Data in Brief

Technoeconomic data adopted for the development of a long-term electricity supply model for the Hashmite Kingdom of Jordan

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ABSTRACT

Electrical generation in Jordan currently relies on imported fossil fuels. In the past, most imported fossil fuels were subsidised by neighbouring countries through grants and aid. This has led to a regulated market, with subsidised low-cost electrical energy consumers, and the government being the sole buyer and seller of electricity. With the ageing of the national electrical infrastructure, political instability in the region, and lack of funds for direct investment, other options needed to be pursued. Long term Power Purchase Agreements (PPA) were granted to Independent Power Producers (IPP) to encourage investment in capacity and infrastructure. In addition, long-term fuel contracts were signed to secure steady flow of primary fuel sources. Over the past few years, renewable energy penetration has increased rapidly, but without proper planning or taking into consideration long term PPA and fuel contracts. Data in regard to the current infrastructure, renewable energy technology, signed

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energy commitments and system operation assumptions are described in this article, which may be used for modelling and analysis. The Data were collected from annual reports from the different energy related entities in Jordan.

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### Specifications table

| Subject                  | Renewable Energy and Sustainability |
|--------------------------|-------------------------------------|
| Specific subject area    | Renewable energy assessment and primary fuel sources. |
| Type of data             | Tables and Graphs                   |
| How data were acquired   | Databases and reports of international and domestic organisations |
| Data format              | Raw and analysed                    |
| Parameters for data collection | Data collected based on inputs required to understand the impact of renewable energy penetration on the reliability of electric delivery in Jordan. |
| Description of data collection | Data were collected from annual reports from the different energy related entities in Jordan. |
| Data source location     | Country: Hashemite Kingdome of Jordan |
| Data accessibility       | With the article                    |

### Value of the data

- The data provided are required to understand the impact of renewable energy penetration to the reliability of electric delivery in Jordan.
- Researchers working on modelling to assist systems planners can use the provided data to better plan future expansion of conventional generation as well as quantifying renewable energy penetration levels.
- The data can be used as a standard model input, which will help define what other data sets may be required for more detailed modelling.

### 1. Data description

The data provided in this paper are used for the development and analysis of an energy model for Jordan. The datasets presented were collected from different energy related entities in Jordan. It includes electrical energy consumption, power demand, generated energy, fuel sources, generation technologies, installed capacity and future projects.

The datasets are provided with this article in the form of tables and a figure, which are described in Table 1.

#### 1.1. Electricity supply and generation data

Jordan is a small country that primarily relies on imported fuel for all electric energy generation, the government serves as a single buyer of primary fuel sources [1]. The current electrical generation installed capacity in Jordan is 4.3 GW [2]. The consumption of electricity based on sector for 2018 is shown in Table 2, and projected peak power demand and generated energy up to year 2040 are shown in Table 3.

Jordan’s peak load in 2016 was 3500 MW, with an installed capacity of 3800 MW from traditional generation, excluding renewable energy penetration. Transmission level Renewable energy
Table 1
Description of items and datasets provided with article.

| Item | Title | Description of content |
|------|-------|-------------------------|
| 1.   | Table 2 | A table that lists the percentage of electrical energy consumption per sector in Jordan. |
| 2.   | Table 3 | A table that lists projected peak power demand and generated energy from 2020 to 2040. |
| 3.   | Table 4 | A table listing installed capacity from all different technologies connected to the Jordanian electric network from 2016 to 2019. |
| 4.   | Table 5 | A table that lists projected fuel prices from 2020 to 2050. |
| 5.   | Fig. 1. | A graph showing generation cost comparison for CCGT, solar PV and wind from 2015 to 2045. |
| 6.   | Table 6 | A table that lists plant cost and performance parameters for future investment for all generation technologies. |
| 7.   | Table 7 | A table showing all current and contracted PV plants from 2020 to 2023. Table includes capacity, predicted energy generation, initial investment and operation cost. |
| 8.   | Table 8 | A table showing all current and contracted wind power plants from 2020 to 2023. Table includes capacity, predicted energy generation, initial investment and operation cost. |

Table 2
Electrical energy consumption per sector [4].

| Sector                  | Residential | Street Lights | Agricultural and Water Pump | Commercial and Hotels | Industrial |
|-------------------------|-------------|---------------|-----------------------------|-----------------------|------------|
| Percent Consumption     | 45.12       | 2.32          | 15.4                        | 15.08                 | 22.08      |

Table 3
Projected peak power demand and generated energy [4].

| Year | Peak Power Demand | Generated Electrical Energy |
|------|-------------------|-----------------------------|
|      | MW                | % growth                   | GWh                        | % growth |
| 2020 | 3146              | 2.9                        | 20,744                     | 3.0      |
| 2022 | 3341              | 3.1                        | 22,063                     | 3.2      |
| 2025 | 3645              | 2.9                        | 24,250                     | 3.2      |
| 2030 | 4186              | 2.8                        | 28,230                     | 3.1      |
| 2040 | 5528              | 2.8                        | 38,261                     | 3.1      |

Table 4
Installed capacity in the Jordanian electric network.

|                                  | 2016 | 2017 | 2018 | 2019 |
|----------------------------------|------|------|------|------|
| CCGT Installed Capacity (MW)     | 3800 | 4200 | 4200 | 4200 |
| PV Capacity (MW)                 | 209.8| 312.8| 648.8| 1028.8|
| Wind Capacity (MW)               | 197  | 197  | 372.2| 616.2 |
| Total Renewable Capacity (MW)    | 407  | 510  | 1061 | 1645 |
| PV share to system Capacity (%)  | 5.00 | 6.60 | 12.30| 17.60 |
| Wind share to system Capacity (%)| 4.70 | 4.20 | 7.10 | 10.50 |
| Total Renewable share to system Capacity (%)| 10  | 11  | 20  | 28   |

installed capacity was approximately 407 MW [1,2,4,5]. In addition, 200 MW of distribution level net-metering PV systems are also operational. Table 4 details installed capacity from all generation technologies.

1.2. Imported fuel

Data from the Jordanian Energy Information System and the U.S. Energy Information Administration are used to compile projected fuel prices as shown in Table 5 [1,6]. Only data for fuel sources used in Jordan are considered.
Table 5
Projected fuel prices [6].

|                | 2020   | 2025   | 2030   | 2035   | 2040   | 2045   | 2050   |
|----------------|--------|--------|--------|--------|--------|--------|--------|
| Oil            | USD/barrel | 77.1   | 97.2   | 123.5  | 148.4  | 173.9  | 199.8  | 225.7  |
|                | USD/MMBtu | 13.3   | 16.8   | 21.3   | 25.6   | 30     | 34.4   | 38.9   |
| Natural Gas Contract Price | USD/MMBtu | 6.3    | 6.3    | 6.3    | 6.3    | 6.3    | –      | –      |
| Natural Gas at Henry Hub | USD/MMBtu | 3.2    | 4.2    | 5      | 6      | 7      | 8.3    | 10.2   |

Fig. 1. Generation cost comparison for CCGT, solar PV and wind.

1.3. Power plant costs and performance data

The initial investment costs for solar PV projects are 1000 USD/kWp and 2020 USD/kW for wind projects [2,4,5]. Fig. 1 shows the generation cost of the different technologies up to year 2045. Table 6 lists plant cost and performance parameters for future investment for all

Table 6
Plant cost and performance parameters for future investment.

| Technology Type            | Input Fuel          | Efficiency | Variable Operation and Maintenance cost (USD/MMBtu) | Fixed operation and maintenance cost (USD/kW) | 2019 investment cost (USD/kW) | Capacity factor | Construction time (years) | Plant Life (years) |
|---------------------------|---------------------|------------|----------------------------------------------------|-----------------------------------------------|-------------------------------|-----------------|--------------------------|-------------------|
| Combined Cycle Gas turbines | Natural Gas        | 47.5       | 37.2                                               | 930                                           | 86                            | 3               | 30                       |                   |
| Wind                      | Natural Gas        | 8.4        | 1920                                               | 32                                            | 1                             | 1               | 20                       |                   |
| Solar PV                  | Natural Gas        | 8.4        | 900                                                | 28                                            | 1                             | 1               | 25                       |                   |
| Solar PV rooftop          | Natural Gas        | 6          | 1000                                               | 28                                            | 1                             | 1               | 25                       |                   |
generation technologies. Table 7 shows all current and contracted PV plants from 2020 to 2023. The table includes capacity, predicted energy generation, initial investment and operation cost. Table 8 showing all current and contracted wind power plants from 2020 to 2023. The table includes capacity, predicted energy generation, initial investment and operation cost [7].

2. Experimental design, materials and methods

Data were collected from annual reports provided by the Energy and Mineral Regulation Commission, the National Electric Power Company (NEPCO), in addition to independent power producers (IPPs) and recent commissioned PV projects in Jordan.

2.1. Electricity supply and generation data

NEPCO is the sole buyer of bulk electricity from the IPPs. NEPCO then sells the bulk power to three geographically distributed, distribution companies, which provide electricity to consumers. Data in Table 2 were collected from NEPCO’s annual report as it includes data from all the distribution companies. Data in Table 3 were collected form the Energy and Mineral Regulation Commission, which tabulated information from all IPPs. Information in Table 4 was collected from the individual IPP annual reports for the traditional generation capacity, as each individual IPP provides the installed capacity connected to the Jordanian Electric Network. While renewable energy data were collected from the International Renewable Energy Agency, which provides data on installed capacity and contracted projects and from the Energy and Mineral Regulation Commission.

2.2. Fuel data

The Jordanian government serves as a single buyer of primary fuel sources, through the government owned Transmission Company NEPCO. NEPCO sells fuel to IPPs at a fixed rate regardless of market prices, in exchange for a fixed generation cost. As the political climate in the region caused a turmoil in gas supplies from Egypt and Arabian Gulf countries, NEPCO signed a 15 year contract to import gas from the Leviathan natural gas field. The contract is to import 3 billion cubic meters for a total contract price of 10 billion USD over the contract period. Projected fuel cost in Table 5 was obtained from the Jordanian Energy Information System and the U.S. Energy Information Administration.
2.3. Power plant costs and performance data

As renewable energy prices dramatically decreased starting in 2010, deployment of renewable energy projects through PPAs in Jordan increased drastically [3]. However, data required for modelling and analysis includes initial investment, in addition to operation and maintenance cost. The Data in Tables 6–8 were compiled from data available in NEPCO’s annual report, the International Renewable Energy Agency roadmap, in addition to recently signed contracts in Jordan, which provided actual recent cost [7].

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Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.dib.2020.105391.

References

[1] Central Energy Generation Company, CEGCO Annual Report 2017. http://www.cegco.com.jo/Admin_Site/Files/PDF/2be98304-1e1a-4dfa-9663-ae29d0c53326.pdf (accessed 15, June 2019).
[2] International Renewable Energy Agency, Pan-Arab Renewable Energy Strategy 2030: Roadmap of Actions for Implementation. https://www.irena.org/publications/2014/Jun/Pan-Arab-Renewable-Energy-Strategy-2030-Roadmap-of-Actions-for-Implementation (accessed 20, June 2019).
[3] Jordan Ministry Energy and Mineral Resources, Energy Information System. http://eis.memr.gov.jo/ (accessed 20, June 2019).
[4] National Electric Power Company, NEPCO Annual Report, 2017. http://www.nepco.com.jo/store/docs/web/2017_en.pdf (accessed 14, June 2019).
[5] Samra Electric Power Company, SEPCO Annual Report, 2017. http://www.sepco.com.jo/en/Publication/AnnualReports/SEPSCO2017EN.pdf (accessed 15, June 2019).
[5] U.S. Energy Information Administration, Annual Energy Outlook 2019. https://www.eia.gov/outlooks/aeo/pdf/aeo2019.pdf, (accessed 25 June 2019).
[6] A. Abuelrub, O. Saadeh, H. Al-Masri, Scenario Aggregation-Based Grid-Connected Photovoltaic Plant Design, Sustainability 10 (4) (2018) 1275–1288, doi:10.3390/su10041275.