply shortages from other sources and regional market plans to trade gas. Additionally, recently the EU Energy Commission proposed an Energy Community Gas Ring, which would enable natural gas to play a role in the power sector and displace coal-generation. Regionally, in Albania, the conversion of a diesel plant to gas opens up the opportunity for future natural gas development in the region. Therefore, we investigate natural gas as a scenario for analysis among a range of alternatives.

The proposed construction of increased regional transmission capacity allows for future energy imports and exports and we also consider the potential for an open regional market via a power exchange. We include the construction of a 400 kV transmission line between Albania and Kosovo financed by the German Development Bank (KfW). The line is expected to be 241 km and cost approximately 75.5 million euros or 94.2 million USD (1 EUR = 1.25 USD). We use the cost of the expansion of transmission capacity in our estimation of the open regional market.

We estimate transmission losses based on the USAID energy efficiency reports and figures from KOSTT, the Kosovar transmission system operator. The KOSTT system already interconnects with Montenegro (400 kV line), Macedonia (400 kV line), Albania (220 kV line), and Serbia (400 kV, 220 kV, and 110 kV) allowing transit, imports and exports of electricity. The existing interconnections will provide key opportunities for future electricity trading in an open regional market situation.

The demand forecasts come from estimates based on KOSTT information. The future expected demand incorporates projected population growth and economic growth by using GDP and we assume 3.2% growth in GDP per annum. This version of the model does not incorporate seasonal fluctuations for hydropower or demand requirements on hourly peak time scales. However, it provides a picture of different ways Kosovo could meet demand, especially given severe supply constraints.
We use energy efficiency costs from the most recent USAID report and the newly funded Kosovo Energy Efficiency and Renewable Energy project funded by the World Bank that aims to reduce energy consumption in public buildings (USAID, 2013). The building sector accounts for approximately 48% of final energy consumption in Kosovo. Additionally, the Government of Kosovo has committed to achieving at least a 20% increase in energy efficiency across the energy sector by 2020 in accordance with the Athens’ Energy Community Treaty, which legally binds Kosovo to meeting EU directives on energy, the environment, and market competition (USAID, 2013). Kosovo experiences severe losses across the distribution system, which is owned and operated by Koorporata Energjetike e Kosoves (KEK). The technical losses on the distribution system have ranged as high as 16% in one year due to outdated equipment, a lack of maintenance, and network inefficiencies.

Furthermore, including a price on carbon widens the difference in cost between the studied scenarios because of the carbon intensity of lignite coal. Therefore the inclusion of a shadow price on CO₂ emissions further pushes the base case scenario from the range of alternatives in terms of total estimated cost.

5. Results

We modeled different scenarios for the Kosovar electricity grid by varying cost assumptions and energy policy targets. The Energy Strategy for Kosovo established specific goals for capacity expansion for renewables. We integrated the targets into each scenario and investigated how the overall cost of each technology would change deployment in the future. Based on latest estimates we created seven different scenarios summarized in Table 1.

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<tr>
<th>Scenario</th>
<th>Name</th>
<th>Notes</th>
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<td>1</td>
<td>Base Case (coal)</td>
<td>TPP C built in 2017</td>
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<tr>
<td>2</td>
<td>Solar Prices Reduce to SunShot Levels</td>
<td>Solar at $1/W by 2020</td>
</tr>
<tr>
<td>3</td>
<td>Aggressive energy efficiency measures to reduce consumption and T&amp;D losses along with expanded open regional market via a power exchange</td>
<td>1 kWh energy avoided displaces 1 kWh coal-fired generation</td>
</tr>
<tr>
<td>4</td>
<td>Introduction of natural gas via TAP by 2018 with aggressive energy efficiency measures</td>
<td>Solar at $2/W by 2020</td>
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<tr>
<td>5</td>
<td>Storage penalty for solar at $200/kWh along with introduction of natural gas via TAP and aggressive energy efficiency measures</td>
<td>Solar at $2/W by 2020 and storage is $200/kWh</td>
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<tr>
<td>6</td>
<td>Carbon Shadow Price at $30/ton of CO₂</td>
<td>Carbon price commensurate with World Bank policy</td>
</tr>
<tr>
<td>7</td>
<td>No natural gas, Affordable Albanian-Kosovar joint projects, national waste-to-energy program, and mini-hydropower availability without Zhur</td>
<td>Solar at $2/W by 2020 and excess generation from Albania is sold on Kosovar market</td>
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</table>

**Table 1. A selection of the multiple pathways examined in this paper that economically and reliably meet Kosovo’s projected future electricity demand.**

We estimated the cost of different renewable energy technologies and the amount of electricity generated based on different capacities for each technology. The cost assumptions influenced the capacity deployed of each technology in different years. Using resource availability data, we calculated the estimated annual generation from each type of electricity and the associated cost, annualized over a twelve-year period. The base case scenario, Figure 2.1, assumes Kosovo C is built in 2017 and upwards of 98% of Kosovo’s electricity generation comes from brown lignite coal. Figure 2.2 highlights the scenario where solar prices reduce to SunShot levels of $1/W by 2020, TPP A ceases production by 2017 and we assume a 3% yearly improvement in transmission and distribution losses. Albanian-Kosovar joint projects and small hydropower reserves balance the system and provide flexibility to accommodate intermittent solar as a part of an open regional market via a power exchange. We added a storage penalty to account for the intermittency of solar PV, by appending 10% of system costs per kWh to each kWh of solar generated in Figure 2.5 (Gur et al., 2012).

The estimated grid consumption data comes from projections by the Ministry of Energy along with expected population growth. Figure 2.2 exhibits the increased ability of solar PV to meet electricity needs, ramping up in magnitude starting in 2020 if the price of solar reduces to $1/W, a current policy
goal of the US government under the SunShot pricing program. These prices are reasonable because of the global competitiveness of the solar PV market and remain consistent with projections for the cost of solar PV in southeast Europe. An aggressive energy efficiency scenario, detailed in Figure 2.3, exhibits the potential to curtail growth in peak energy consumption to 5000-7000 GWh. Figure 2.4 introduces natural gas to Kosovo’s electricity portfolio by 2018 and gas quickly facilitates a rise in solar PV deployment due to the ability to serve as a fast-ramping, flexible generator that can compensate for the variability of solar PV due to cloudiness. Given that bringing TAP or IAP is an official policy of the Government of Kosovo, a scenario incorporating natural gas should be analyzed. With the introduction of gas, the demand for all coal generation disappears by 2022. The final scenario, not pictured here, introduces low-cost energy imports from an open regional market, which allows solar to develop along with available hydropower resources. A waste-to-energy program could supplement the grid in the final scenario, providing a potential of nearly 257 GWh per year assuming the availability of 384,000 tons per year of landfill material. The results highlight the wide variety of options Kosovo has to meet its future electricity demand at lower cost than building Kosovo C and the opportunities for Kosovo to become an energy hub by exporting electricity to neighboring states.

In Figure 2.6, we test the sensitivity by including a shadow price of $30/ton of CO₂, as World Bank President Jim Kim has suggested should be accounted for when planning new World Bank projects. We estimate that the construction of Kosovo C could add up to 11.5 million tons of CO₂ per year, adding an additional amortized cost of $330 million to the construction of Kosovo C.
Figure 2.3. Aggressive energy efficiency measures to reduce consumption and T&D losses along with an open regional market via a power exchange.

Figure 2.4. Introduction of natural gas via TAP by 2018 with aggressive energy efficiency measures.

Figure 2.5. Storage penalty for solar at $200/kWh along with introduction of natural gas via TAP and aggressive energy efficiency measures.

Figure 2.6. Carbon Shadow Price of $30/ton CO₂
<table>
<thead>
<tr>
<th>Scenario</th>
<th>Name</th>
<th>Notes</th>
<th>Estimated Cost*</th>
<th>Figure</th>
</tr>
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<td>1</td>
<td><strong>Base Case (coal)</strong></td>
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<td>1 kWh energy avoided displaces 1 kWh coal-fired generation</td>
<td><strong>$1.75 billion USD</strong></td>
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<td>Introduction of natural gas via TAP by 2018 with aggressive energy efficiency measures</td>
<td>Solar at $2/W by 2020</td>
<td><strong>$1.71 billion USD</strong></td>
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<td>5</td>
<td>Storage penalty for solar at $200/kWh along with introduction of natural gas via TAP and aggressive energy efficiency measures</td>
<td>Solar at $2/W by 2020 and storage penalty at $200/kWh, representing 10% of system generation costs</td>
<td><strong>$1.74 billion USD</strong></td>
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<td>6</td>
<td>Carbon Shadow Price at $30/ton</td>
<td>$30/ton of CO\textsubscript{2} added to cost of coal generation</td>
<td><strong>$1.97 billion USD</strong></td>
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* See Appendix A for detailed annualized cost estimation.
| 7 | No natural gas, Affordable Albanian-Kosovar joint projects, national waste-to-energy program, and mini-hydropower availability without Zhur | Solar at $2/W by 2020 and excess generation from Albania is sold on Kosovar market | $1.94 billion USD | Not pictured; Appendix Table A.7 |

Table 2. Total cost estimates of each scenario including business-as-usual case. Technology costs are based on current operating costs (BAU), and renewable energy technology costs as estimated by the Global Energy Assessment (2012) project.

Each of the different scenarios will provide electricity until at least 2025 at a cost of less than $1.7-$1.9 billion dollars. This is significantly less than an estimated cost of $2-2.2 billion dollars to build a 600 MW coal fired power plant. The alternative pathways presented could save the Kosovo Energy Corporation (KEK) between $200-500 million USD before considering health, job creation, or societal benefits of a more resilient system. This upper-bound estimate does not include any externalities. World Bank President Jim Kim has stated that all current WB projects require a shadow price of $30/ton of carbon. If we apply a shadow price of $30/ton of carbon, the difference between each scenario and the base case could double.

Particularly important in this work is the observation that there are multiple, economically realistic scenarios that can provide reliable, low-carbon energy for Kosovo. Technical and political preferences may lead different analysts to prefer different energy mixtures, but the diversity of viable cases leads directly to three very clear conclusions:

- There is no shortage of low-cost, low-carbon paths that Kosovo and international investment and development partners could follow;
- As a result of the above, a coal-dominated future is neither a resource, economic, nor political necessity. In ongoing work, the job creation and both human and environmental
health benefits of these non-coal scenarios will be further detailed, which makes the case for a multi-billion dollar coal-based pathway unnecessary.

- A diversity of low-carbon pathways requires further discussion and action; the range of options presented, in fact, may make the pathway to a decision challenging in a contentious environment.

Further work will examine: 1) regional interconnections; 2) the job benefits of clean energy scenarios; and 3) health, agricultural and political benefits of a clean energy sector. Each of these assessments will increase the value of the clean energy path for Kosovo, Europe, and the international partners engaged in pro-growth sustainable regional development.

5. Discussion

5.1 Developing a Smart Grid

The development of smart grids could leverage under-utilized resources in Kosovo. Currently Kosovo’s transmission system experiences approximately 34% losses including technical and non-technical losses. Furthermore, given the Ministry of Finance’s revised renewable energy targets of 29.4% by 2020, the development of smart grid infrastructure for both improved efficiency and communications could greatly aid the reduction of technical losses on the system and improve system performance. With the Energy Regulatory Office already approving 67 MW in small-scale hydropower and 30 MW of wind in December, the improvement of existing infrastructure and information and communication technology on the transmission and distribution system becomes increasingly important.

5.2 Expanding Regional Cooperation

The potential for Kosovo’s participation in the existing regional market remains high. Excess hydropower capacity from Albania can be purchased to secure balancing reserves and enable a more resilient power grid. Enhanced regional cooperation will facilitate the transition to renewables in contrast to building a new coal-fired power plant and will improve overall system efficiency.
6. Conclusions

Many options exist for Kosovo’s future electricity system, however one certainty is the ability for different combinations of renewable energy to provide reliable electricity at a greatly reduced cost compared to building a 600 MW coal-fired power plant. Under a range of scenarios with the current and projected cost of solar electricity, coal consistently remains a more expensive option for the country’s electric grid. Moreover, aggressive energy efficiency and future ability to import electricity from Albania would facilitate more solar PV development beyond the base case scenario, which indicates the feasibility of using alternative energy to improve Kosovo’s electric grid. This report highlights that Kosovo’s energy future will not depend on the economy or technology, yet will remain a policy choice with significant implications for the electricity sector, public health, and the environment.

Acknowledgment

We thank the many dedicated partners working on energy scenarios for discussions leading to this work. Maryam Mozafari and Dan Prull provided key foundational analyses as part of the RAEL team. Justin Guay of the Sierra Club and the European Climate Foundation have been invaluable colleagues in this assessment effort, along with colleagues at the Harvard School of Public Health. We thank the Zaffaroni Family, the Karsten Family Foundation, the Rockefeller Brothers Fund, and the SAGE-IGERT program at the University of California, Berkeley for their support.
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### Appendix A. Detailed annualized costs for each scenario.

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Table A.1. Kosovo C is built with business-as-usual growth.
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Table A.1.1. Kosovo C is built with business-as-usual growth and we introduce a shadow price of $30/ton of CO2.

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Table A.2. Solar reaches SunShot Prices ($1/W) by 2020.
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Table A.3. Low cost energy imports available from Albania along with aggressive energy efficiency measures to reduce consumption and T&D losses.
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RAEL: http://rael.berkeley.edu/kosovoenergy | KOSID http://www.kosid.org
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|------|-------|-----|-----|-----|-----|-----|-----|-----|-------------|-----|-------------|-----|-------------|-----|-------------|-----|-------------|-----|-------------| ($1,101,501,109.97) |
| Import s | 805629.6435 | 893517.0506 | 979646.70.96 | 106405.377.5 | 114677.270 | -   | 143583.724.6 | -   | 140712.050.1 | -   | 137897.809.1 | -   | 135139.852.9 | -   | 132437.055.9 | -   | 129788.314.7 | -   | 127192.548.4 | -   | 124648.697.5 |
| Biomass | 0   | 0   | -   | 135289.4.4 | -   | 135289.4.4 | -   | 135289.4.4 | -   | 135289.4.4 | -   | 676447.0 | -   | 0 | -   | 0 | -   | 0 | -   | 0 | ($9,891,227.12) |
| Total  | 853607.854.8 | 104565.344.2 | 114676.910.2 | 121385.957.5 | 130546.113.9 | -   | 159452.568.5 | -   | 822741.94.05 | -   | 100860.282.7 | -   | 549419.88.68 | -   | 135524.398.9 | -   | 176475.546.5 | -   | 177876.968.2 | -   | 186090.525.7 | ($1,707,873,465.46) |

Table A.4. Increased energy efficiency measures alongside the introduction of natural gas via TAP by 2018 and phase out of coal by 2022.
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Table A.5. Increased energy efficiency measures alongside the introduction of natural gas via TAP by 2018 and storage cost of $200/kWh.
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Table A.7. Affordable imports from Albania, Solar @ $2/W, national waste-to-energy program, no gas, and limited hydropower availability (not pictured).