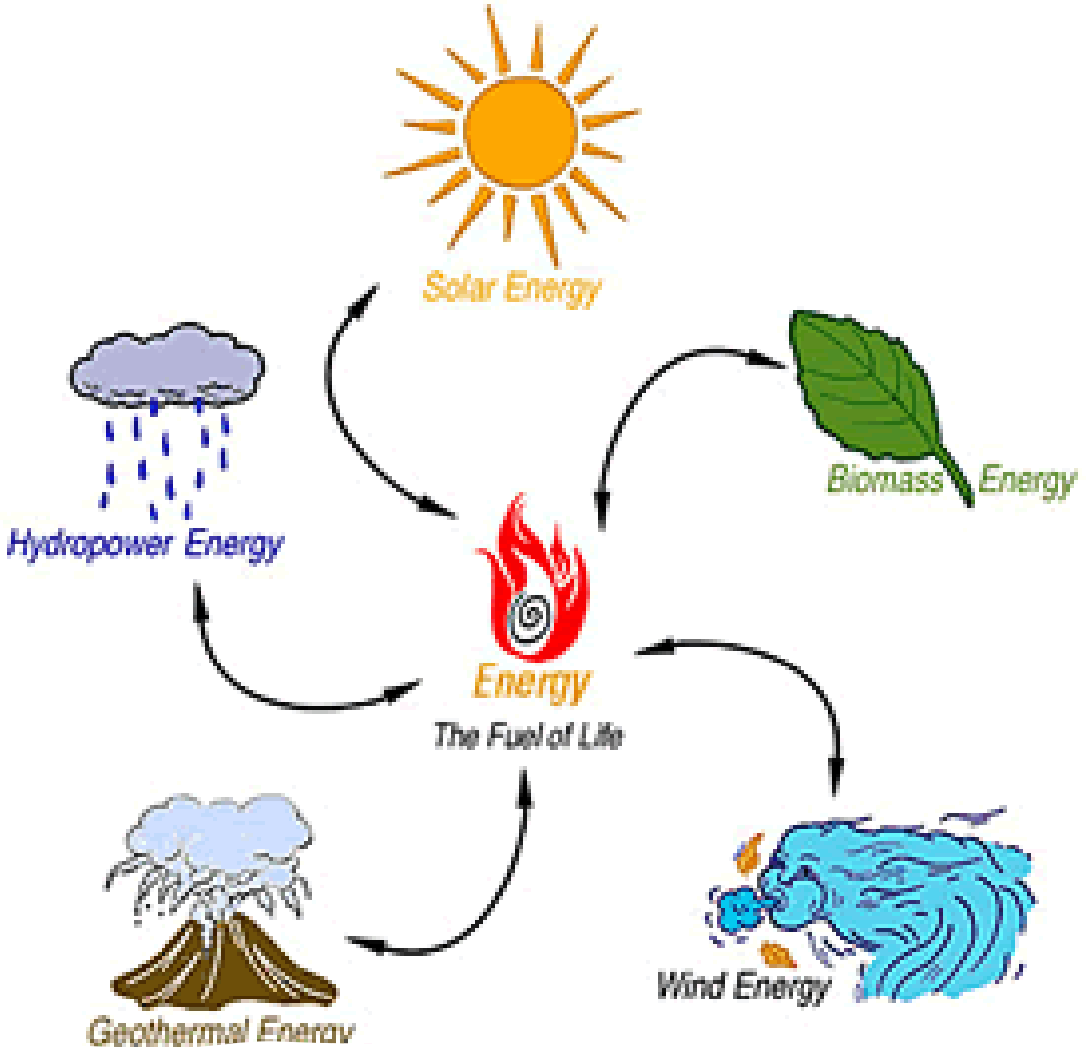
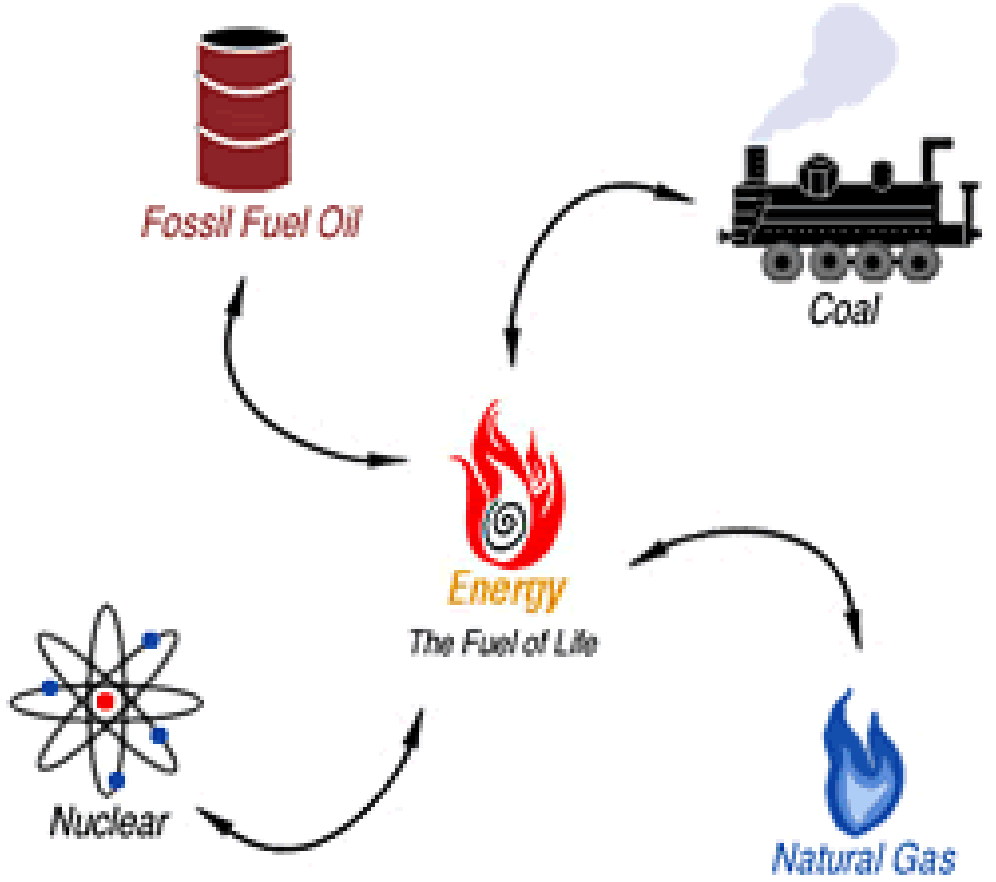
Energy in Jordan

Dr. Osama Ayadi

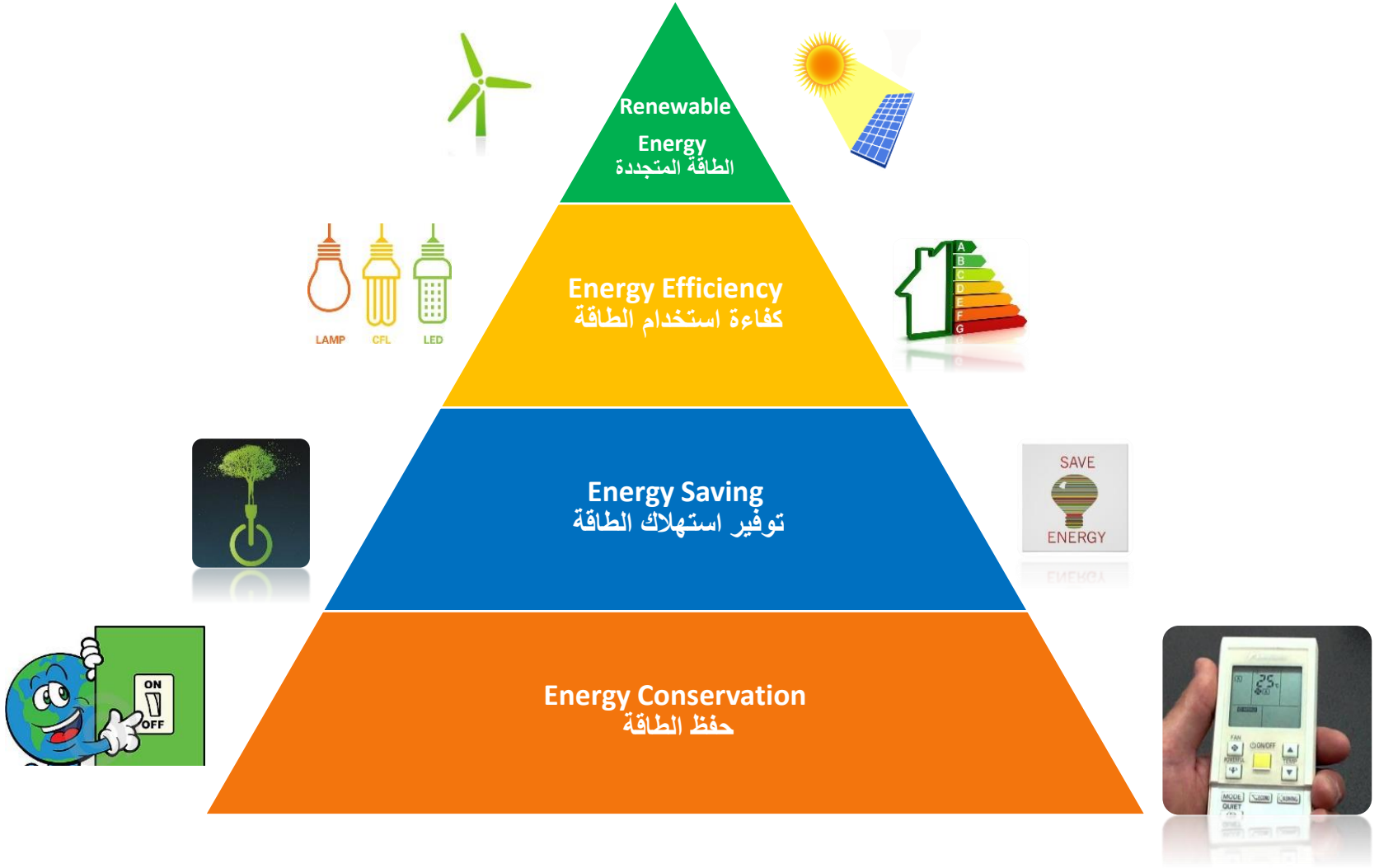
Renewable Energy



Non-Renewable Energy



Energy Pyramid



Energy Pyramid

حفظ الطاقة Energy Conservation:

Energy Reduction Methodology:

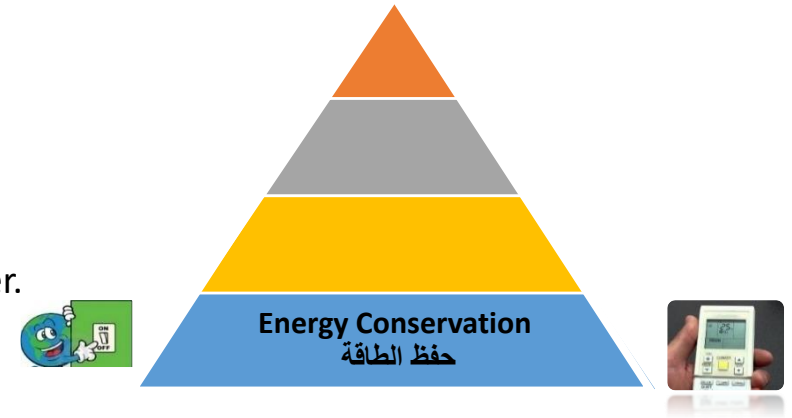
Social behavior with the aim of preserving the environment and raising the responsibility of individuals and societies

Cost: The lowest

Sustainability: The highest

Examples:

- Close or turn off the lighting fixtures that we do not need.
- Adjust the air conditioners to a lower set point in winter and higher in summer.
- Close the curtains and shades on hot summer days.
- Cleaning of air conditioner filters.
- Remove unused electrical appliances from electricity when not in use.
- Take advantage of sunlight instead of artificial lighting.



Energy Pyramid

توفير الطاقة Energy Saving:

Energy Reduction Methodology:

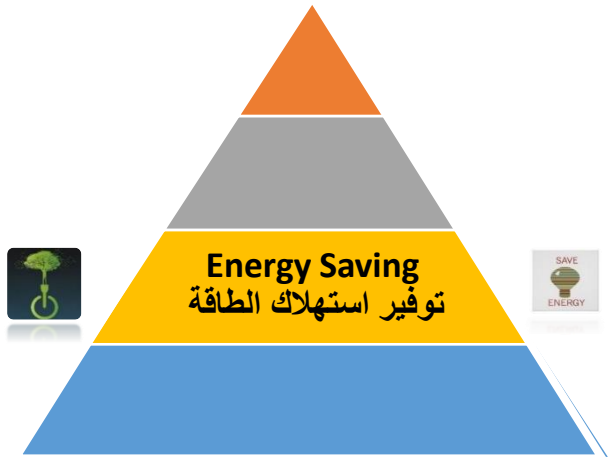
Individual behavior to increase energy efficiency

Cost: Median

Sustainability: low

Examples:

- Using less number of lamps
- Driving for shorter distance.



Energy Pyramid

كفاءة استخدام الطاقة Energy Efficiency:

Energy Reduction Methodology:

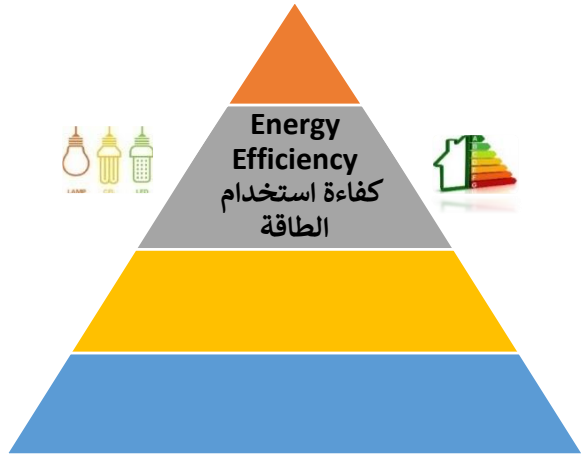
Develop the technology used to reduce the amount of consumption without compromising quality / comfort

Cost: High

Sustainability: High

Examples:

- Thermal Insulation implementation.
- Lighting Retrofitting.
- Double Glazing
- High energy label appliances
- Building orientation

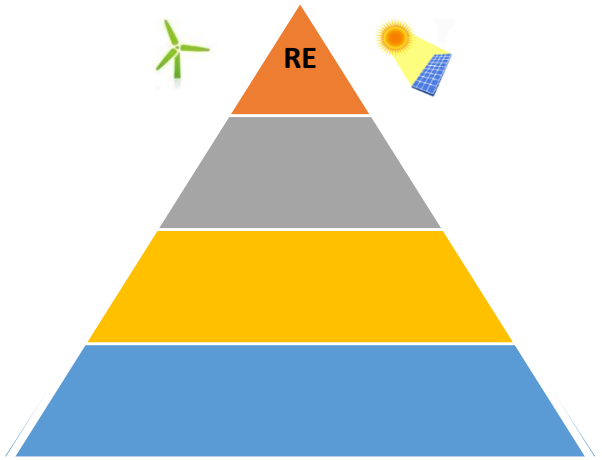


Energy Pyramid

الطاقة المتجددة Renewable Energy:

Energy Reduction Methodology:

Utilizing energy from a renewable source and reducing fossil fuel dependency



Cost: The highest

Sustainability: The highest

Examples:

- On grid/Off grid PV Systems.
- Domestic & Process SWH systems
- Wind turbines.
- Biofuel

Energy Challenge in Jordan

- Jordan faces two significant challenges in its energy sector:

1. The rising energy demand,
2. and limited domestic resources to meet the country's needs.

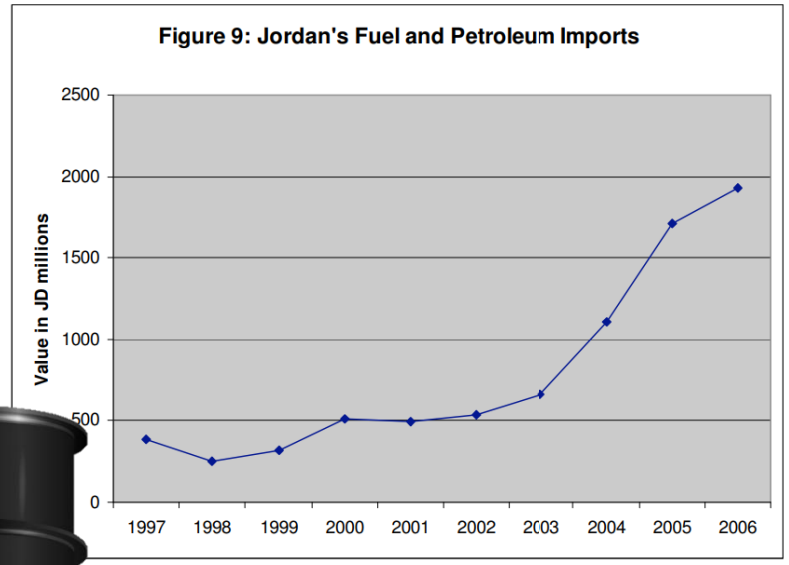
CONTENTS

- Energy challenge in Jordan
- What are the main energy sources we use in Jordan?
- Who are the main energy consumers?
- How is electricity produced in Jordan?
- Where is electricity being used?
- What MEMR, EMRC, NEPCO, JEPCO, … stands for?
- Who is responsible for what?

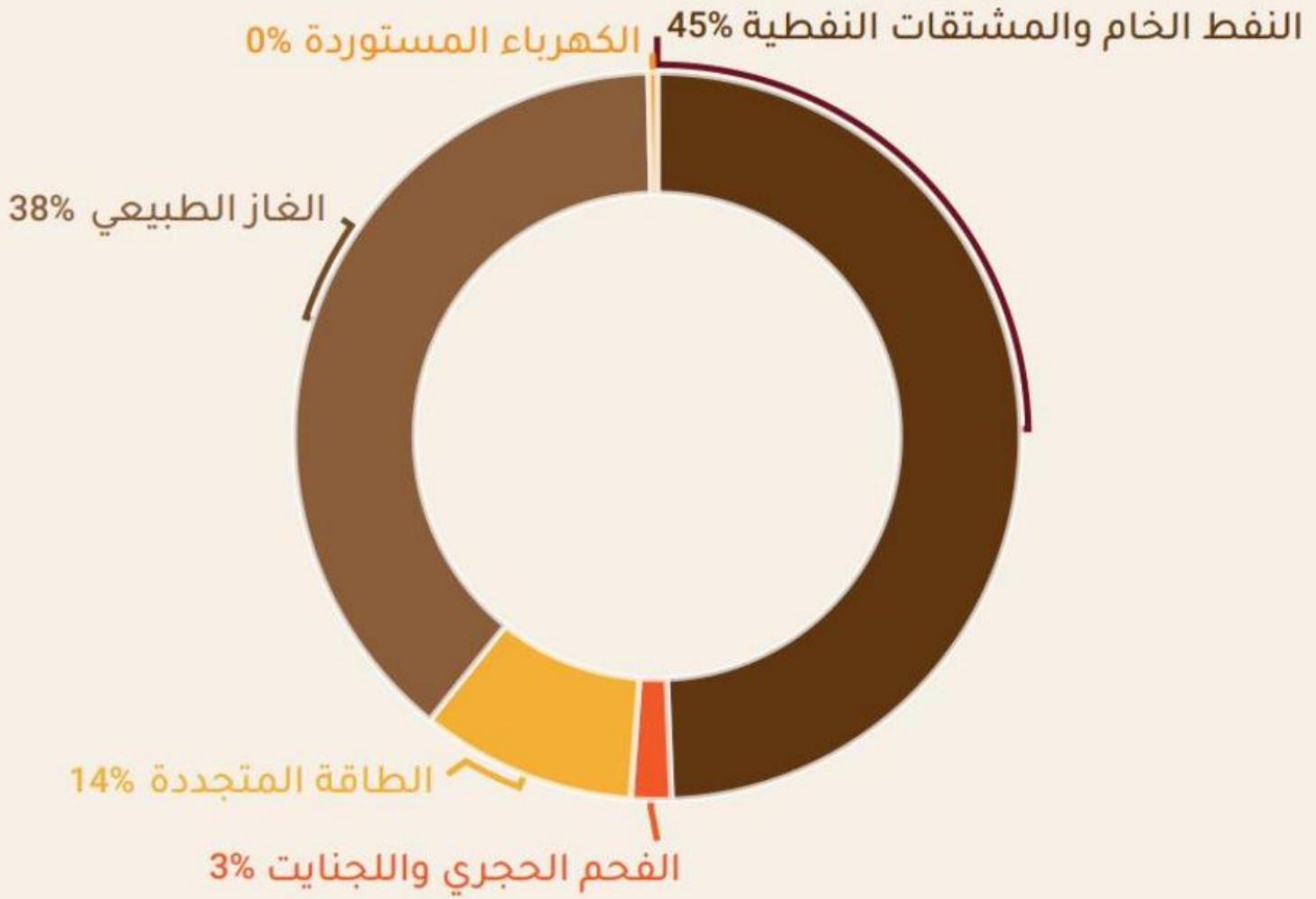
Energy in the news

Energy Challenge in Jordan

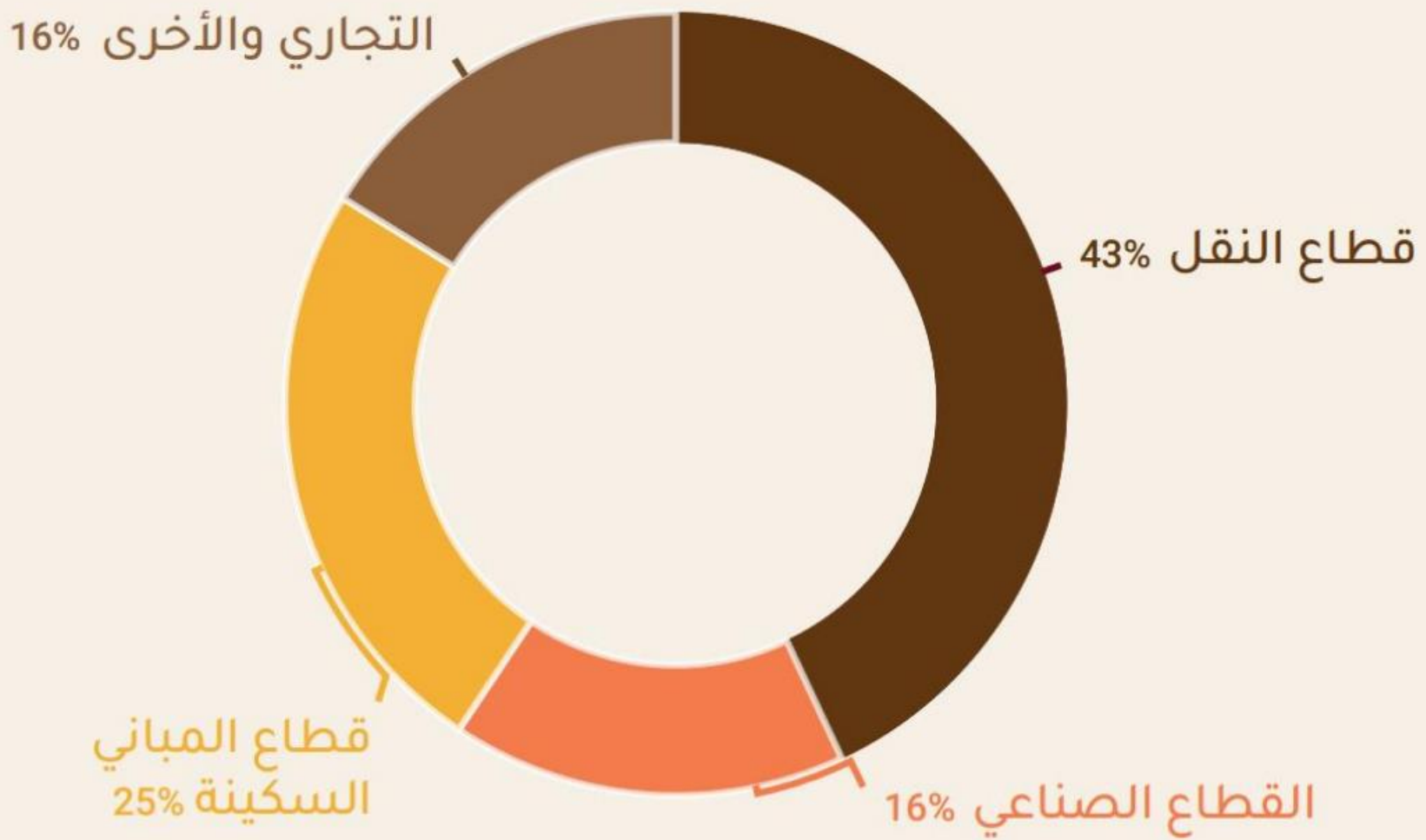
- Jordan imports 96% of its energy needs from abroad. Prior to the US occupation of Iraq, The Iraqi supplied half of Jordan's oil for free, and the rest at a discount price.



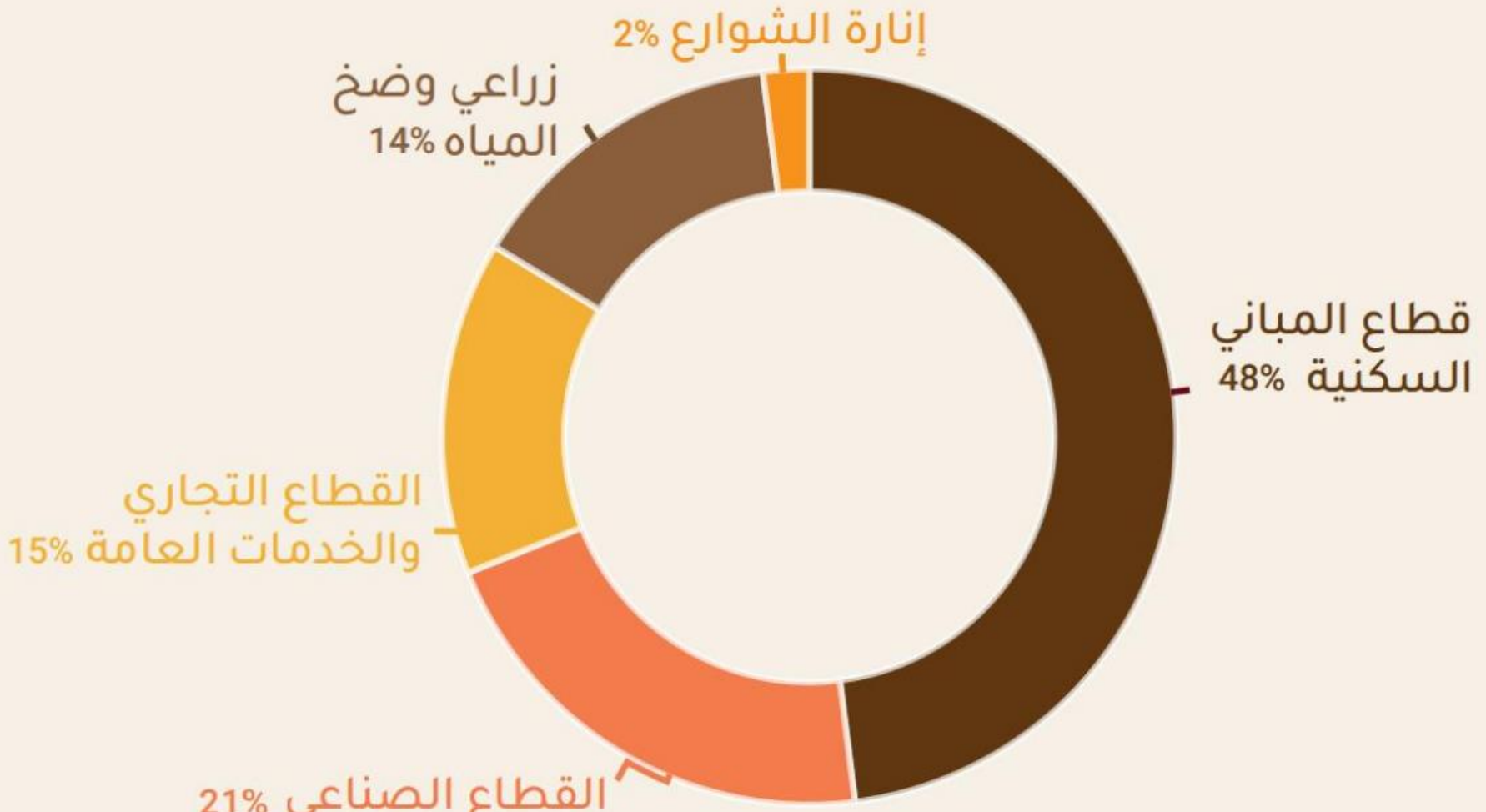
خليط الطاقة الكلي 2021



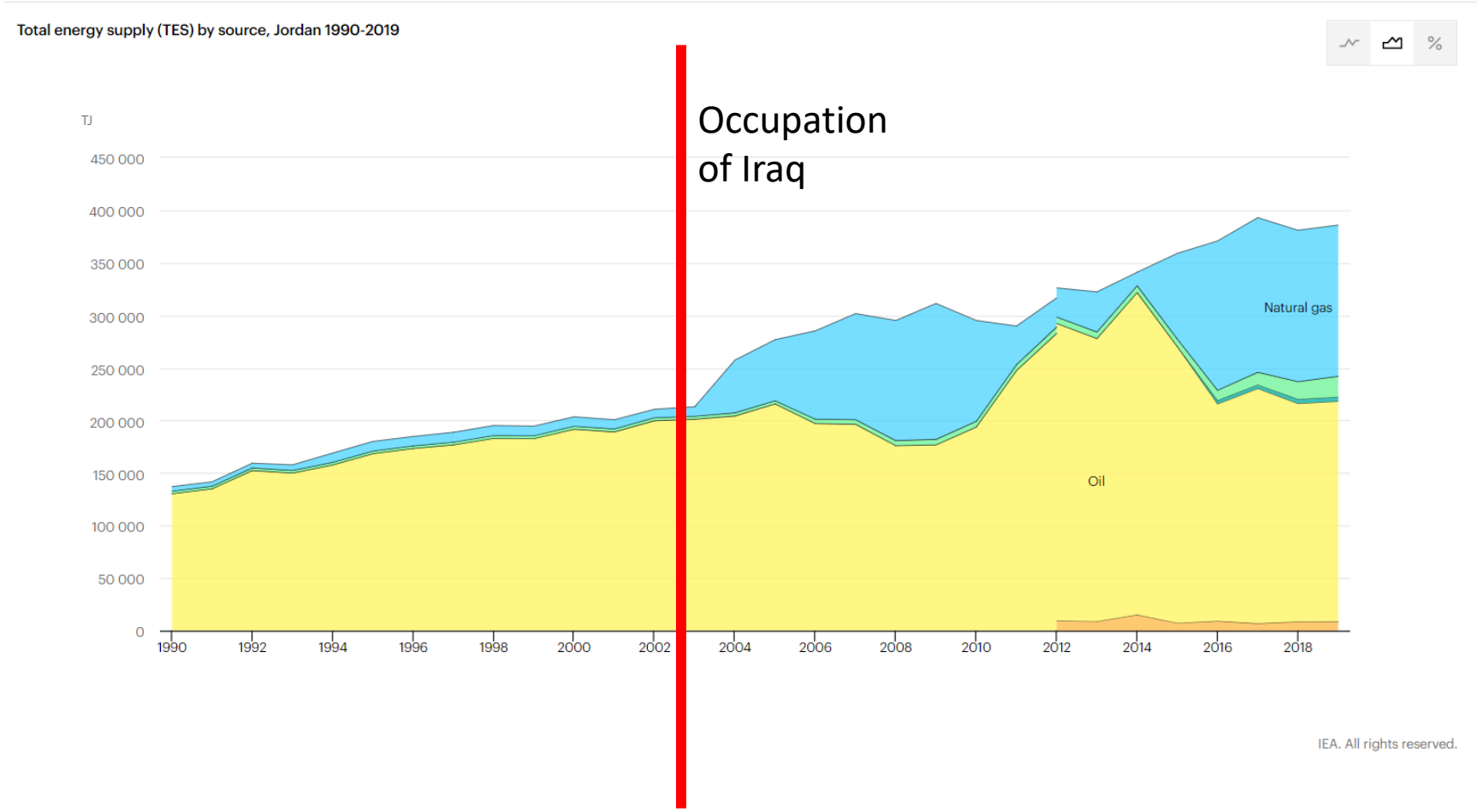
التوزيع القطاعي لاستهلاك الطاقة لعام 2021



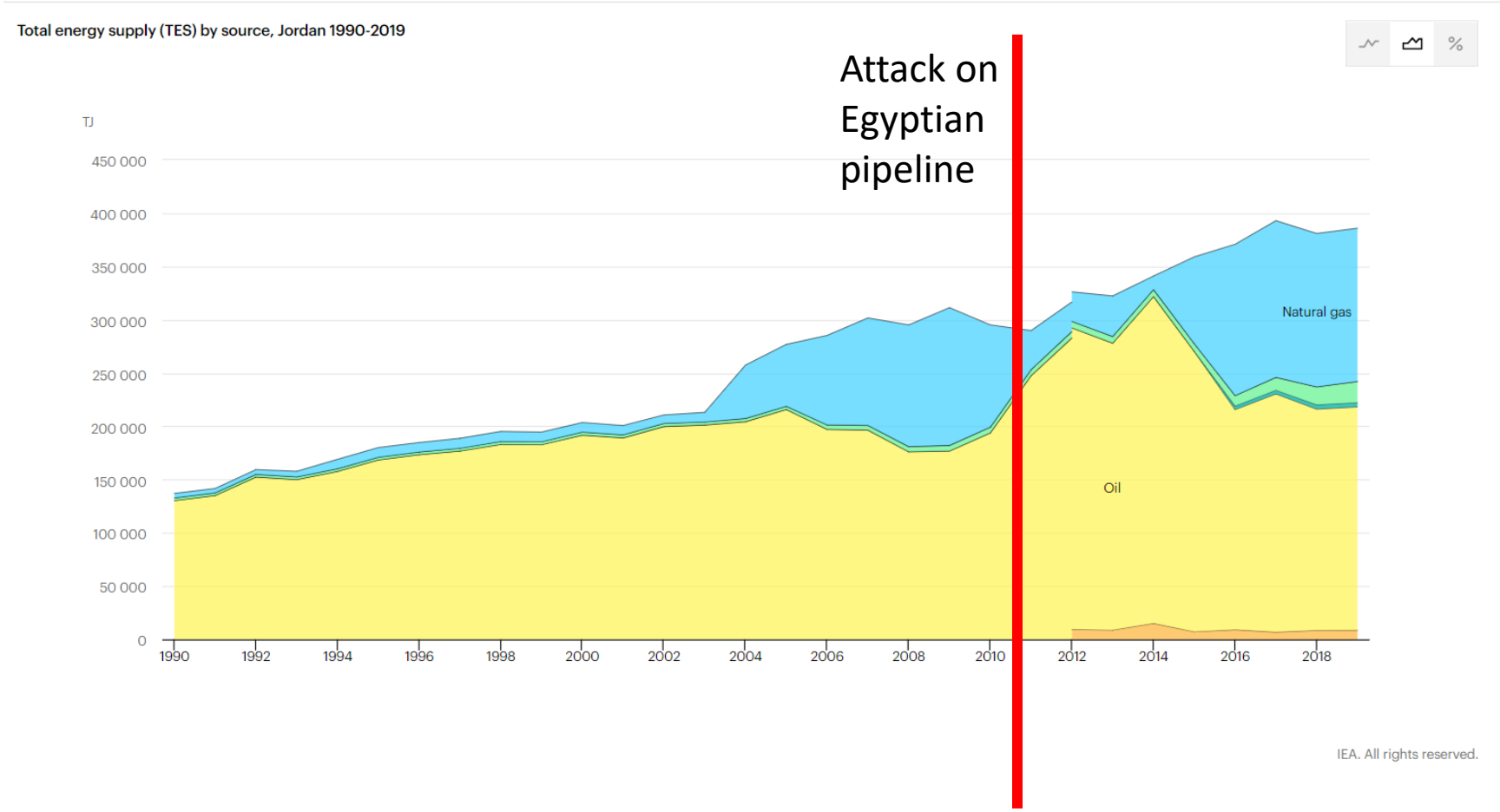
التوزيع القطاعي لاستهلاك الطاقة الكهربائية لعام 2021



Total energy supply by source
Jordan 1990-2019



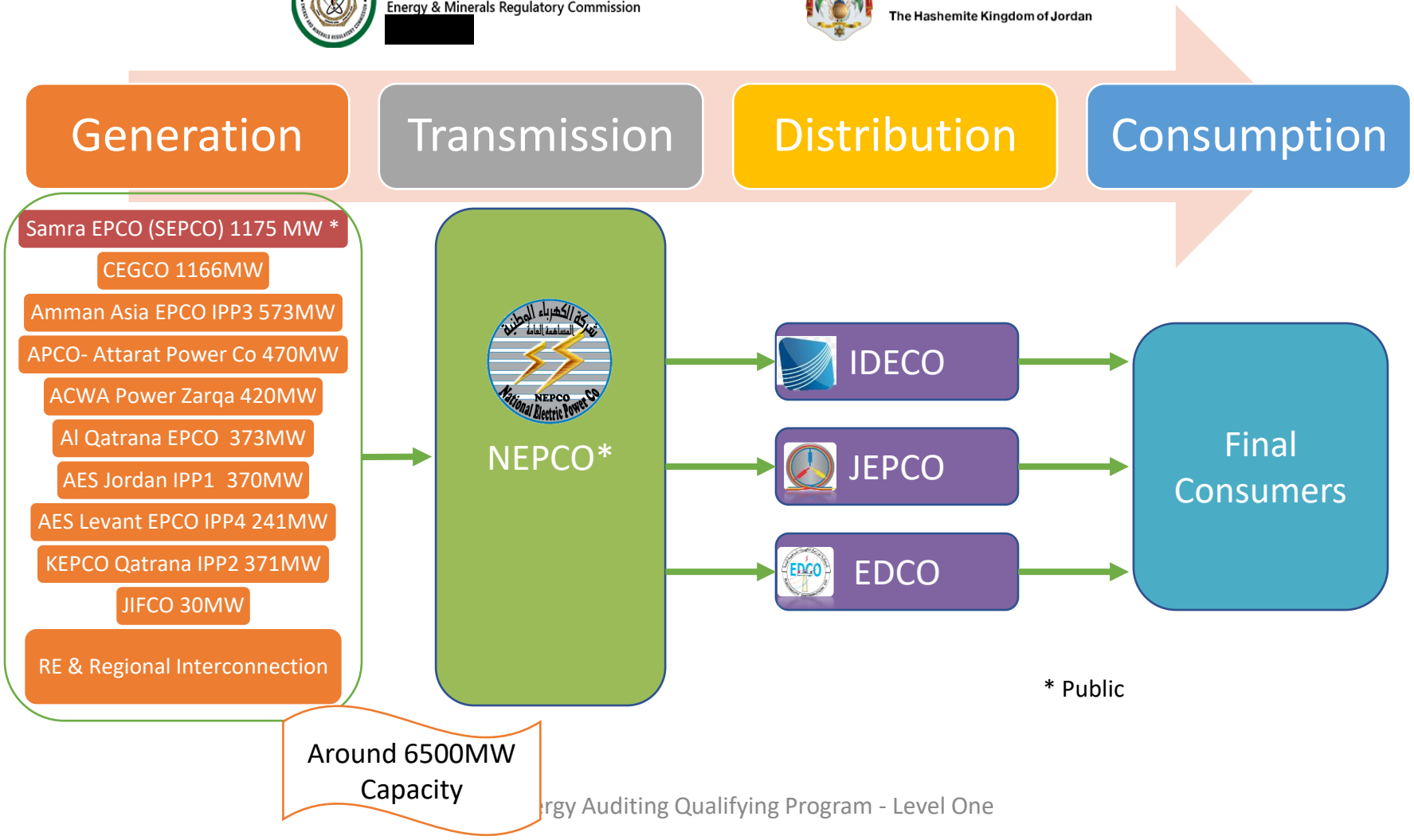
Total energy supply by source
Jordan 1990-2019



Electricity Sector in Jordan

هيئة تنظيم قطاع الطاقة والمعادن
Energy & Minerals Regulatory Commission

Ministry of Energy and Mineral Resources
The Hashemite Kingdom of Jordan

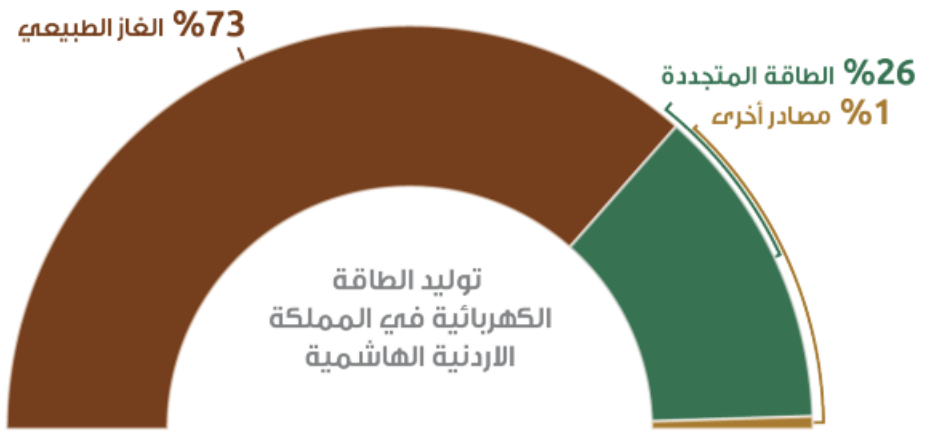


الأهداف القطاعية لوزارة الطاقة والثروة المعدنية

انجازات وزارة الطاقة والثروة المعدنية

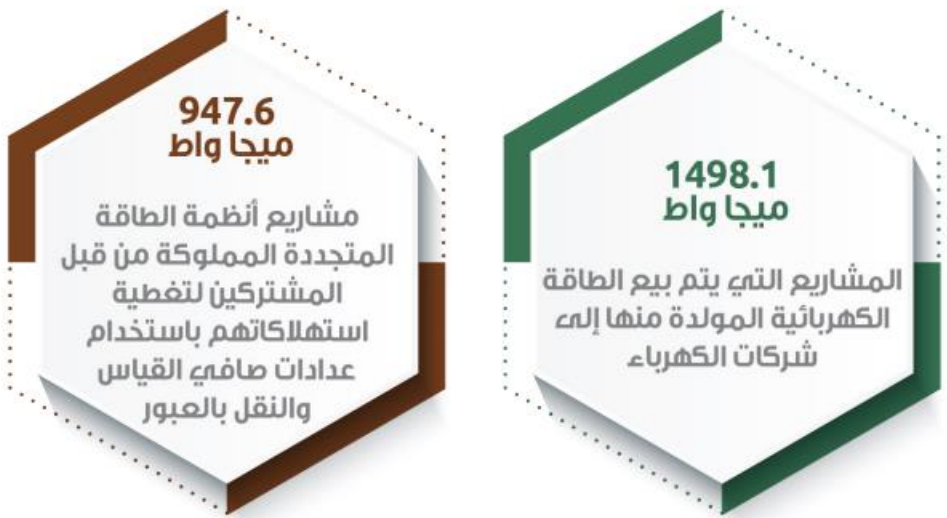
1. في مجال الطاقة الكهربائية

تم توليد الطاقة الكهربائية في المملكة الاردنية الهاشمية باستخدام الغاز الطبيعي بنسبة (73%) والطاقة المتجددة بنسبة (26%) و(1%) من مصادر اخرى، مقارنة بنسبة 80% و 20% على التوالي للعام 2020.



2.1 توليد الطاقة الكهربائية باستخدام الطاقة المتجددة

بلغت الاستطاعة الكلية المركبة لمشاريع توليد الطاقة الكهربائية من مصادر الطاقة المتجددة حوالي 2445.7 ميجاواط، وتشمل:



3.1 توليد الكهرباء باستخدام الحرق المباشر للصخر الزيتي

يتم تنفيذ هذا المشروع والذي يعتمد على الحرق المباشر للصخر الزيتي لتوليد الكهرباء باستطاعة 470 ميجا واط من قبل شركة عطارات للطاقة، ومن المتوقع ان يتم الانتهاء من التجارب التشغيلية للمشروع وتشغيله تجاريا خلال عام 2022.

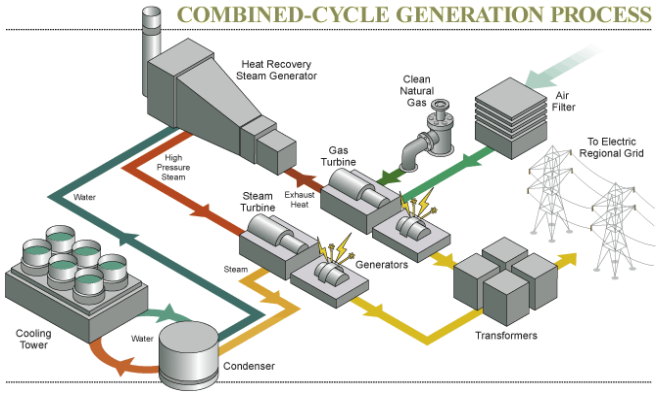
Generation | Transmission | Distribution

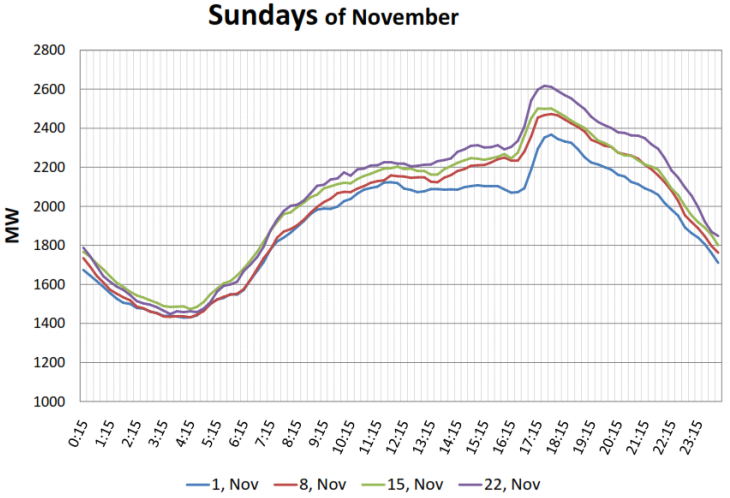
- Steam turbine
- Gas turbine (CC & SC)
- Diesel Engines
- Hydro, Wind & PV

- Distributing Companies
- Large Consumers

Transmission System Operator (TSO)

Transmission system operator (TSO)-NEPCO
National control center





National Electric Power Co. (NEPCO)

National Transmission Grid

SYRIA

EGYPT

Main Bulk Substations

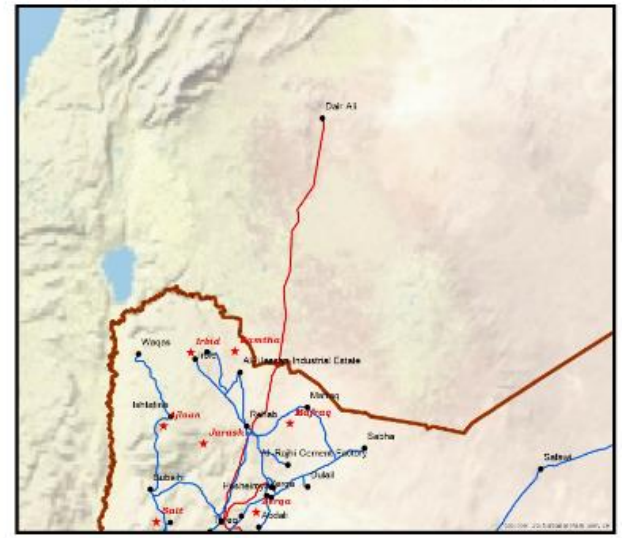
OHTL 132 kV

U.G. Cable 132 kV

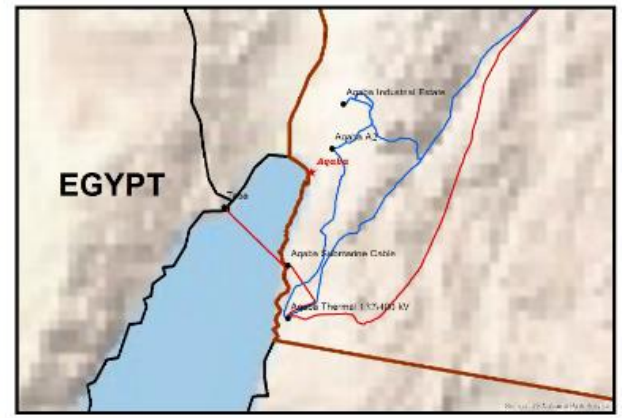
OHTL 400 kV

0 25 50 100 Km

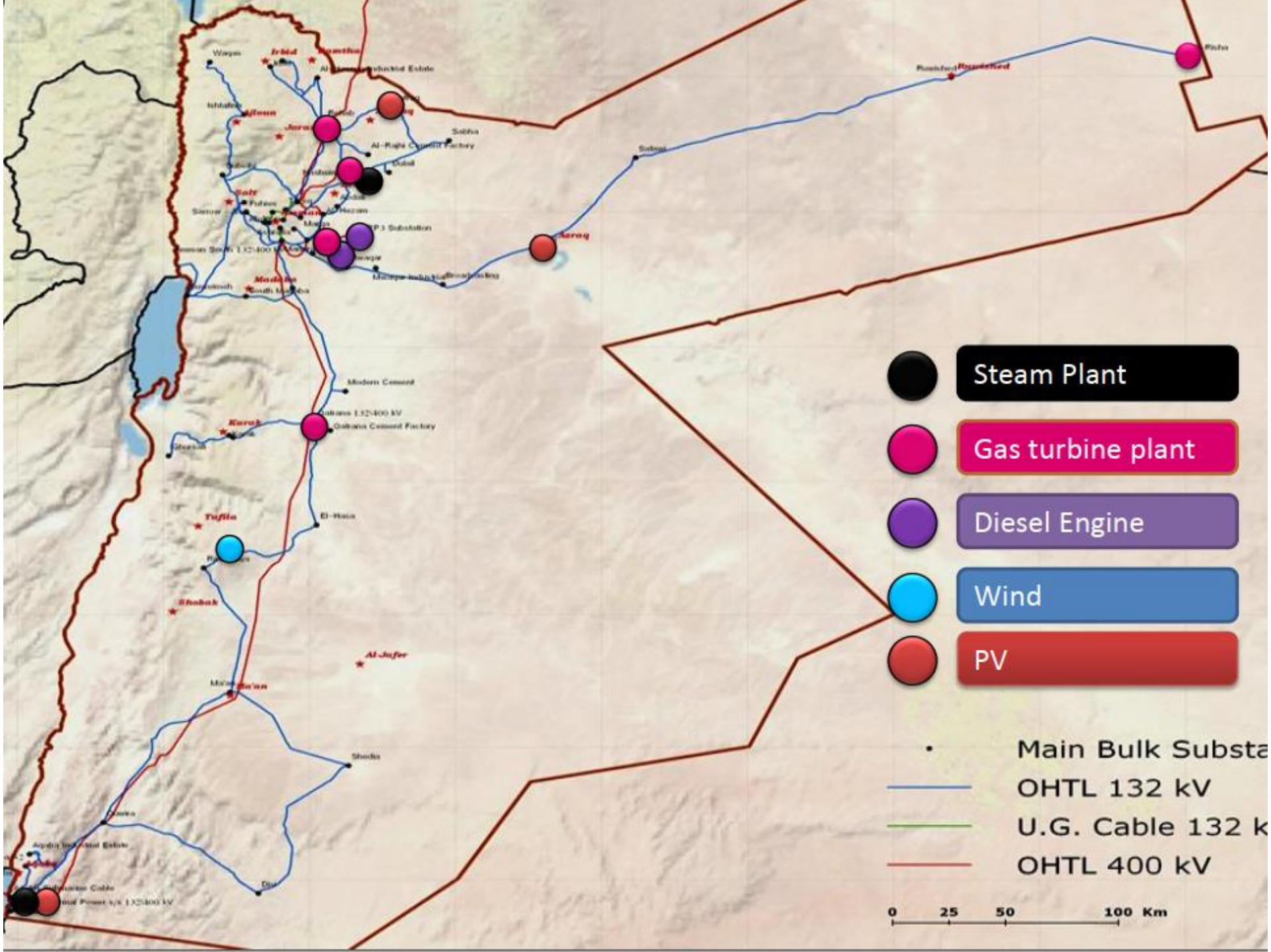
JORDAN - SYRIA Interconnection



EGYPT - JORDAN Interconnection



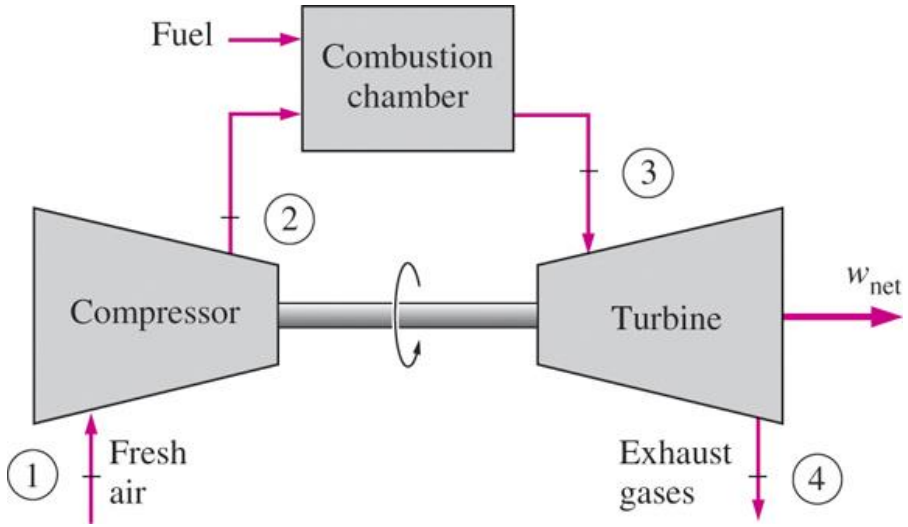
Generation Systems


Steam Plant
Gas turbine plant
Diesel Engine
Wind
PV
Main Bulk Substa
OHTL 132 kV
U.G. Cable 132 k
OHTL 400 kV
0 25 50 100 Km

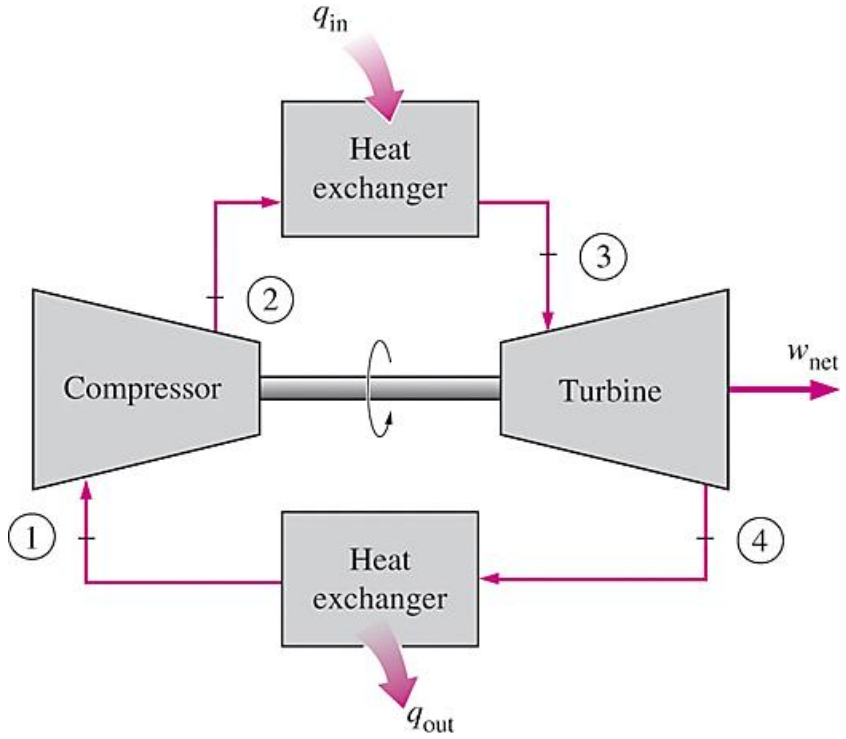
BRAYTON CYCLE: THE IDEAL CYCLE FOR GAS-TURBINE ENGINES

The combustion process is replaced by a constant-pressure heat-addition process from an external source, and the exhaust process is replaced by a constant-pressure heat-rejection process to the ambient air.

1-2 Isentropic compression (in a compressor)
2-3 Constant-pressure heat addition
3-4 Isentropic expansion (in a turbine)
4-1 Constant-pressure heat rejection



An open-cycle gas-turbine engine.

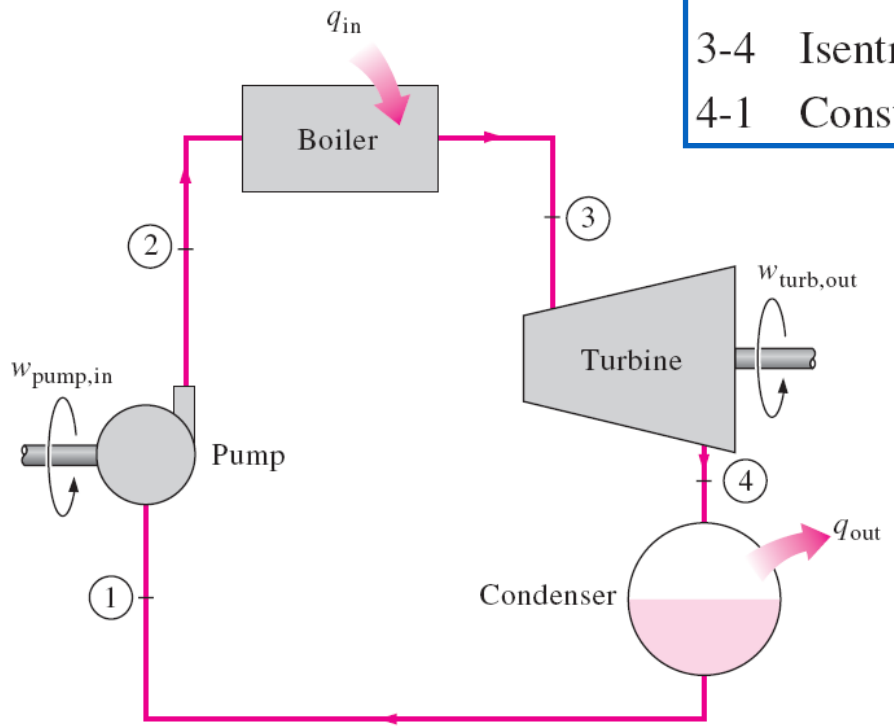


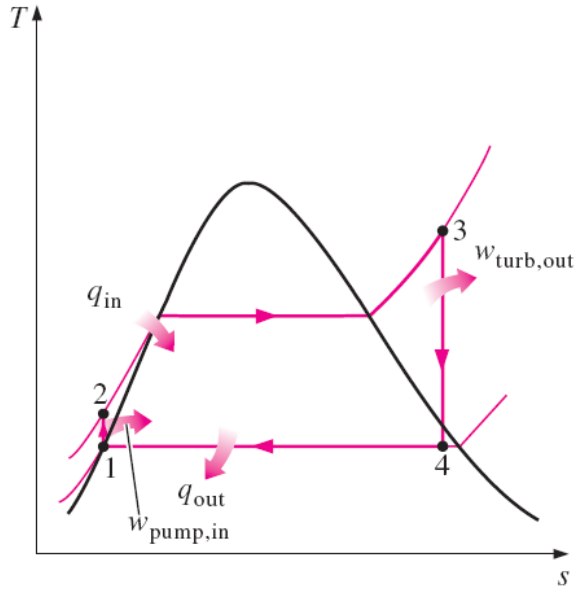
A closed-cycle gas-turbine engine.

RANKINE CYCLE: THE IDEAL CYCLE FOR VAPOR POWER CYCLES

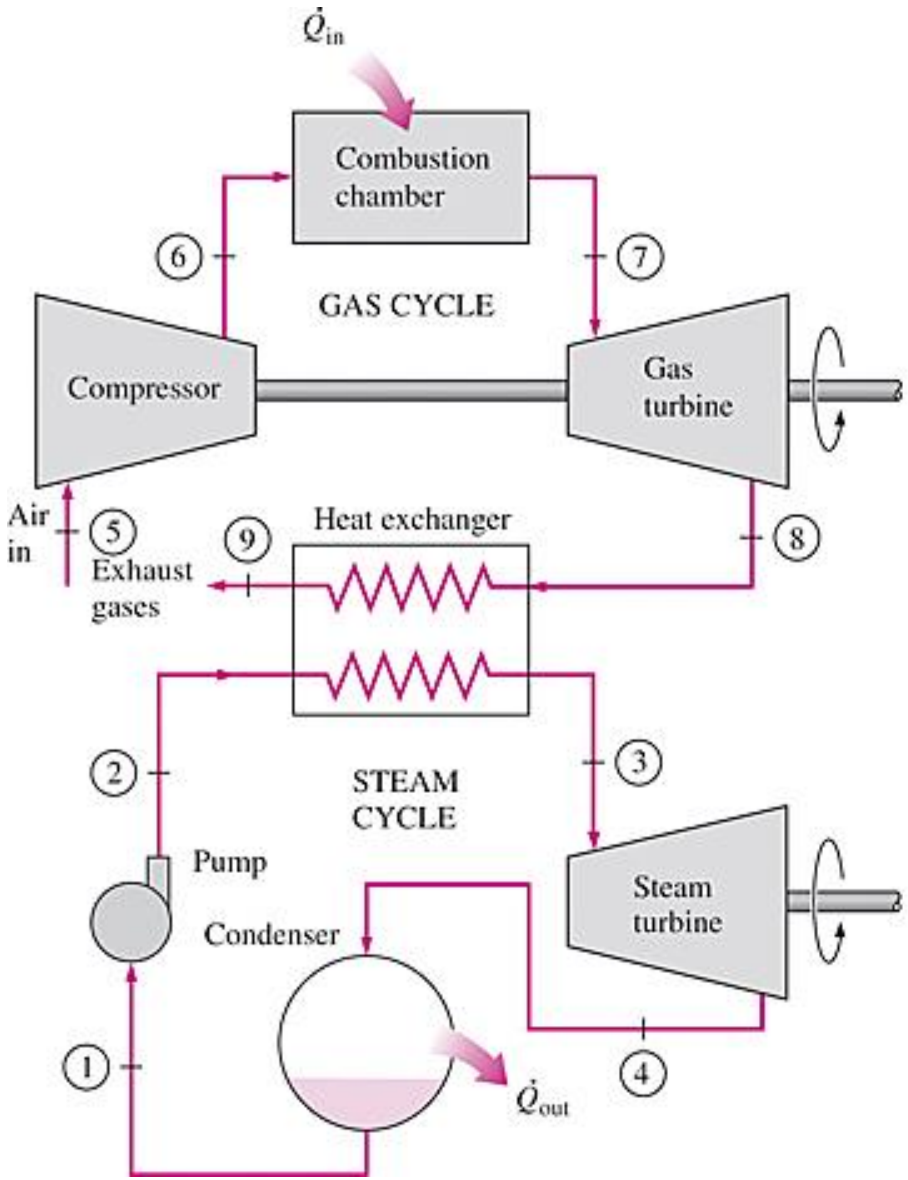
Many of the impracticalities associated with the Carnot cycle can be eliminated by superheating the steam in the boiler and condensing it completely in the condenser. The cycle that results is the **Rankine cycle**, which is the ideal cycle for vapor power plants. The ideal Rankine cycle does not involve any internal irreversibilities.

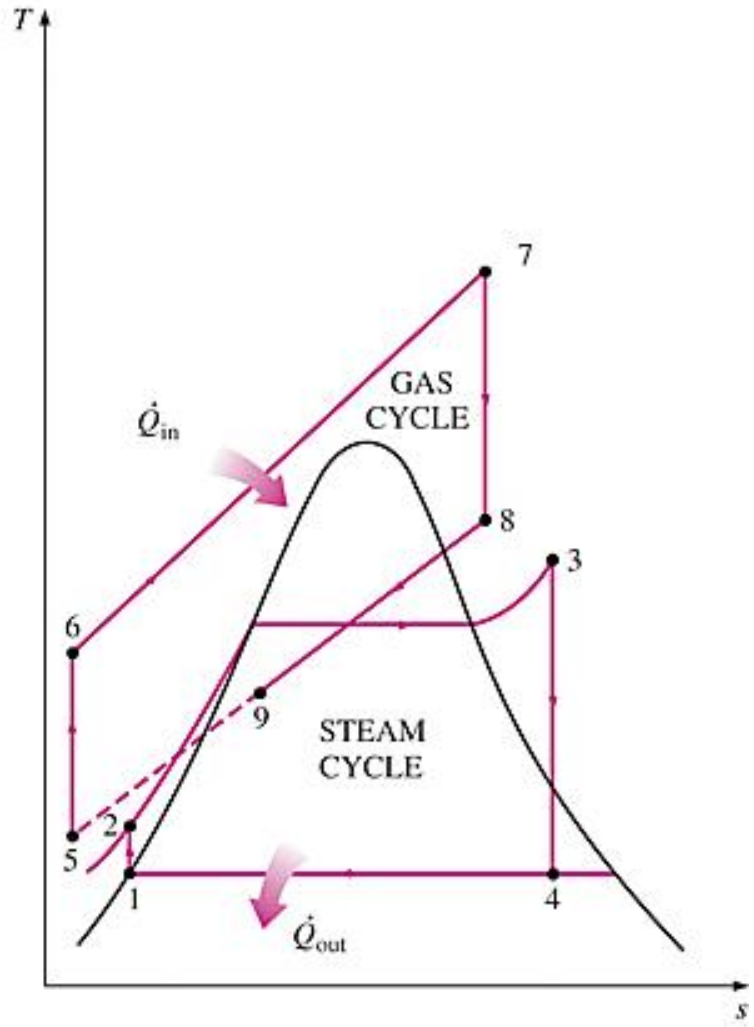
1-2	Isentropic compression in a pump
2-3	Constant pressure heat addition in a boiler
3-4	Isentropic expansion in a turbine
4-1	Constant pressure heat rejection in a condenser





The simple ideal Rankine cycle.





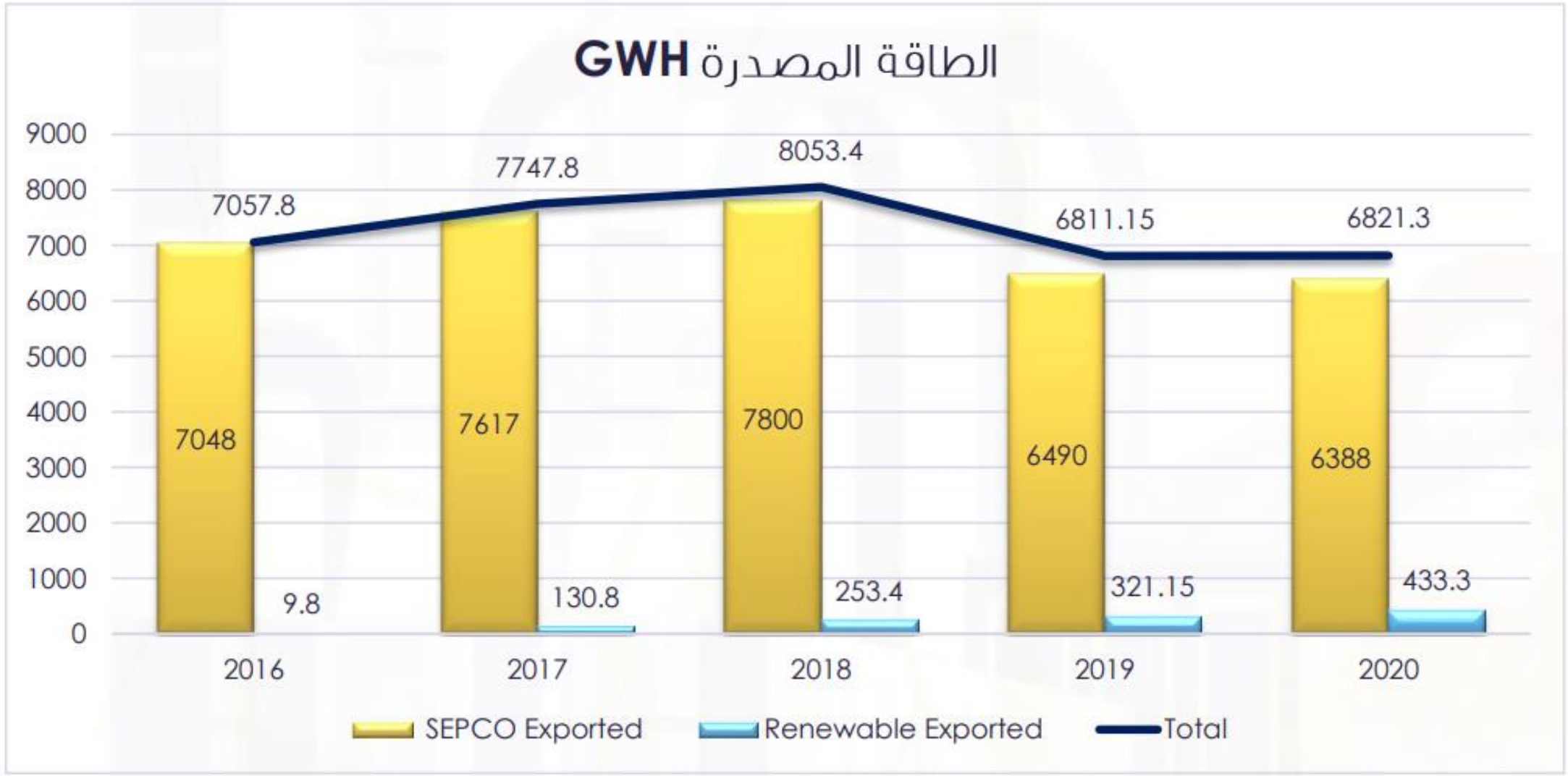
Combined gas–steam power plant.


English
شركة السمرا لتوليد الكهرباء
Samra Electric Power Co. (SEPCO)
الرئيسية
عن الشركة
محطات التوليد
العطاءات
المركز الإعلامي
الاستدامة
مركز المعلومات
شاركنا رأيك
محطة السمرا لتوليد الكهرباء
نساهم بالحصة الأكبر من إنتاج الطاقة الكهربائية في المملكة الأردنية الهاشمية من خلال محطة السمرا بشكل أساسي والتي صممت وفق أحدث تكنولوجيا على مبدأ الدورة المركبة
اقرأ المزيد

الوحدات التوليدية العاملة في شركة السمرا لتوليد الكهرباء

المرحلة	الاستطاعة الاسمية (م.و)	الوحدة	تاريخ التشغيل التجاري	الاستطاعة الاسمية (م.و)
المرحلة الاولى	٣٠٠	الوحدة الغازية الأولى	٢٠٠٥/١١/١	١٠٠
		الوحدة الغازية الثانية	٢٠٠٦/٢/١١	١٠٠
		الوحدة البخارية الأولى	٢٠٠٦/١/٨	١٠٠
المرحلة الثانية	٣٠٠	الوحدة الغازية الثالثة	٢٠٠٧/١٢/١٣	١٠٠
		الوحدة الغازية الرابعة	٢٠٠٨/٧/٥	١٠٠
		الوحدة البخارية الثانية	٢٠١٠/٨/٢	١٠٠
المرحلة الثالثة	٤٢٩	الوحدة الغازية الخامسة	٢٠١١/١/٢٥	١٤٣
		الوحدة الغازية السادسة	٢٠١١/٥/٤	١٤٣
		الوحدة البخارية الثالثة	٢٠١٥/٦/١٥	١٤٣
المرحلة الرابعة	٢١٢	الوحدة الغازية السابعة	٢٠١٣/٦/٢٦	١٤٦
		الوحدة البخارية الرابعة	٢٠١٨/٠٣/١٢	٦٦
الطاقة الشمسية	١٦٢,٠٤	مجمع الشيخ زايد الشمسي	٢٠١٨/٧/١٧	١٠٣,٤٢٠
		محطة الأزرق ١	٢٠١٥/٦/٨	٣
		محطة الأزرق ٢	٢٠١٥/٦/٨	٢,١٧
		محطة الأزرق ٣	٢٠٢٠/٢/٦	٥,٧٥
		محطة جنوب عمان	٢٠٢٠/١/٨	٤٦,٦
محطات الرياح	٨٠	محطة رياح معان ١	٢٠١٦/٩/٢٢	٦٦
		محطة رياح معان ٢	٢٠١٧/٨/٣٠	١٤
الاستطاعة الاسمية لشركة السمرا (م و)				١٤٨٢

جدول (٢) الوحدات التوليدية العاملة في شركة السمرا لتوليد الكهرباء



شكل (٤) الطاقة المصدرة

Jordan's IPP3

Guinness record: the world's largest internal combustion engine power plant

Amman Asia Electric Power Co. & The Bank of Tokyo-Mitsubishi UFJ (Global Facility Agent) | Jordan | 2012 to present

World's largest reciprocating engine

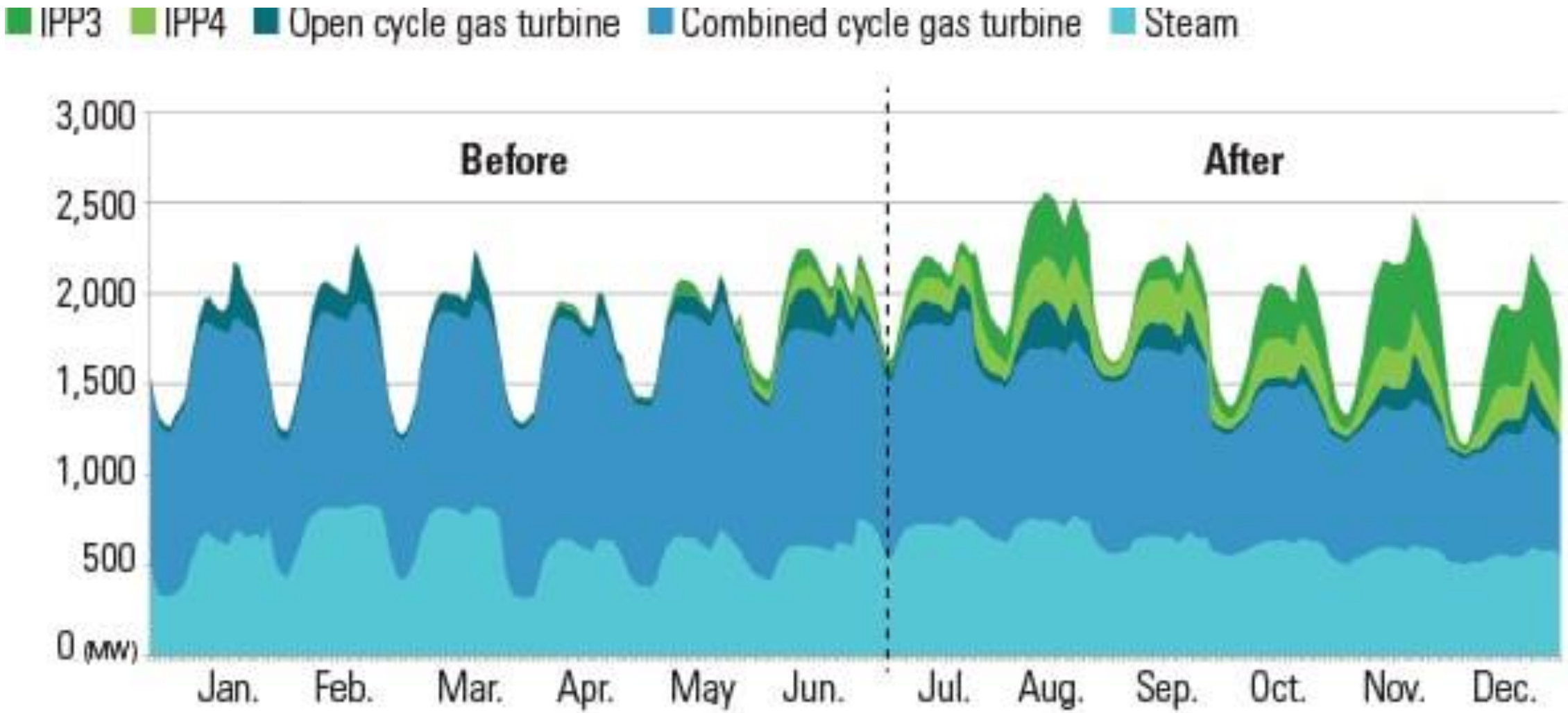
573 MW of generating capacity

3 fuel-type burning ability (natural gas, light fuel oil, and heavy fuel oil)

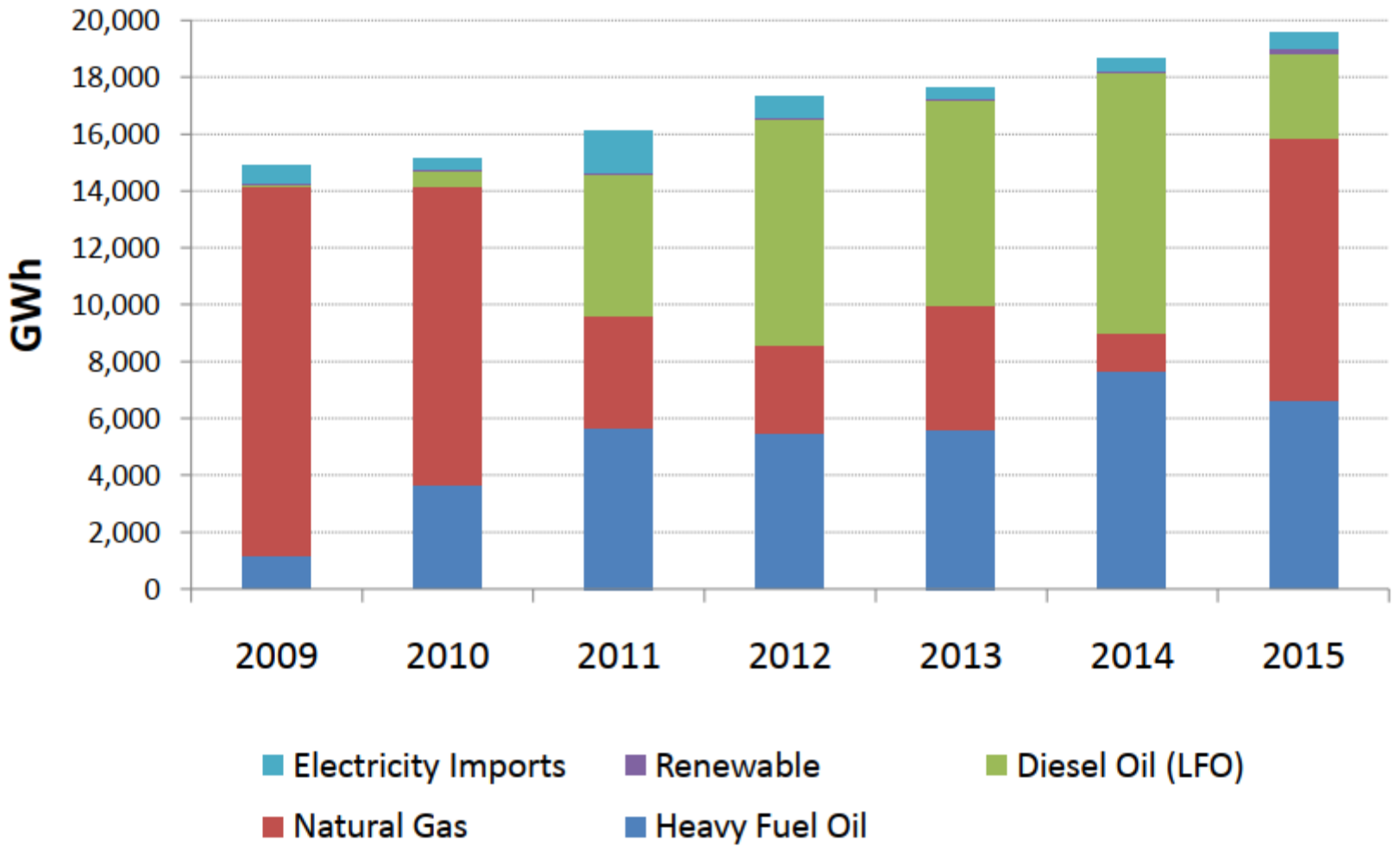
24 months to complete the project

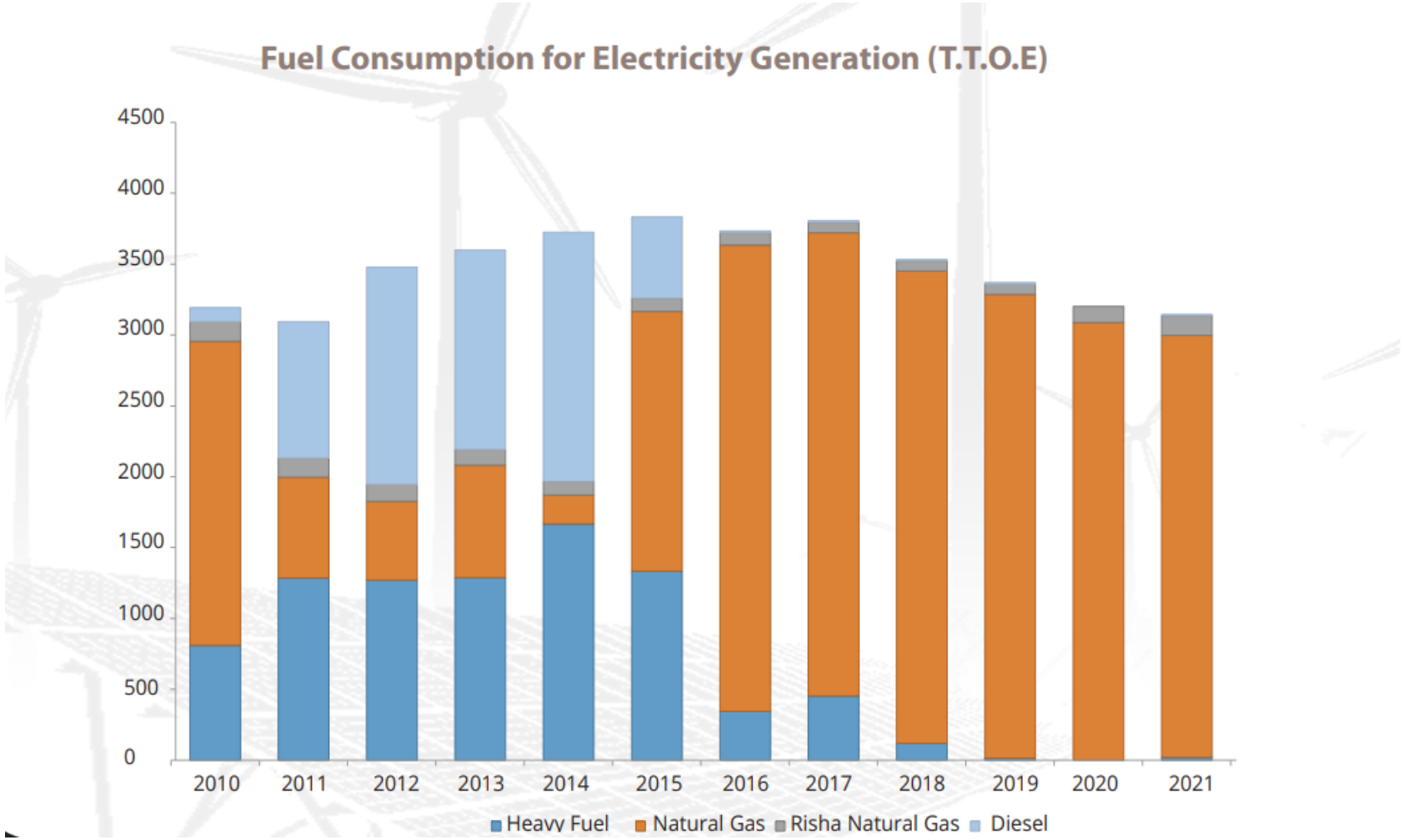
https://www.facebook.com/100057517807153/videos/1119788094701782/

- Jordan’s IPP3, located at Al Manakher, 30km from the Jordanian capital Amman, is the world’s biggest tri-fuel power plant and has an installed capacity of 573MW. The plant is designed to use natural gas and heavy fuel oil (HFO) as its main fuels and light fuel oil (HFO) as the backup fuel.

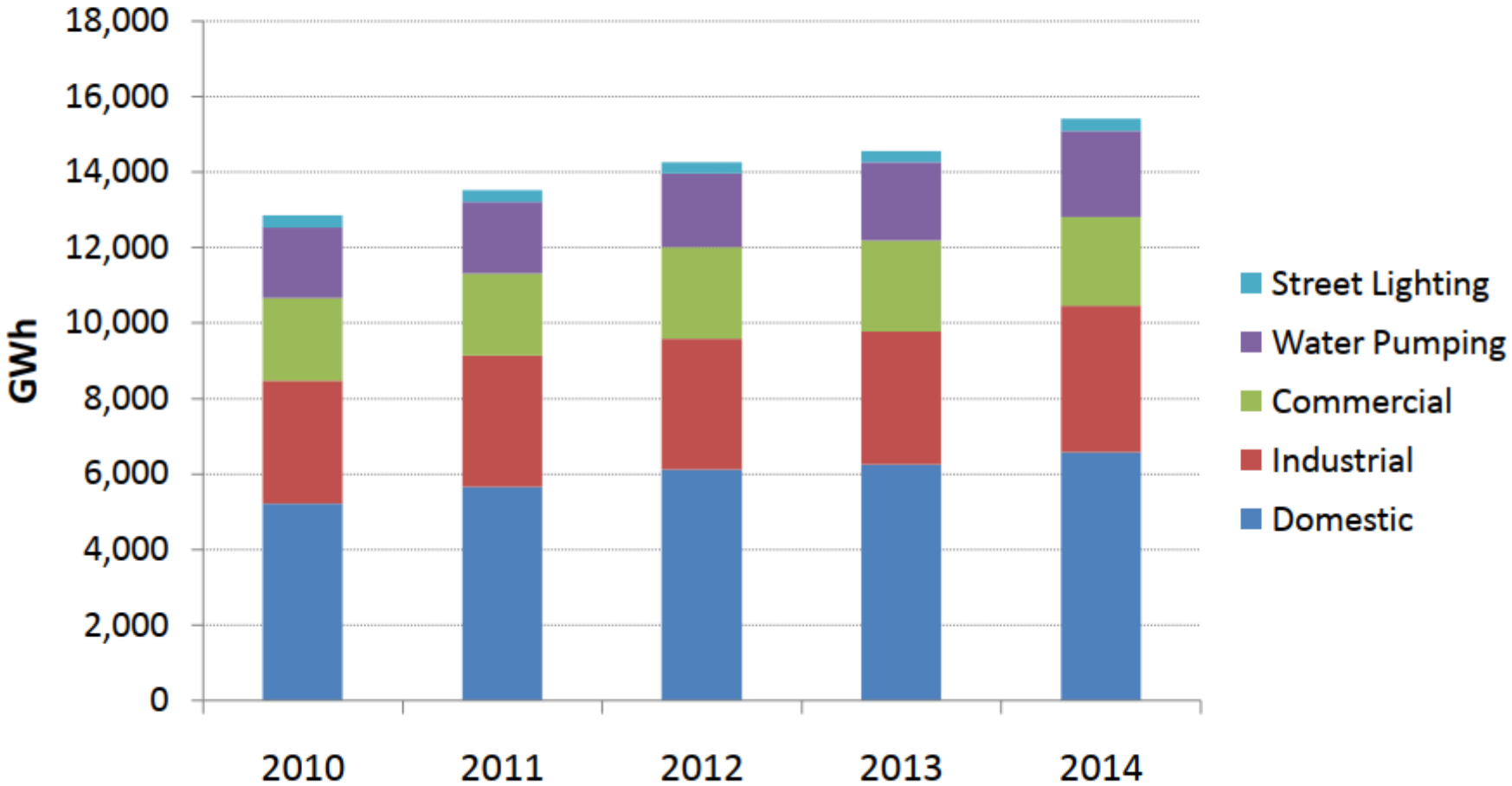

IPP3
IPP4
Open cycle gas turbine
Combined cycle gas turbine
Steam
3,000
2,500
2,000
1,500
1,000
500
0 (MW)
Before
After
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.

Generated Energy by Fuel

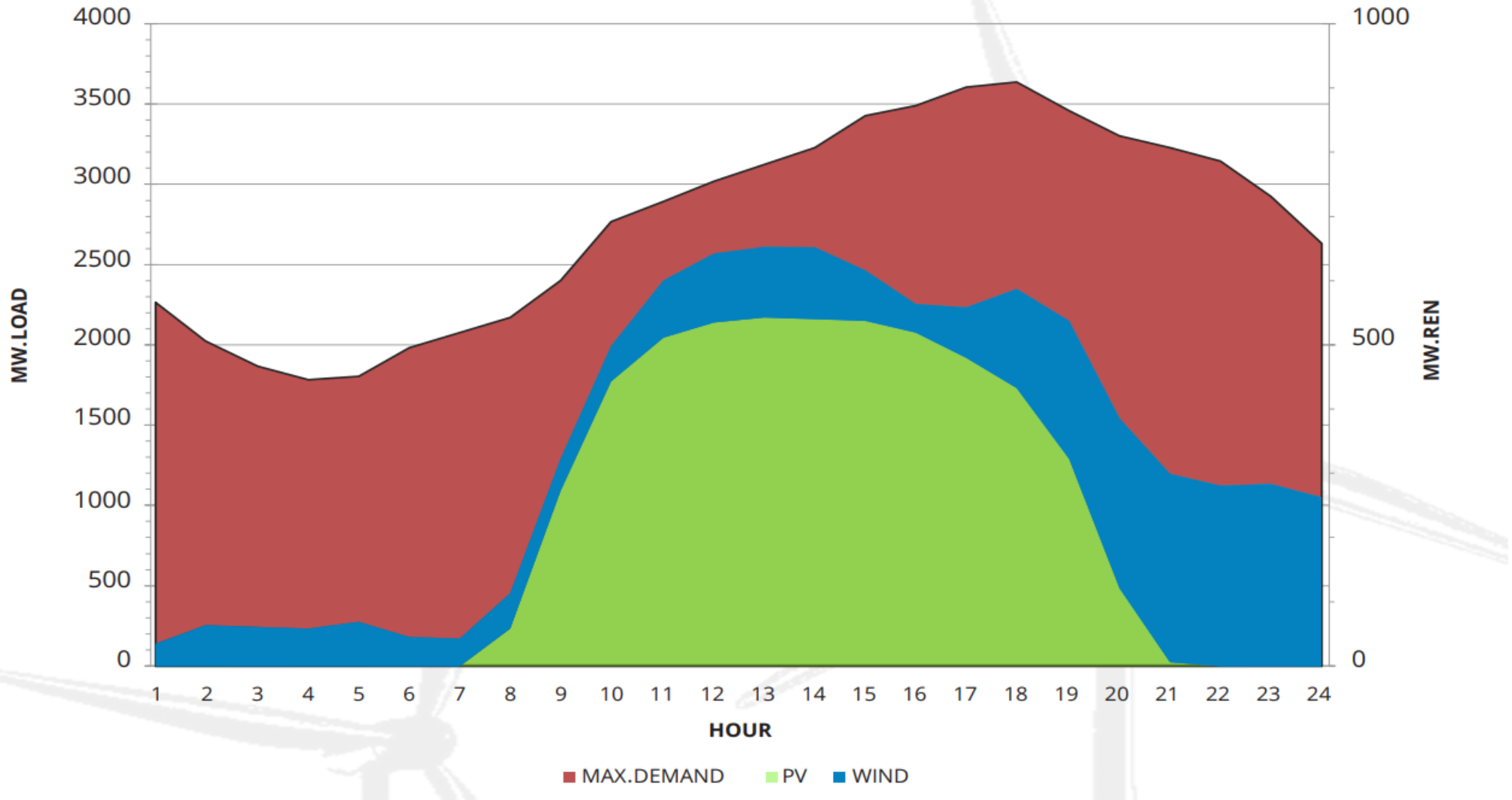



Fuel Consumption for Electricity Generation (T.T.O.E)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Heavy Fuel
Natural Gas
Risha Natural Gas
Diesel

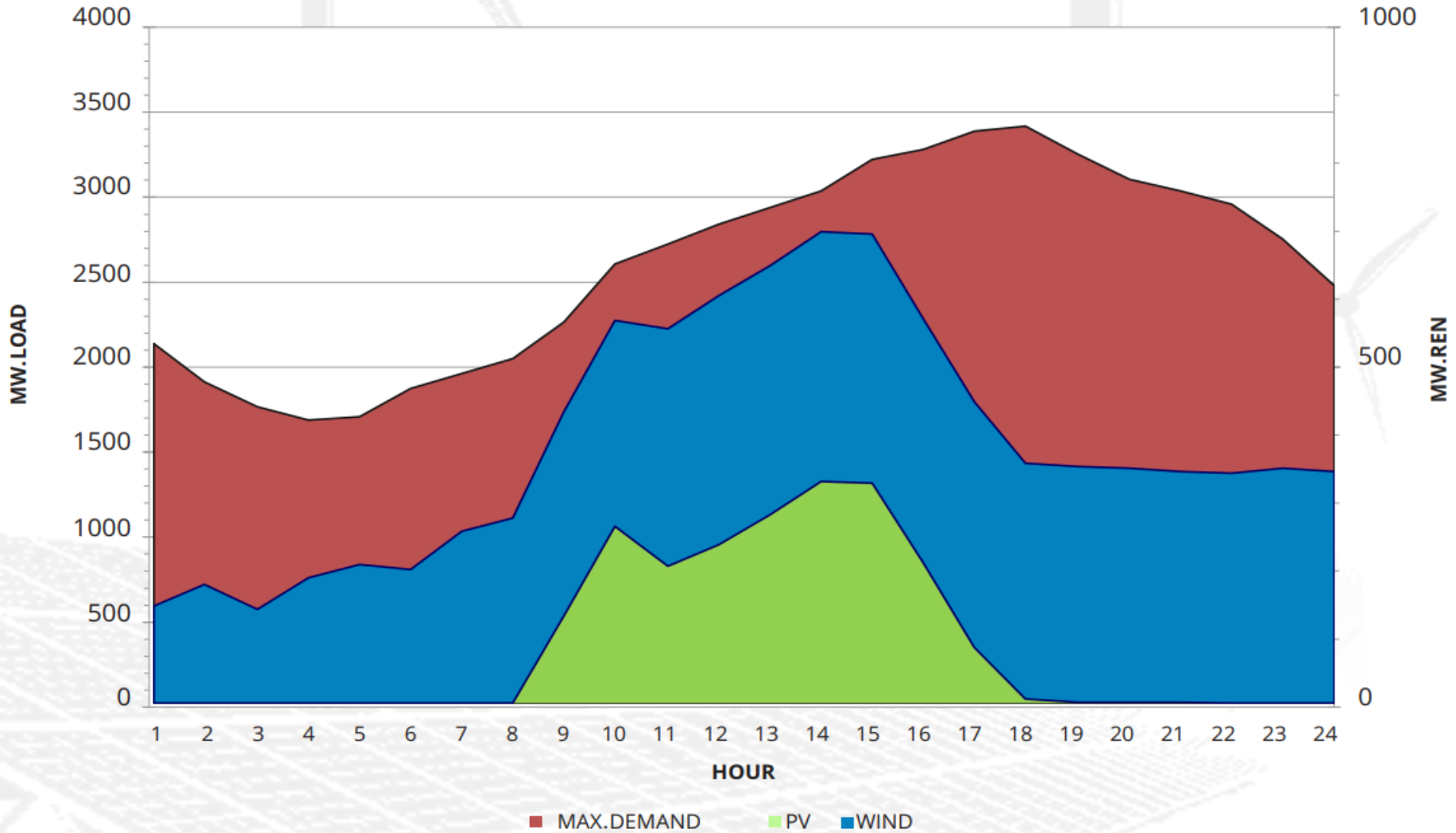
Electric Energy Consumption



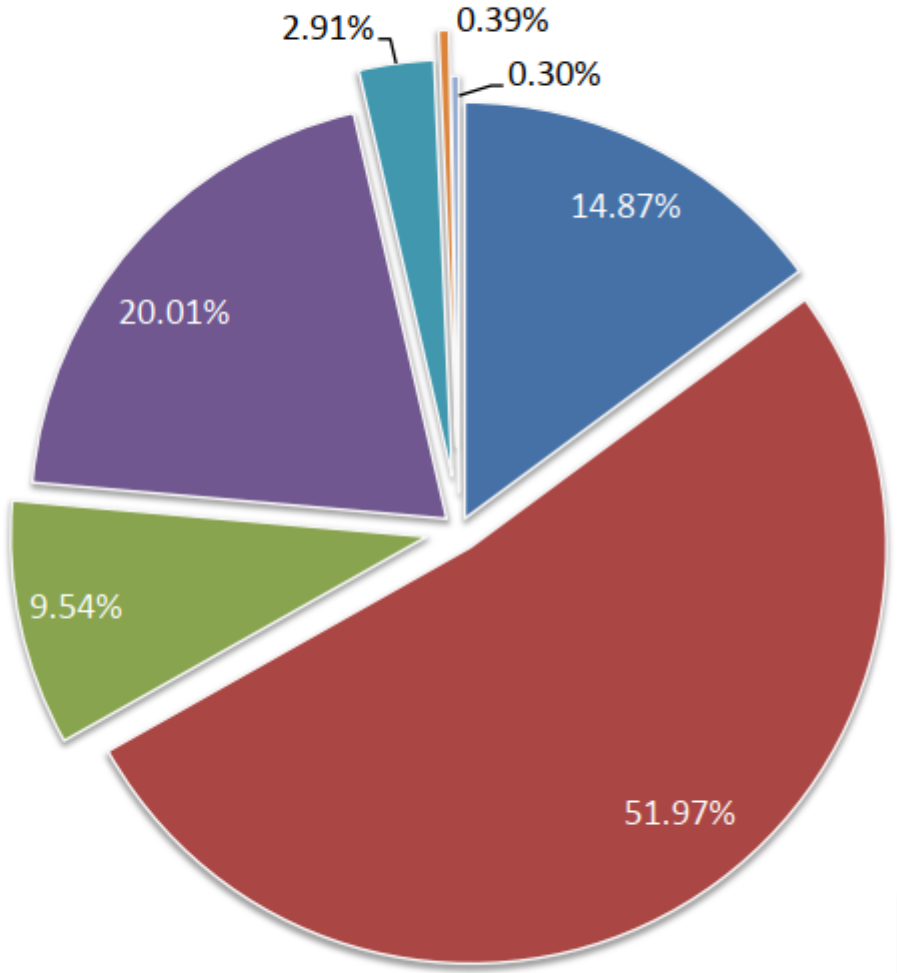
Summer Peak Load Curve (19/07/2021)



Winter Peak Load Curve (20/12/2021)



Generating Plants Capacity [MW]



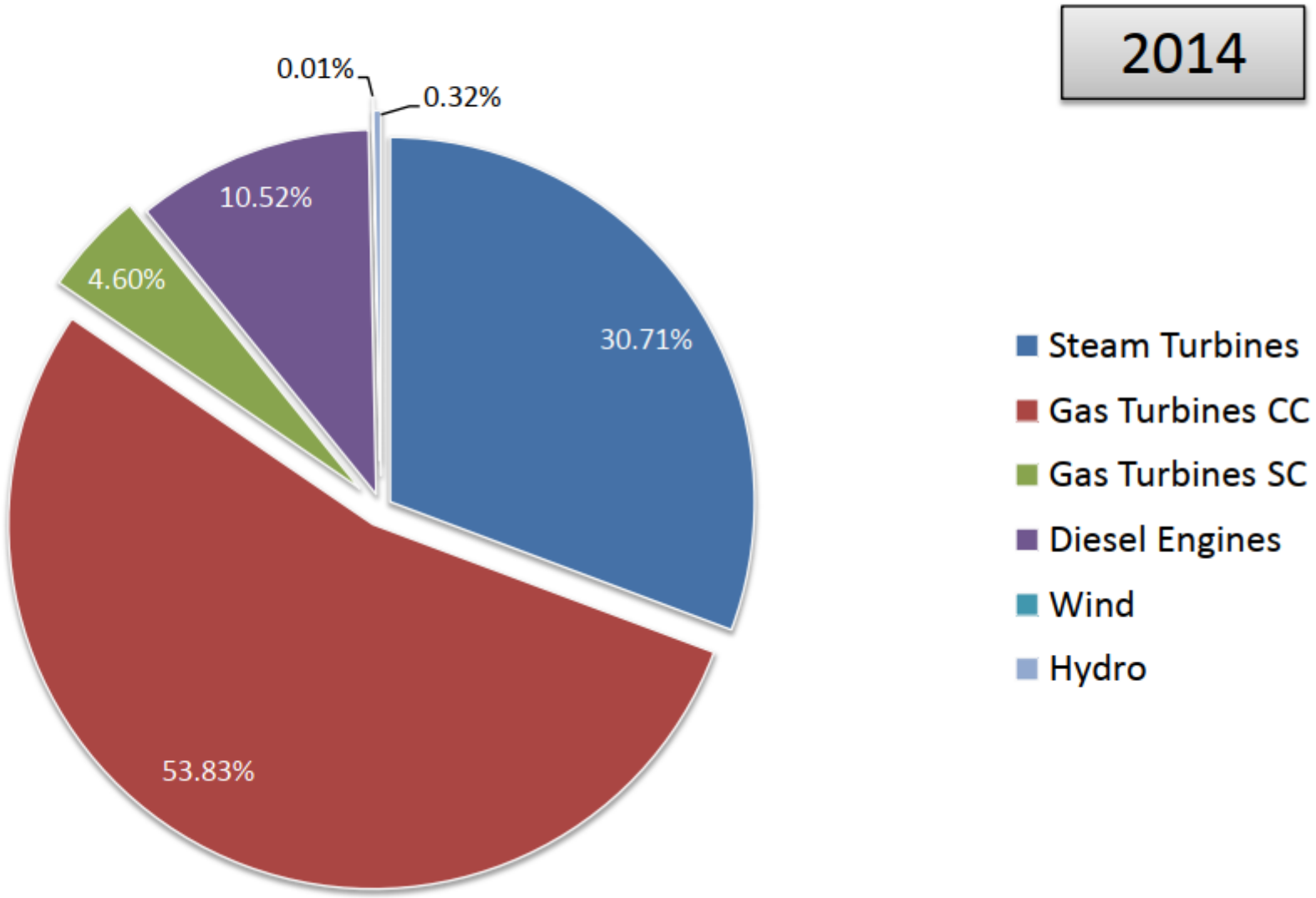
2015

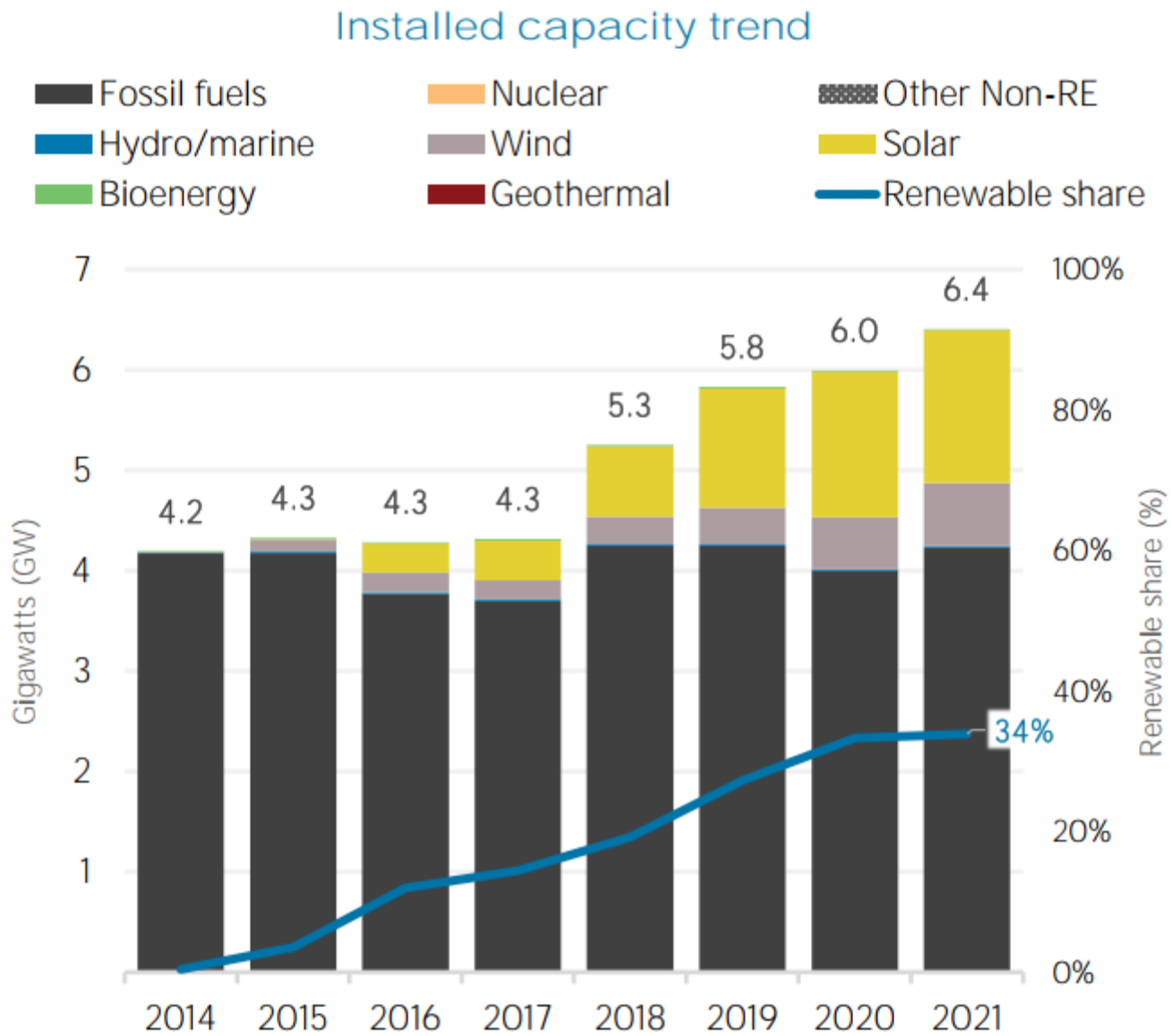
- Steam Turbines
- Gas Turbines CC
- Gas Turbines SC
- Diesel Engines
- Wind
- PV
- Hydro

Total: 4060 MW

Renewable: 146 MW

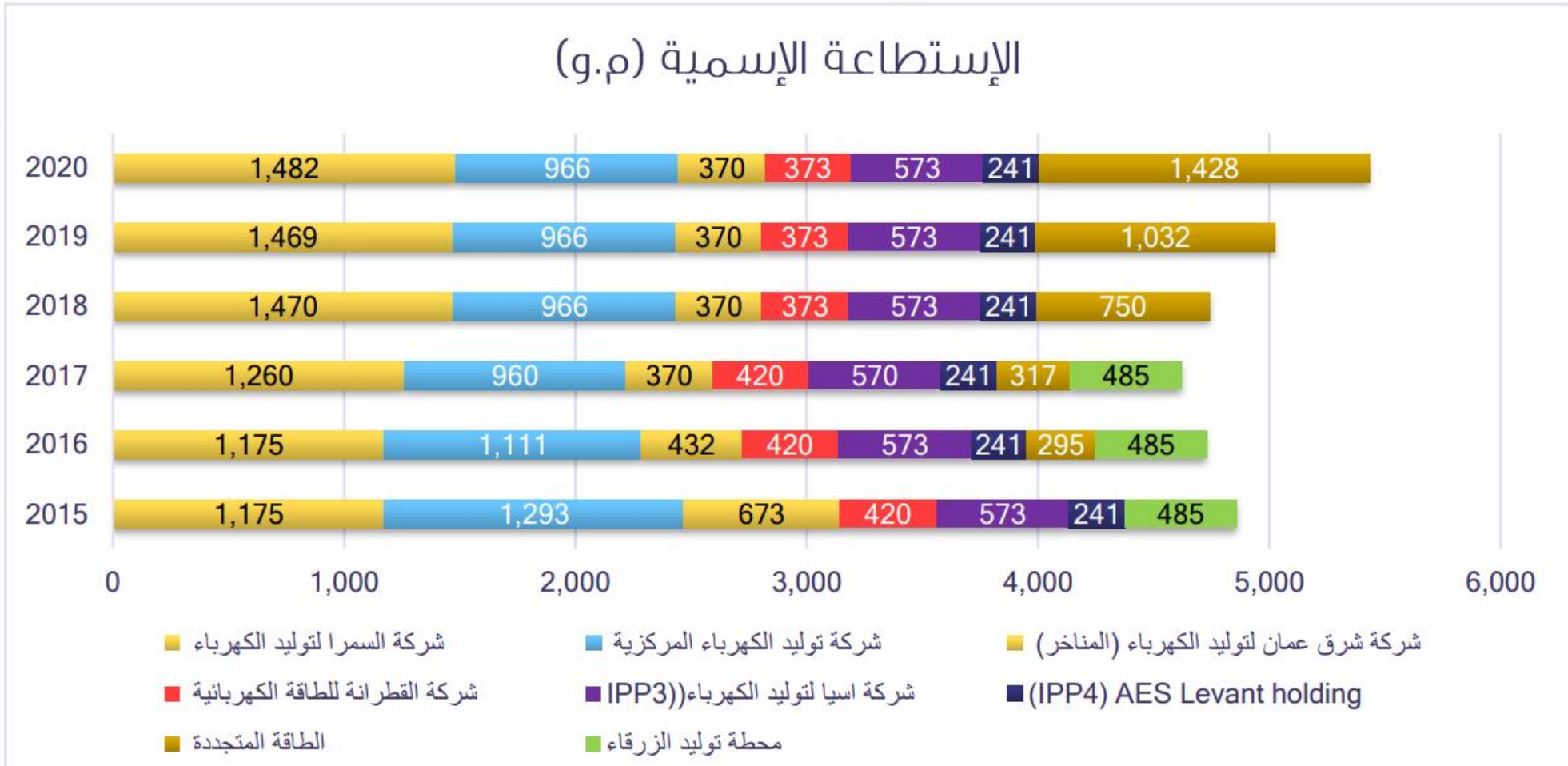
Generating Plants Energy [MWh]

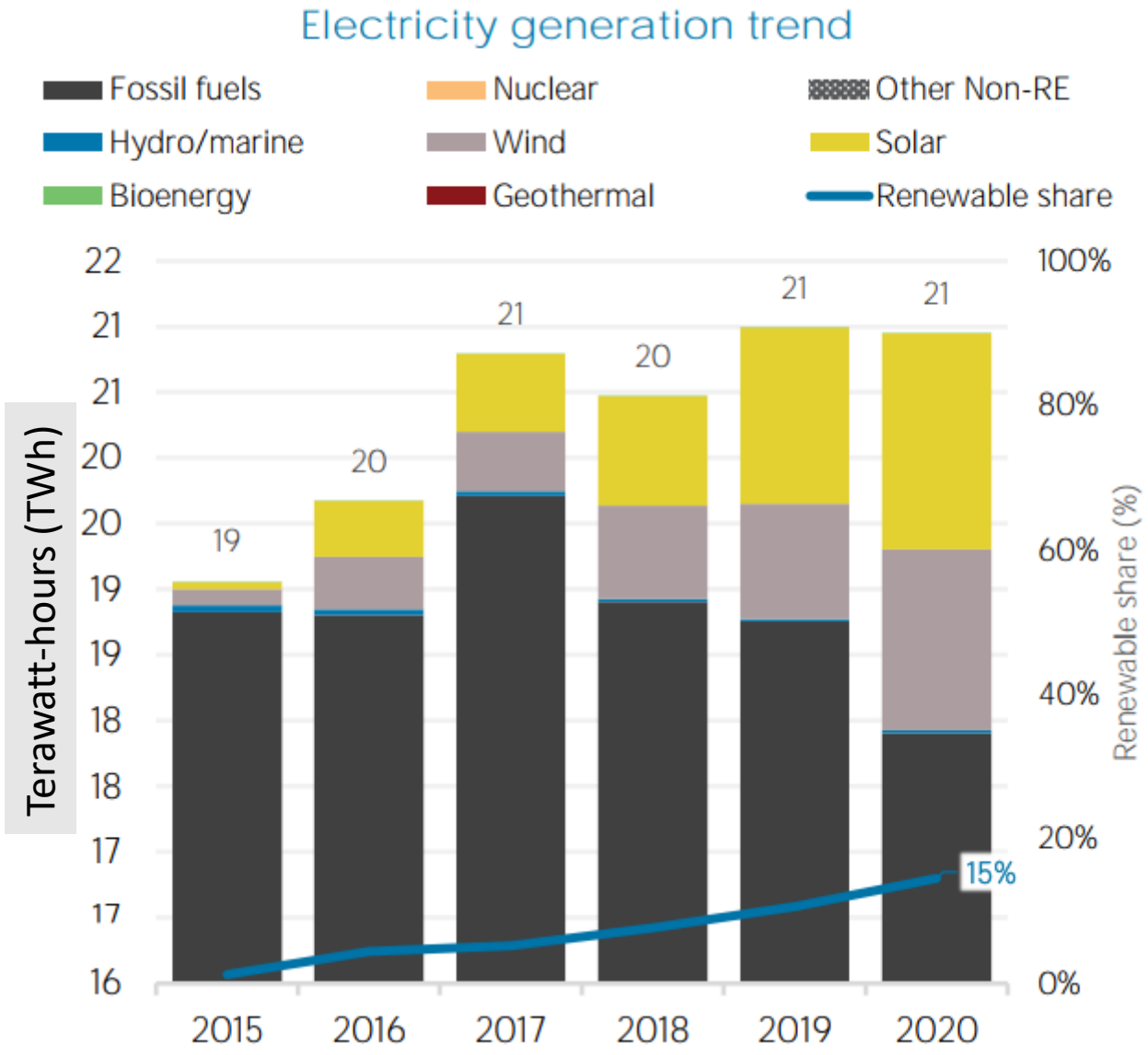



Installed capacity trend
Fossil fuels
Nuclear
Other Non-RE
Hydro/marine
Wind
Solar
Bioenergy
Geothermal
Renewable share
Gigawatts (GW)
Renewable share (%)
7
6
5
4
3
2
1
100%
80%
60%
40%
20%
0%
4.2
4.3
4.3
4.3
5.3
5.8
6.0
6.4
34%
2014
2015
2016
2017
2018
2019
2020
2021

الاستطاعة الإسمية

بلغت الاستطاعة الاسمية لشركة السمرا ١٤٨٢م.و خلال عام ٢٠٢٠ بحيث انها تشكل ٣١ ٪ من الاستطاعة الاسمية في الاردن ويوضح الشكل ٣ تطور الاستطاعة الاسمية في الاردن:



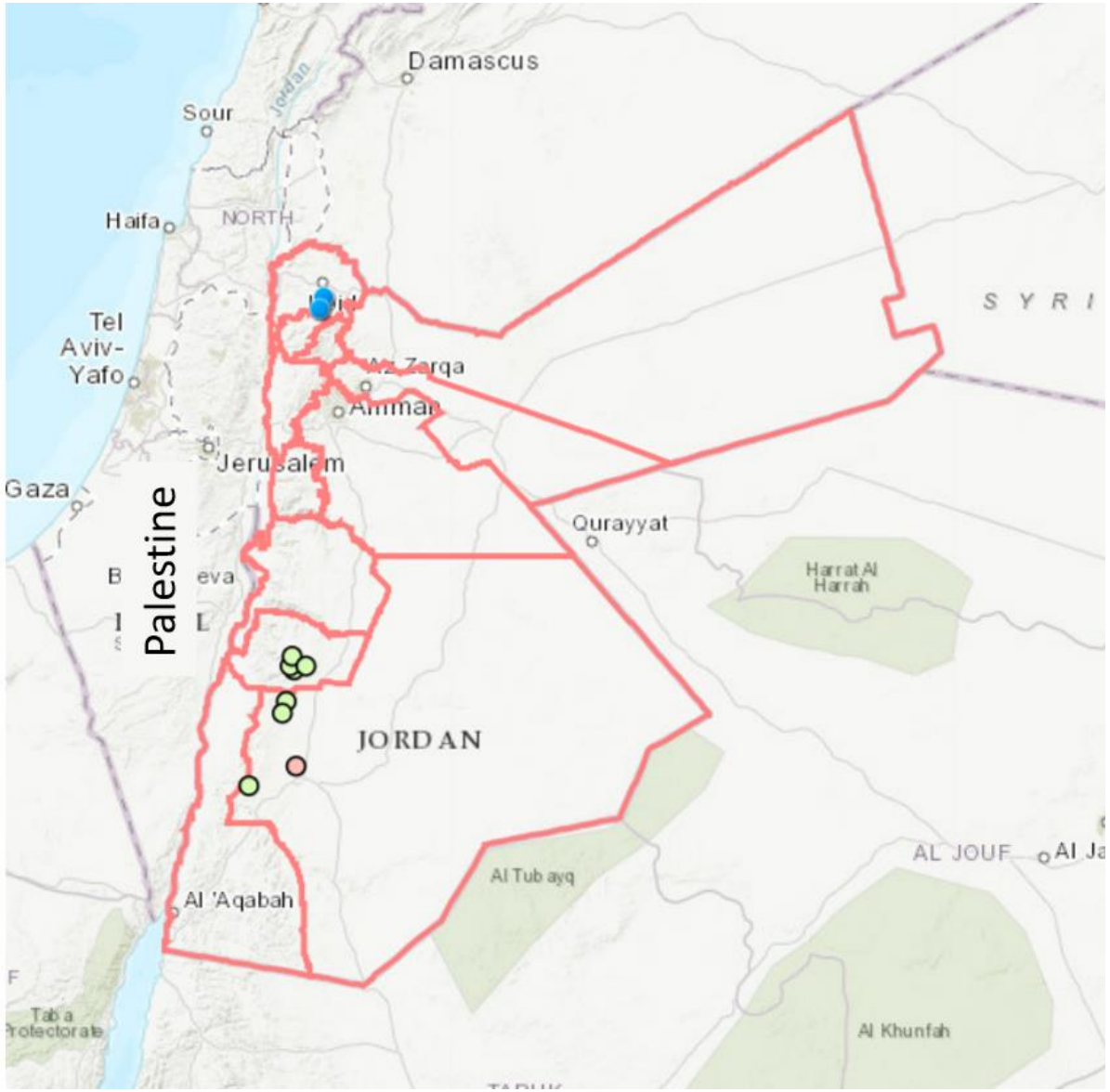

Electricity generation trend
Fossil fuels
Nuclear
Other Non-RE
Hydro/marine
Wind
Solar
Bioenergy
Geothermal
Renewable share
Terawatt-hours (TWh)
Renewable share (%)
22
21
21
20
20
19
19
18
18
17
17
16
100%
80%
60%
40%
20%
0%
19
20
21
20
21
21
15%
2015
2016
2017
2018
2019
2020

٢. المشاركة في الطاقة الكهربائية المولدة والمستوردة في المملكة

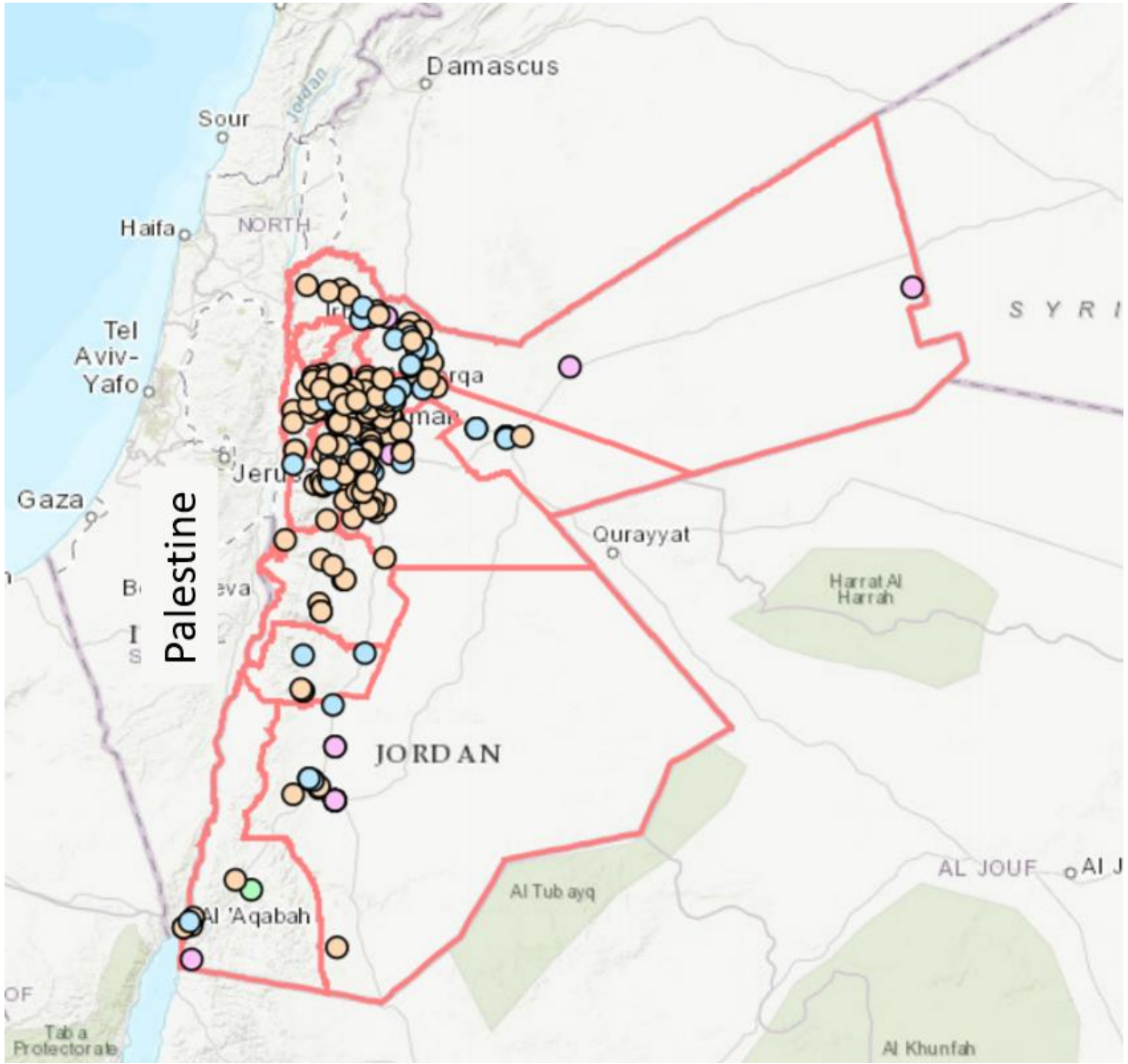
الشركة	٢٠١٦	٢٠١٧	٢٠١٨	٢٠١٩	٢٠٢٠
	(ج.و.س)	(ج.و.س)	(ج.و.س)	(ج.و.س)	(ج.و.س)
شركة توليد الكهرباء المركزية	٤,٢٦٠	٤,٣٣٢	١,٧٠٨	٤٥٥	٥٤٥
شركة السمرا لتوليد الكهرباء	٧,١٩٤	٧,٦٤٣	٧,٥٦٩	٦,٤٧٥	٦,٣٨٤
IPP1	٣,١٦٣	٢,٦٢٦	٢,٧٤٠	٢,٨٤٠	٢,٦١٤
IPP2	٢,٨٨١	٣,٠٣٣	٢,٧١٢	٢,٧٧٩	٢,٦٦١
IPP3	٢٦٣	٢٨٨	٤٨٦	٣٩٨	٢٩٧
IPP4	٥٠٩	٧٦٧	٧٥٢	٦٣٢	٤٠٦
مشاريع الرياح	٣٨٨	٤٤٨	٦٥٨	٨٧٥	١,٢٥٤
مشاريع الشمسي	٢٦٦	٨٩٥	٨٣٤	١,٣٤١	١,٧٨٥
محطة الزرقاء الجديدة	٠	٠	١,١٩٨	٣,٢١٧	٢,٩٠٩
سد الملك طلال + شركة الغاز الحيوي الأردنية	٢٢	٢١	١٩	٢٤	٠
طاقة مستوردة (مصر)				٢٣٩	٣٨٠
قطاع الصناعة / تقديري	٤٤٢	٠	٠		
المجموع الكلي / اولية	١٩,٣٨٨	٢٠,٠٥٤	١٨,٦٧٤	١٩,٢٧٤	١٩,٢٣٤

جدول (٣) الطاقة الكهربائية المولدة والمستوردة في المملكة (ج. و. س)

Wind energy projects in Jordan



Solar energy projects in Jordan



National Electric Power Co. (NEPCO)

National Transmission Grid

SYRIA

EGYPT

Main Bulk Substations

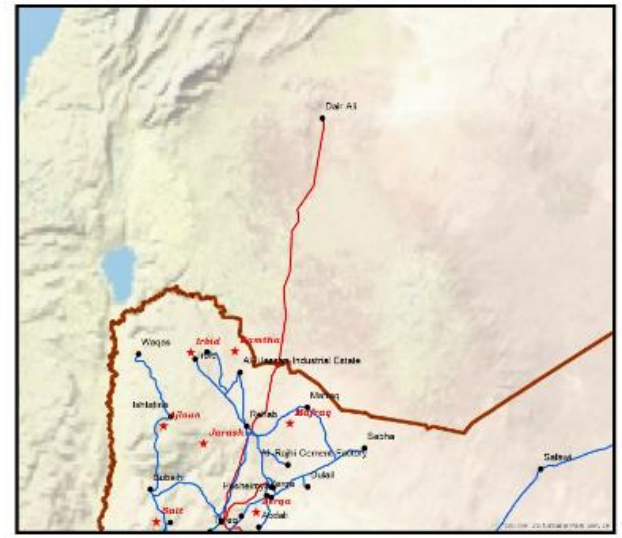
OHTL 132 kV

U.G. Cable 132 kV

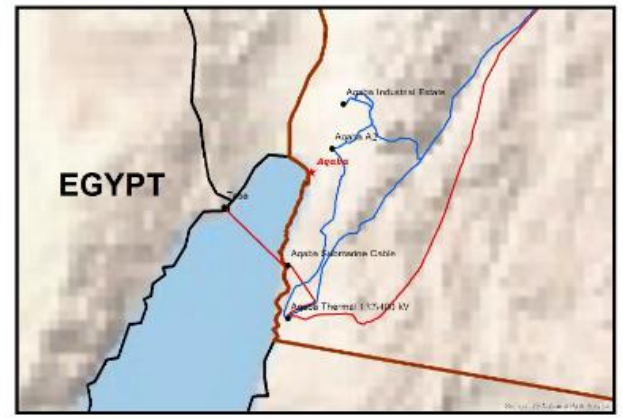
OHTL 400 kV

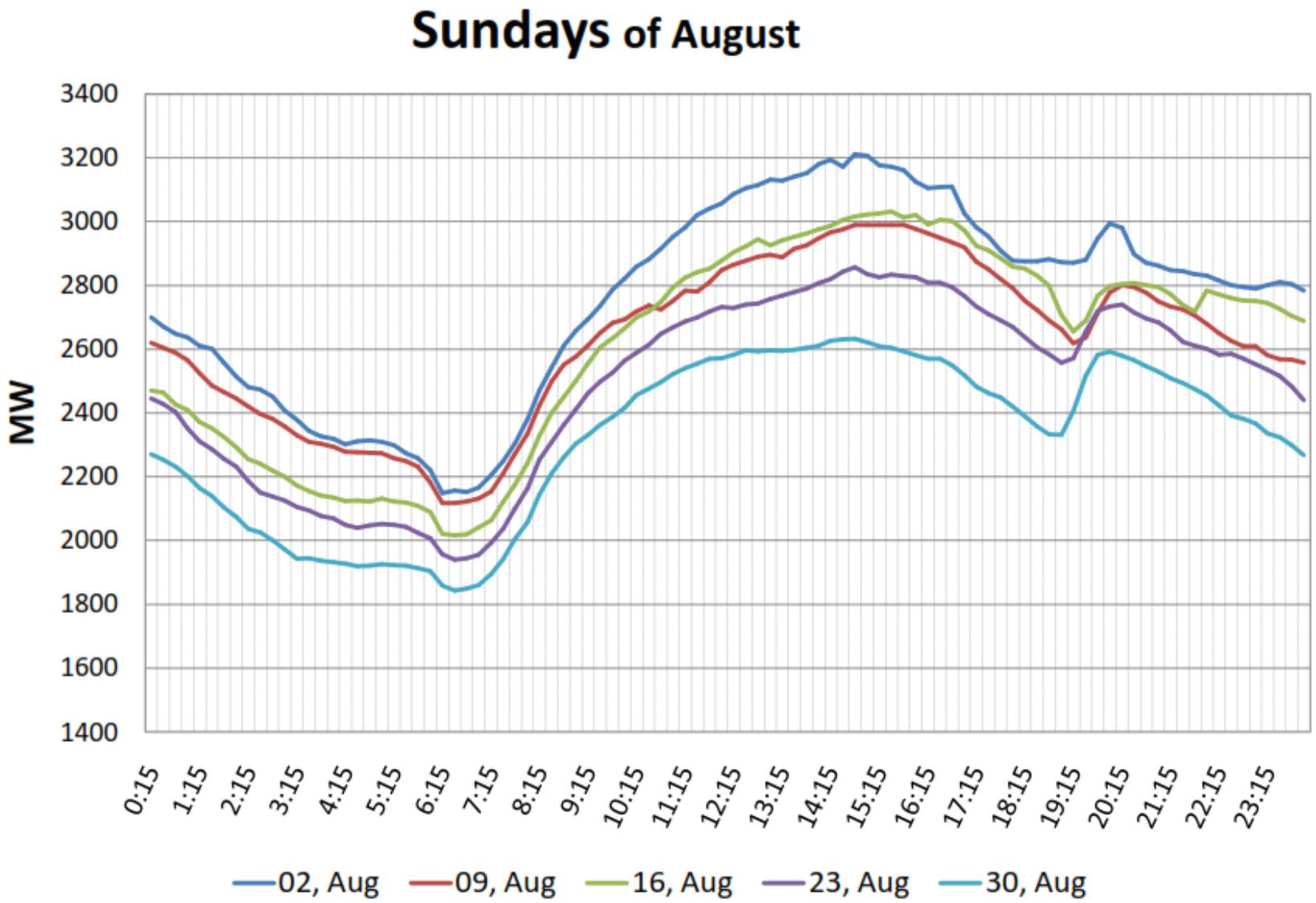
0 25 50 100 Km

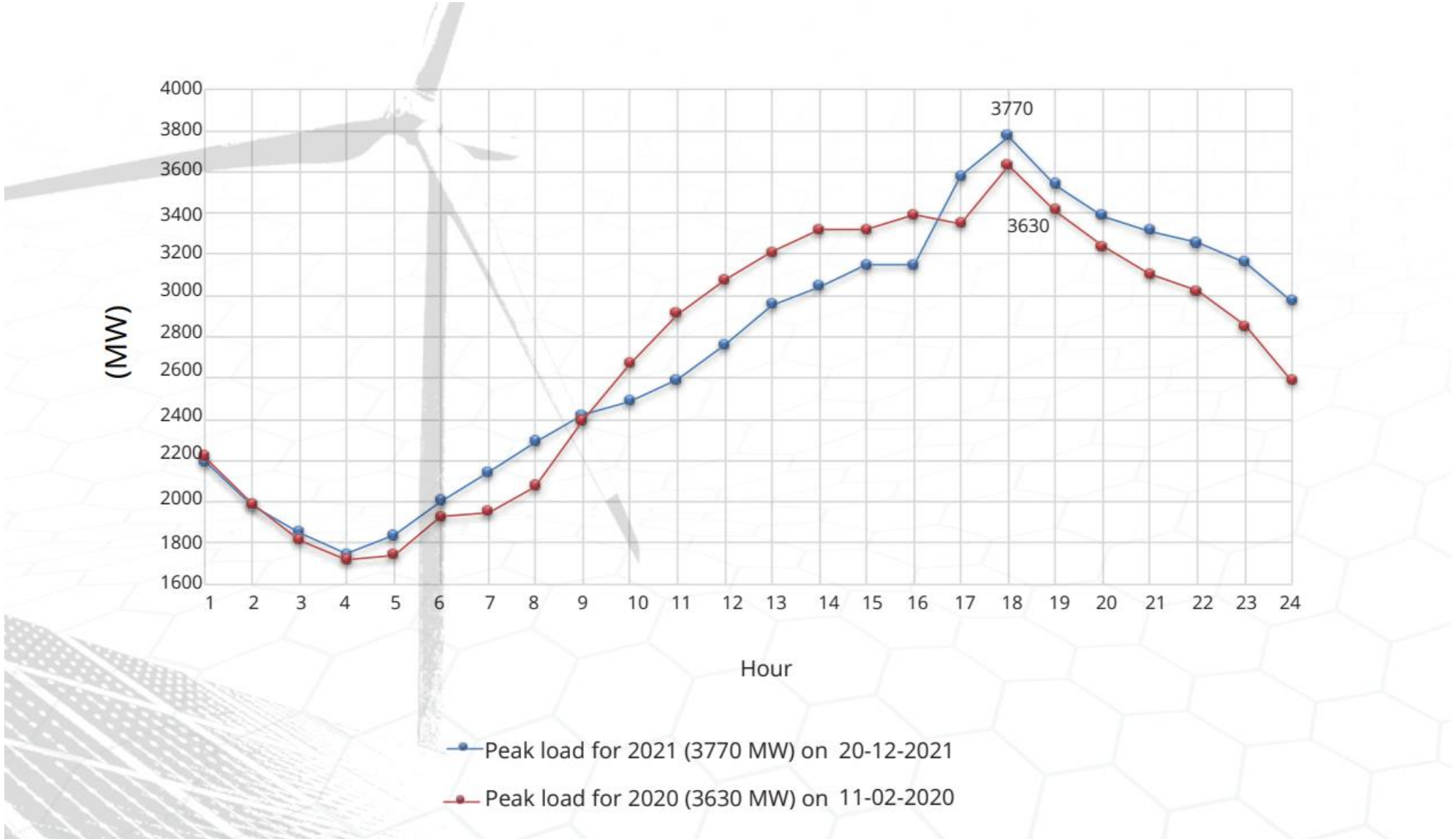
JORDAN - SYRIA Interconnection



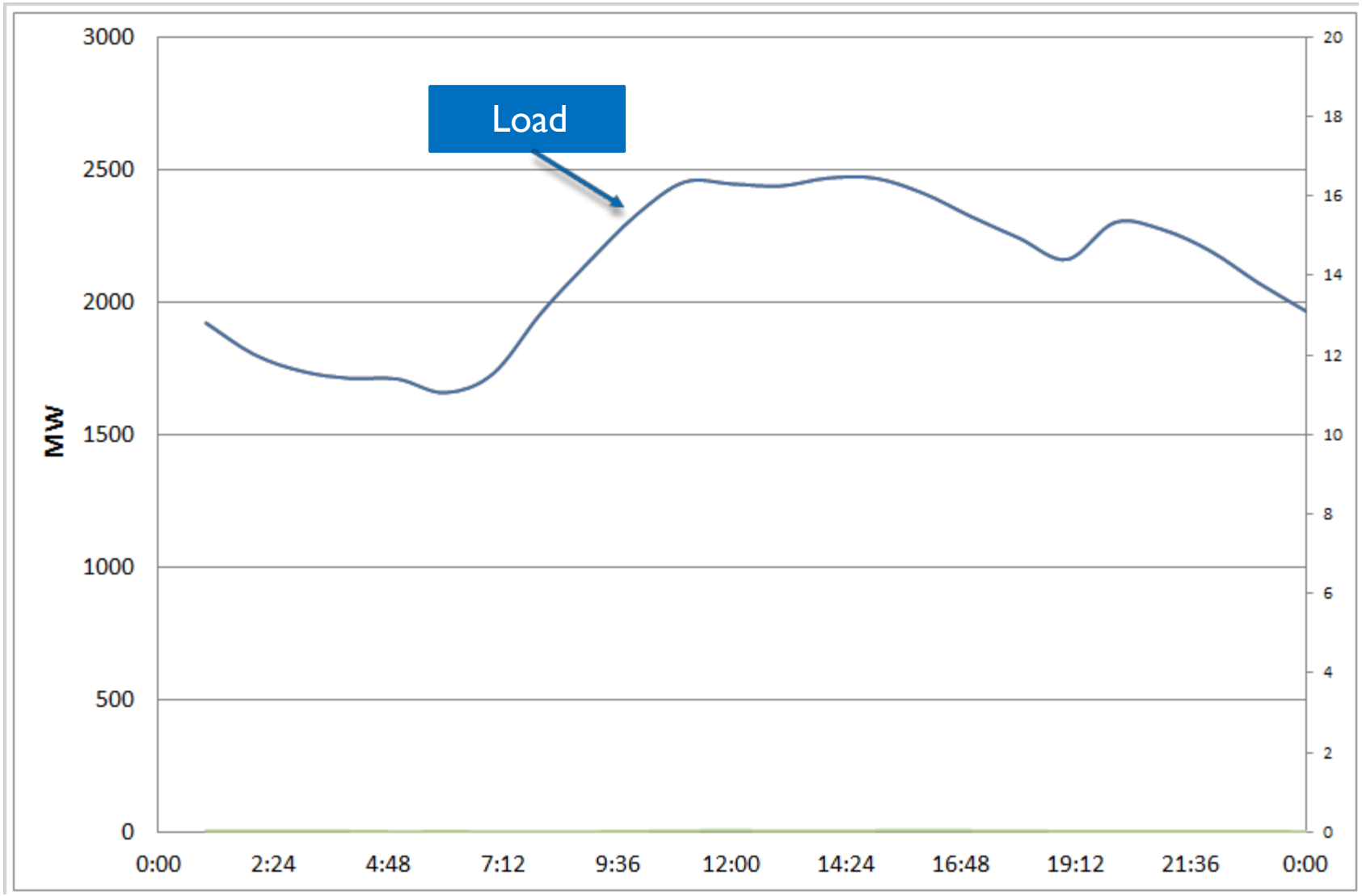
EGYPT - JORDAN Interconnection



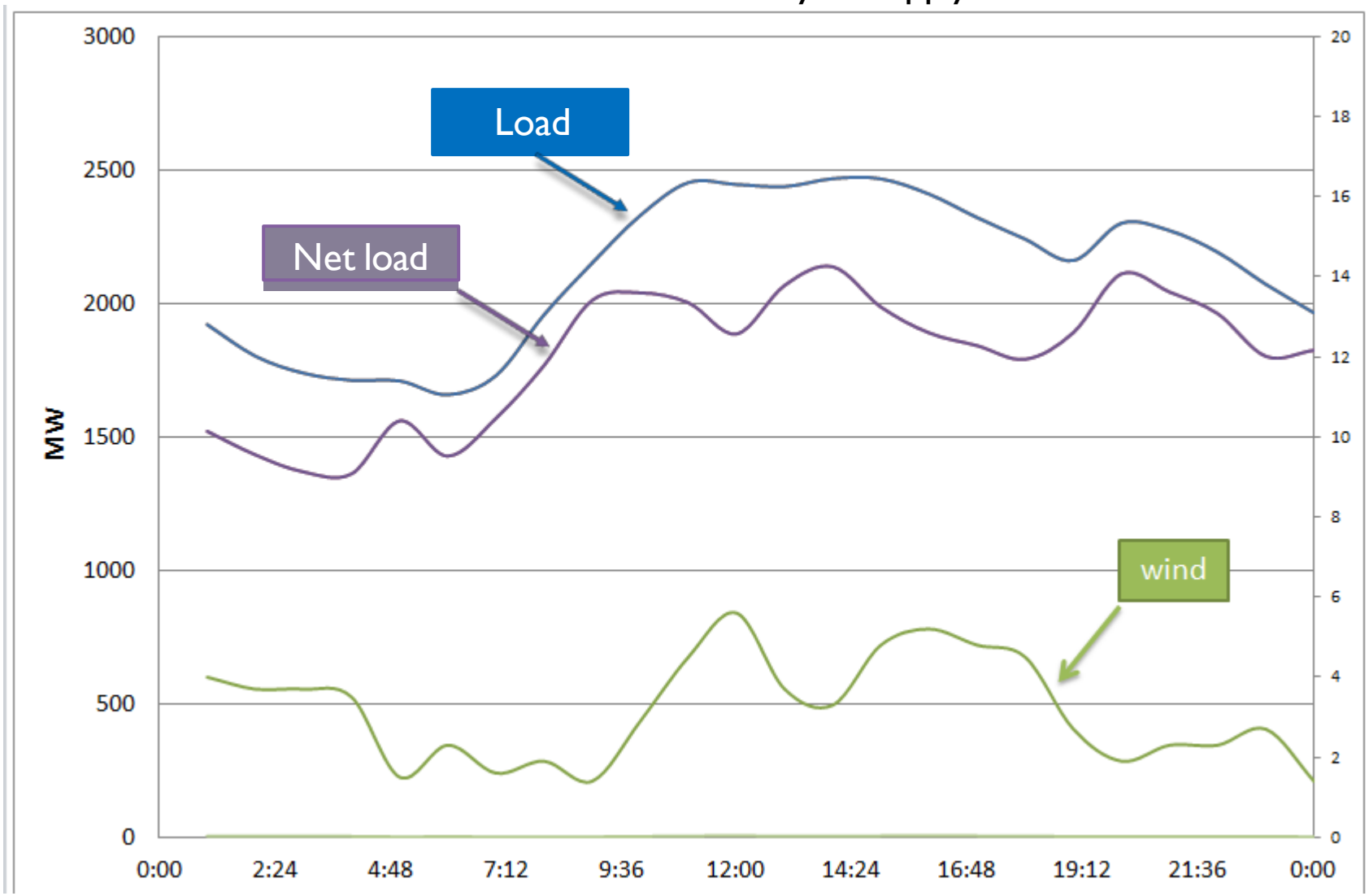

Sundays of August
MW
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
0:15
1:15
2:15
3:15
4:15
5:15
6:15
7:15
8:15
9:15
10:15
11:15
12:15
13:15
14:15
15:15
16:15
17:15
18:15
19:15
20:15
21:15
22:15
23:15
02, Aug
09, Aug
16, Aug
23, Aug
30, Aug


4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
(MW)
3770
3630
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour
Peak load for 2021 (3770 MW) on 20-12-2021
Peak load for 2020 (3630 MW) on 11-02-2020

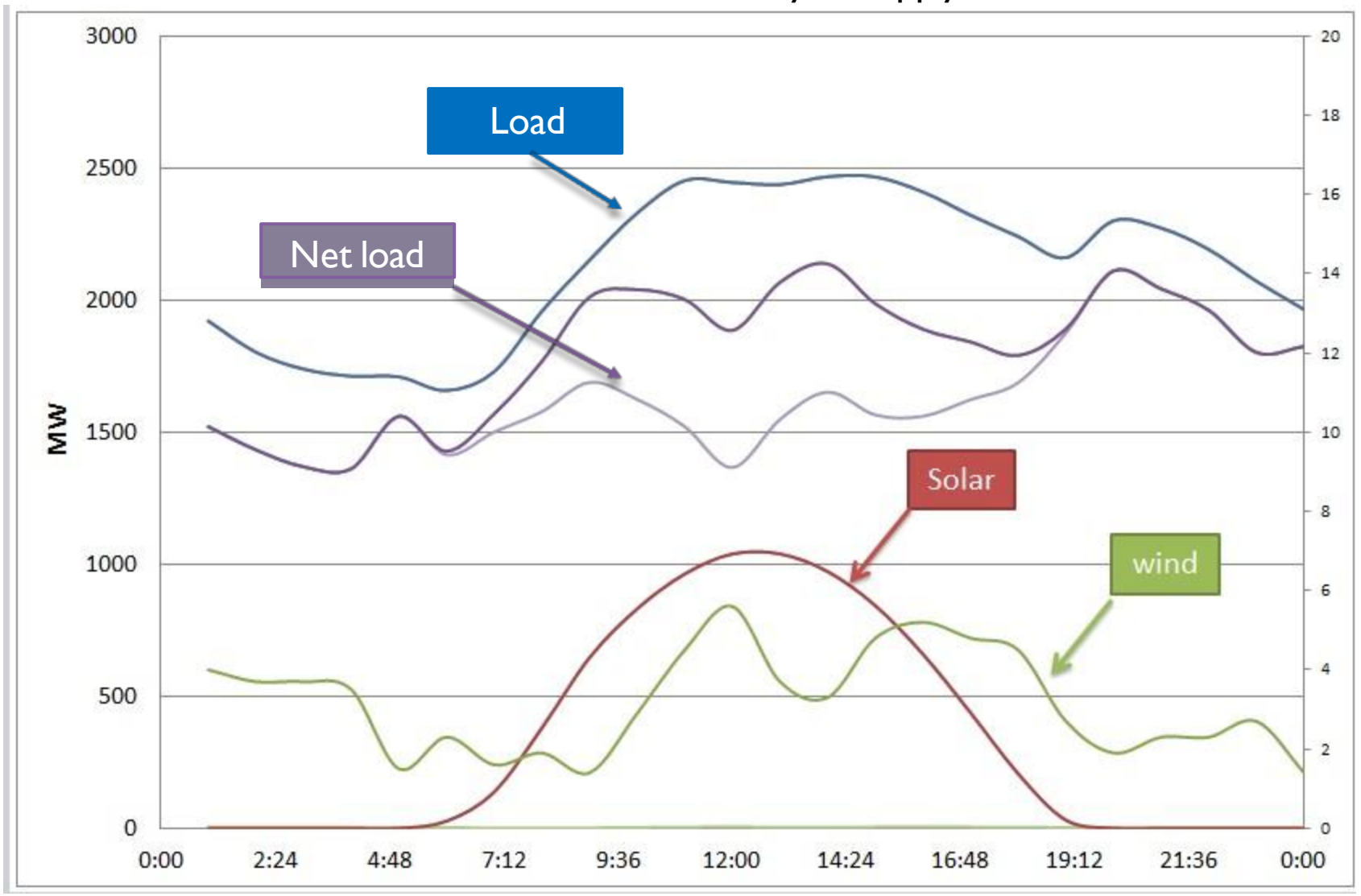
Wind and Solar Add Variability to Supply Side



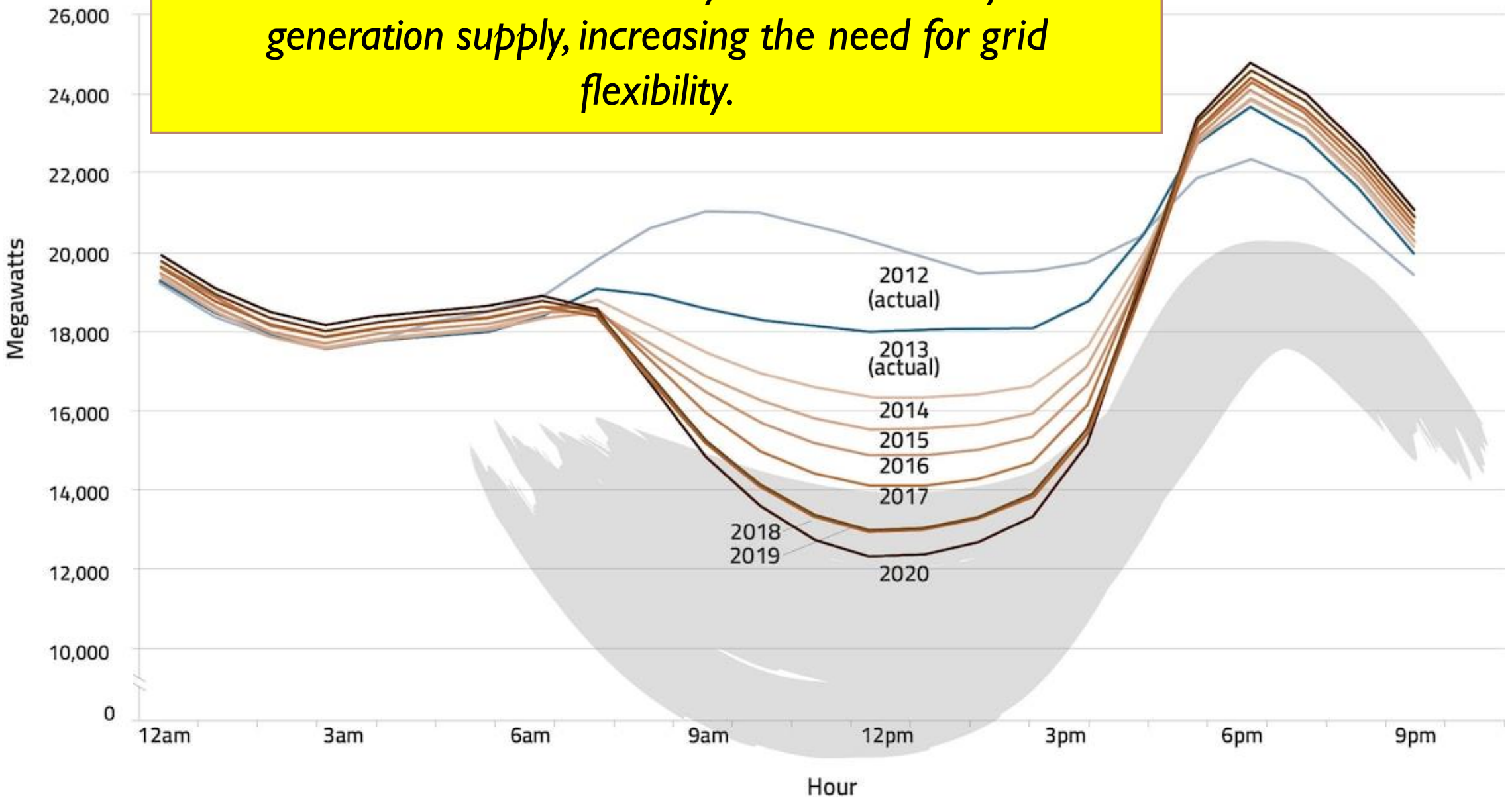
Wind and Solar AddVariability to Supply Side



Wind and Solar AddVariability to Supply Side



Wind and solar add variability and uncertainty to the generation supply, increasing the need for grid flexibility.

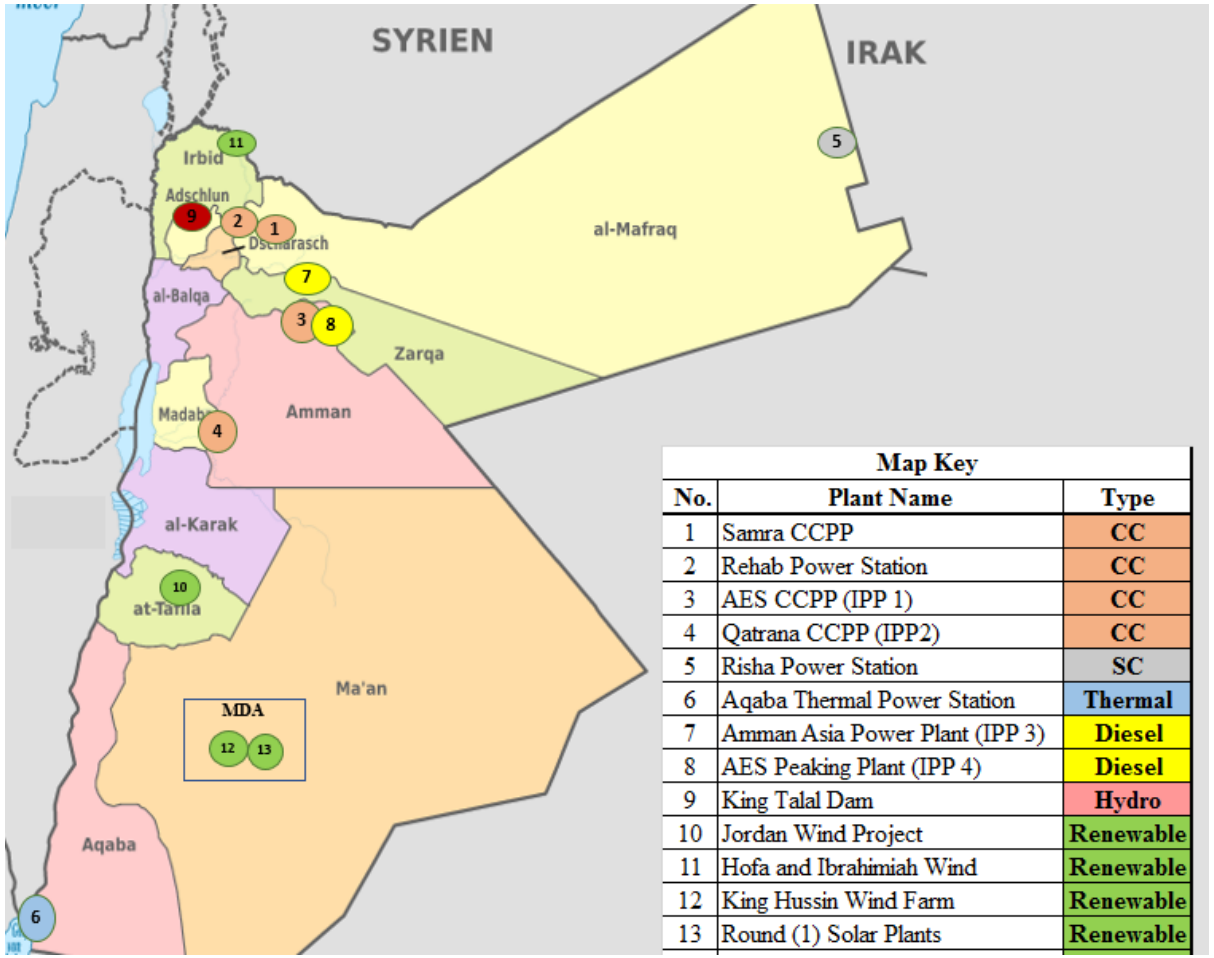


Energy and Minerals Regulatory Commission (EMRC)

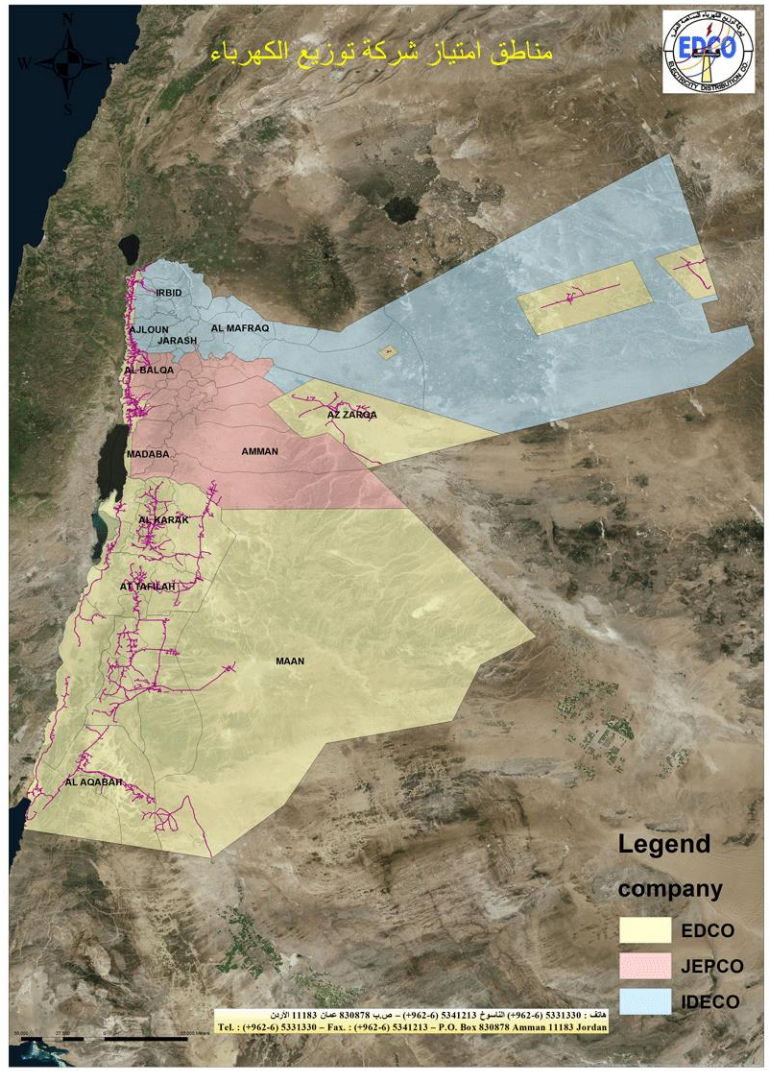
- EMRC: is a governmental body considered as the legal successor of the:
  1. Electricity Regulatory Commission (ERC)
  2. Jordan Nuclear Regulatory Commission (JNRC)
  3. Natural Resources Authority (NRA)

هيئة تنظيم قطاع الطاقة والمعادن
Energy & Minerals Regulatory Commission

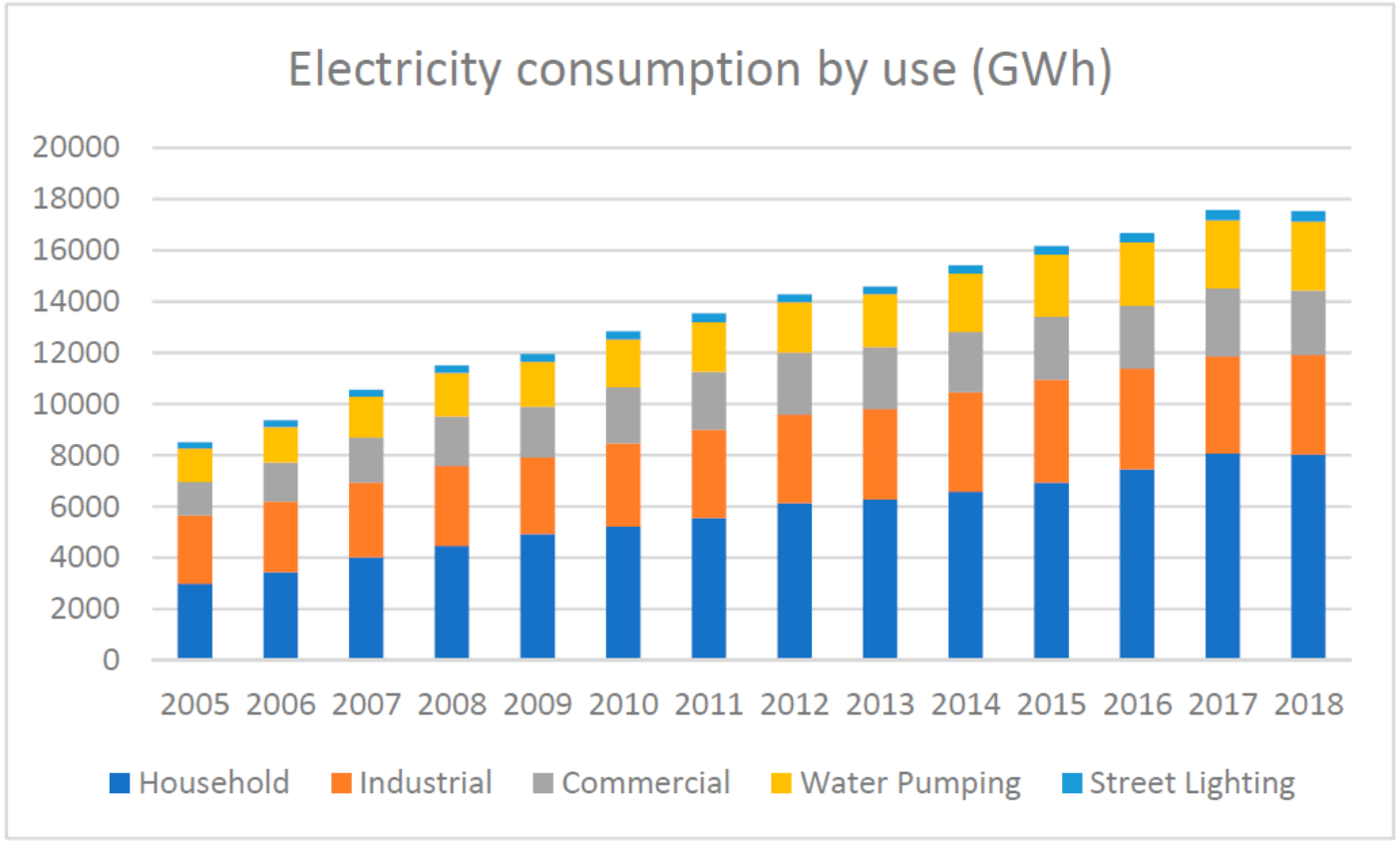
Location of Generation Plants



Map Key		
No.	**Plant Name**	**Type**
1	Samra CCPP	CC
2	Rehab Power Station	CC
3	AES CCPP (IPP 1)	CC
4	Qatrana CCPP (IPP2)	CC
5	Risha Power Station	SC
6	Aqaba Thermal Power Station	Thermal
7	Amman Asia Power Plant (IPP 3)	Diesel
8	AES Peaking Plant (IPP 4)	Diesel
9	King Talal Dam	Hydro
10	Jordan Wind Project	Renewable
11	Hofa and Ibrahimiah Wind	Renewable
12	King Hussin Wind Farm	Renewable
13	Round (1) Solar Plants	Renewable


مناطق امتياز شركة توزيع الكهرباء
EDCO
IRBID
AJLOUN
JARASH
AL MAFRAQ
AL BALQA
AZ ZARQA
MADABA
AMMAN
AL KARAK
AT TAFILAH
MAAN
AL AQABAH
Legend
company
EDCO
JEPCO
IDECO
هاتف : 5331330 (6-962+) الناسوخ 5341213 (6-962+) – ص.ب 830878 عمان 11183 الأردن
Tel. : (+962-6) 5331330 – Fax. : (+962-6) 5341213 – P.O. Box 830878 Amman 11183 Jordan

Jordan's Electrical Grid Interconnection



Jordan's electricity consumption by use between 2005 and 2018 (Data from MEMR).

National Control Center

NCC Duty

- **Economic Dispatch**: load the running units differently in order to cover the needed system demand with the most economic manner according to the order of merits.

- **Unit commitment**: Decide which generating units to be switched ON/OFF. Considerations include:
  - Start up cost
  - Generating unit characteristics

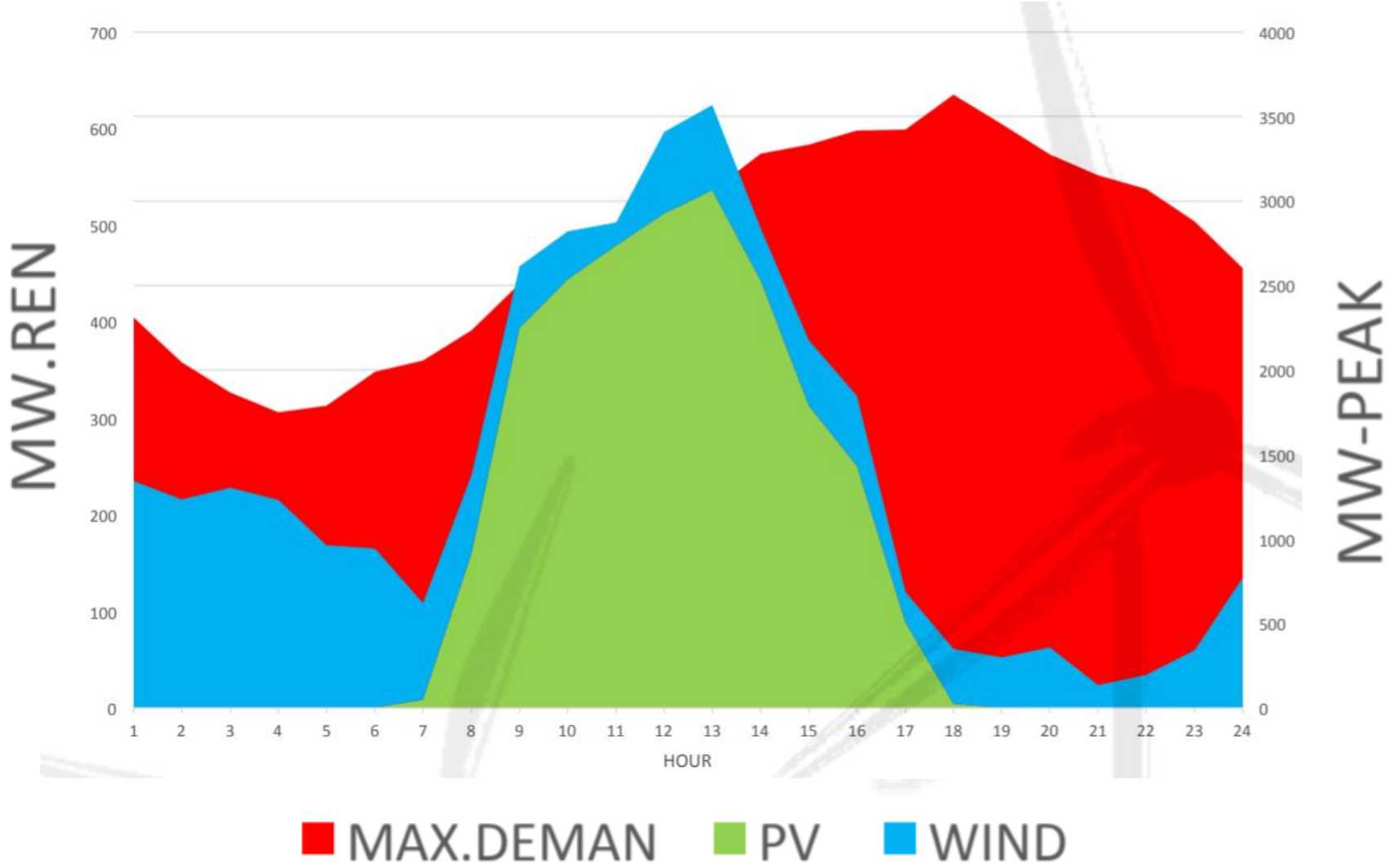
Dispatch Considerations

- Day ahead forecast
- Availability of generating units
- Availability of fuel
- Generating unit characteristics (ramp rate, startup time and cost)
- Fuel price/Energy price

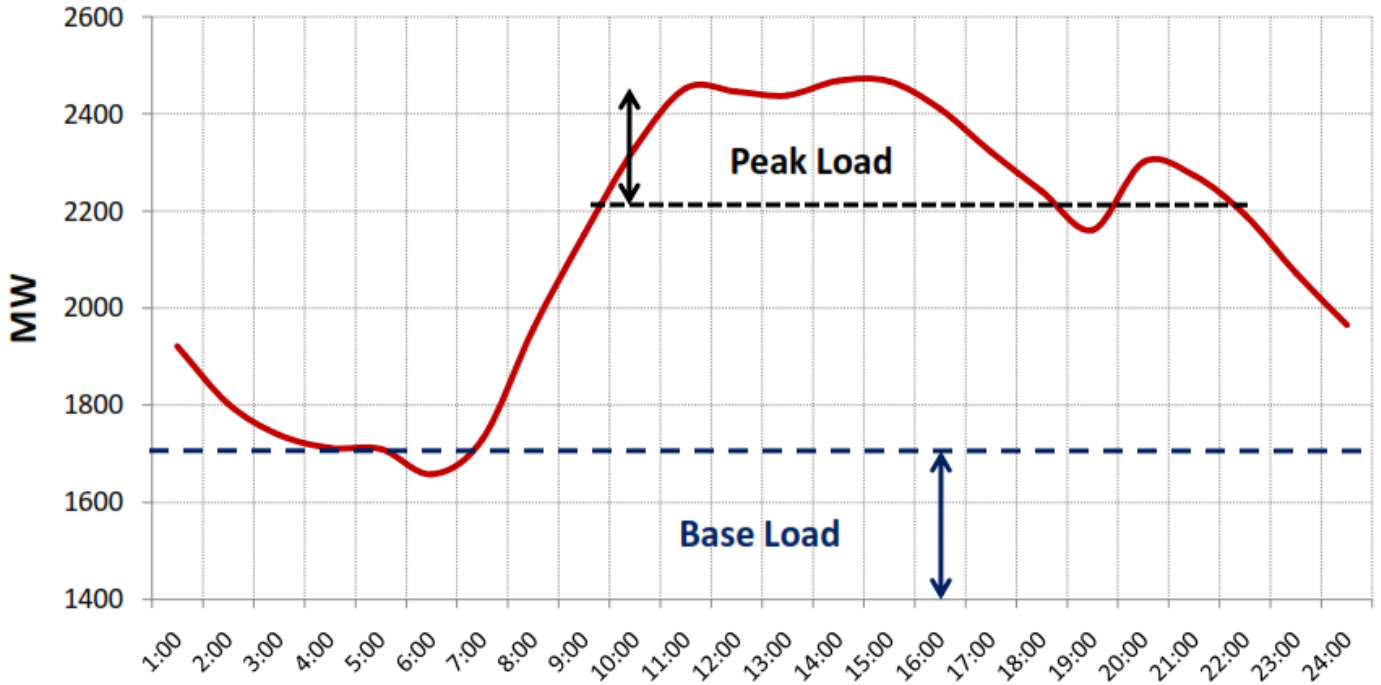
Penalty periods

- Applicable on consumers having multi tariff:
  - Principal consumers, large industries
- Includes peak loading periods which require operating higher cost units
  - Evening peaks are considered
- Summer & winter timing is considered
- Special months are considered (Ramadan)

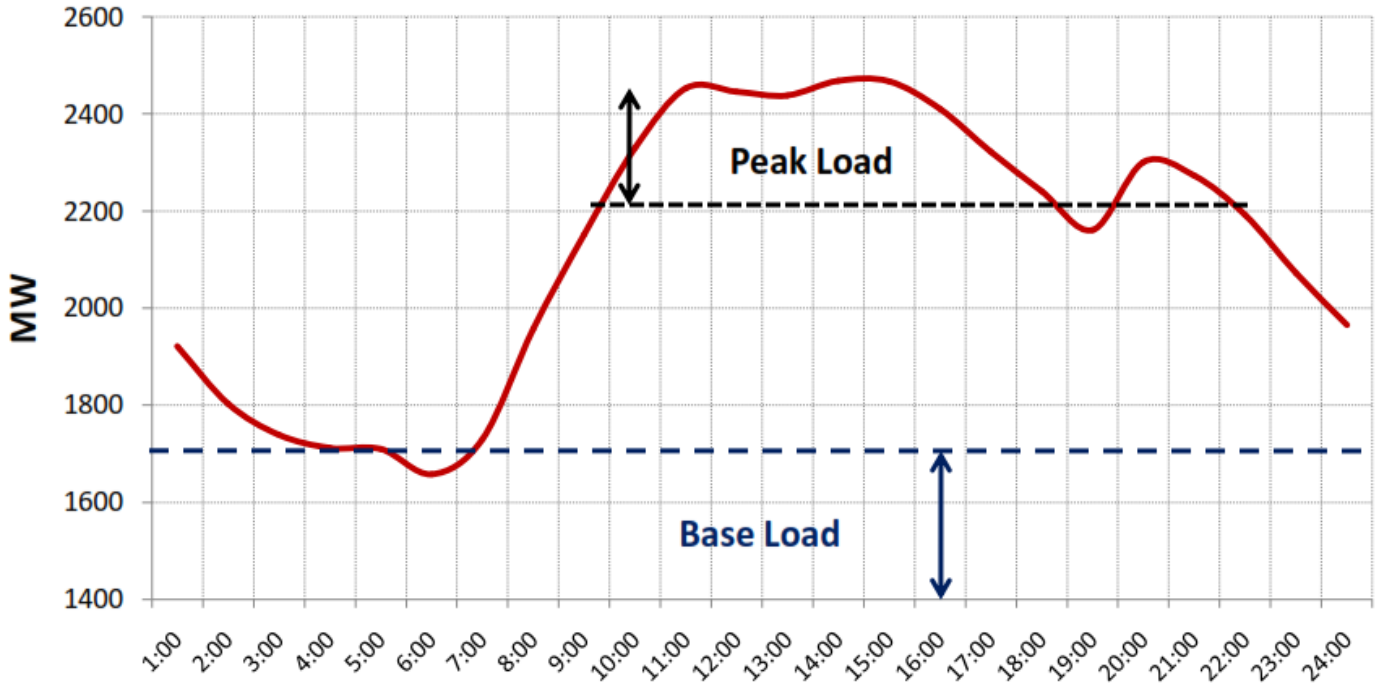
Winter Peak Load Curve (11 /2/ 2020)

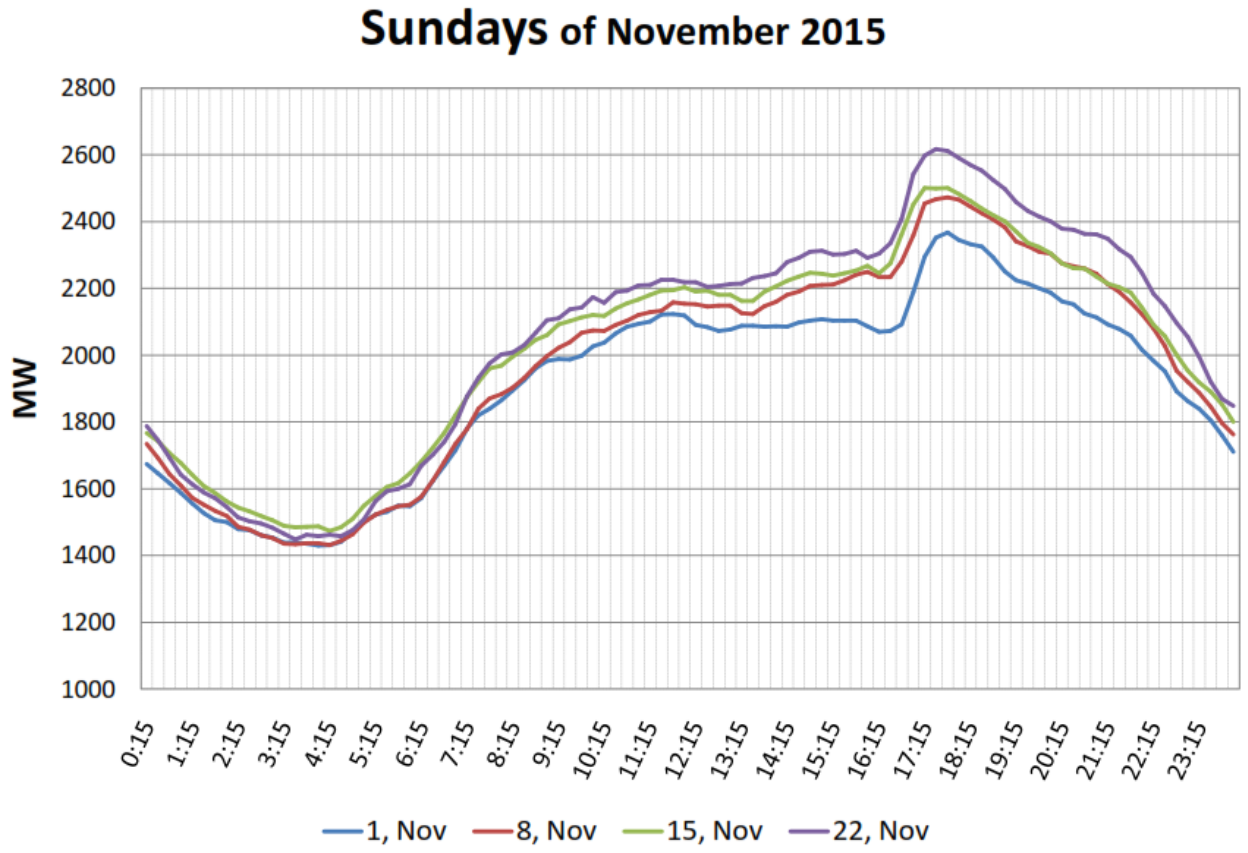


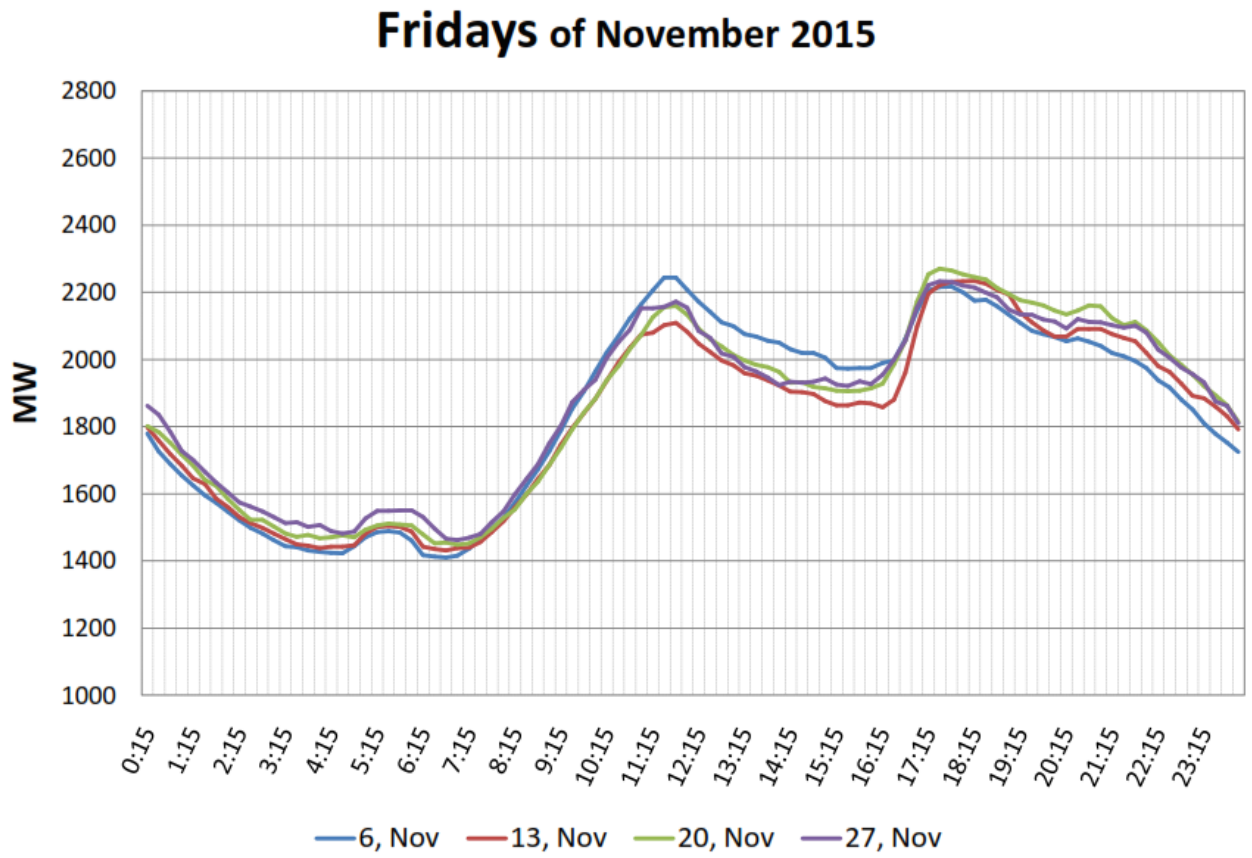
Electricity Load

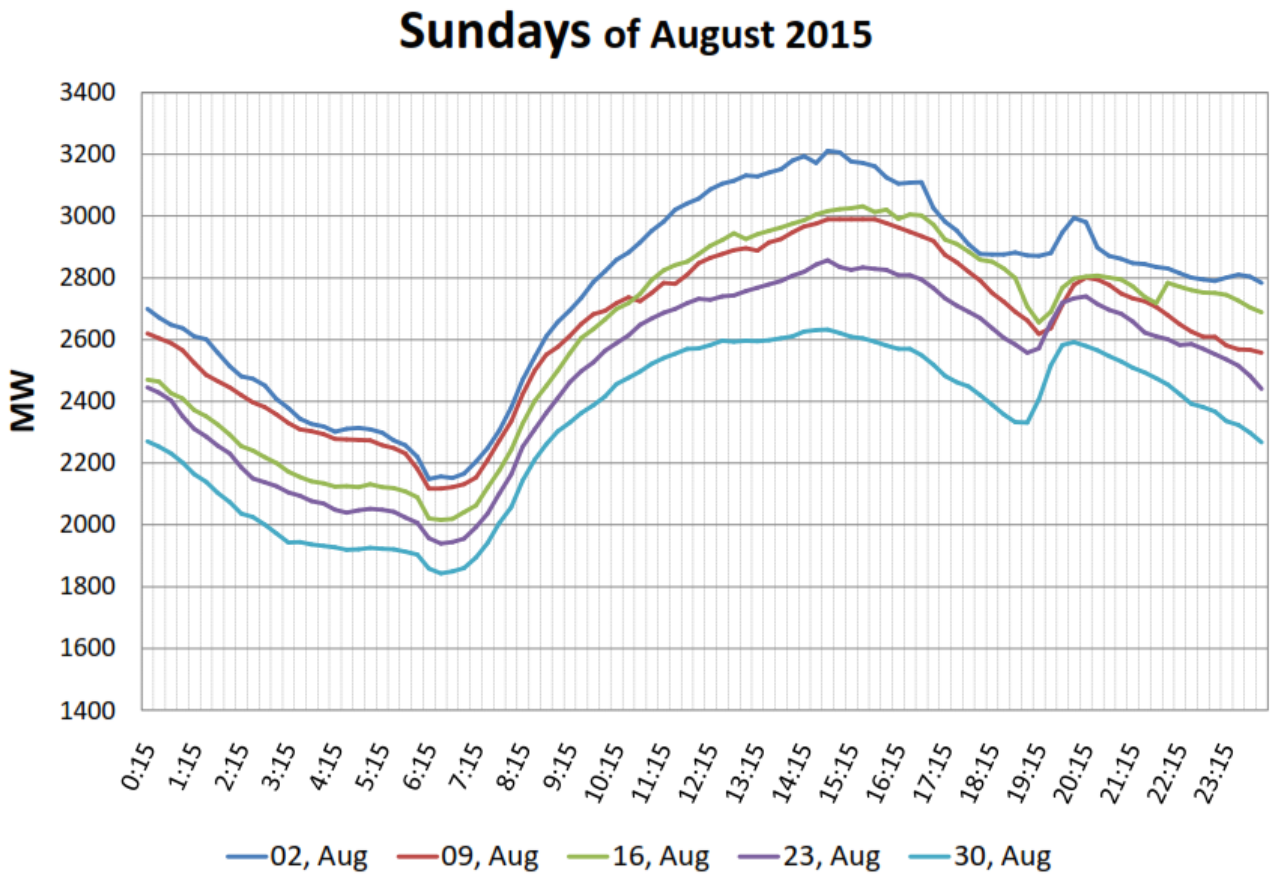


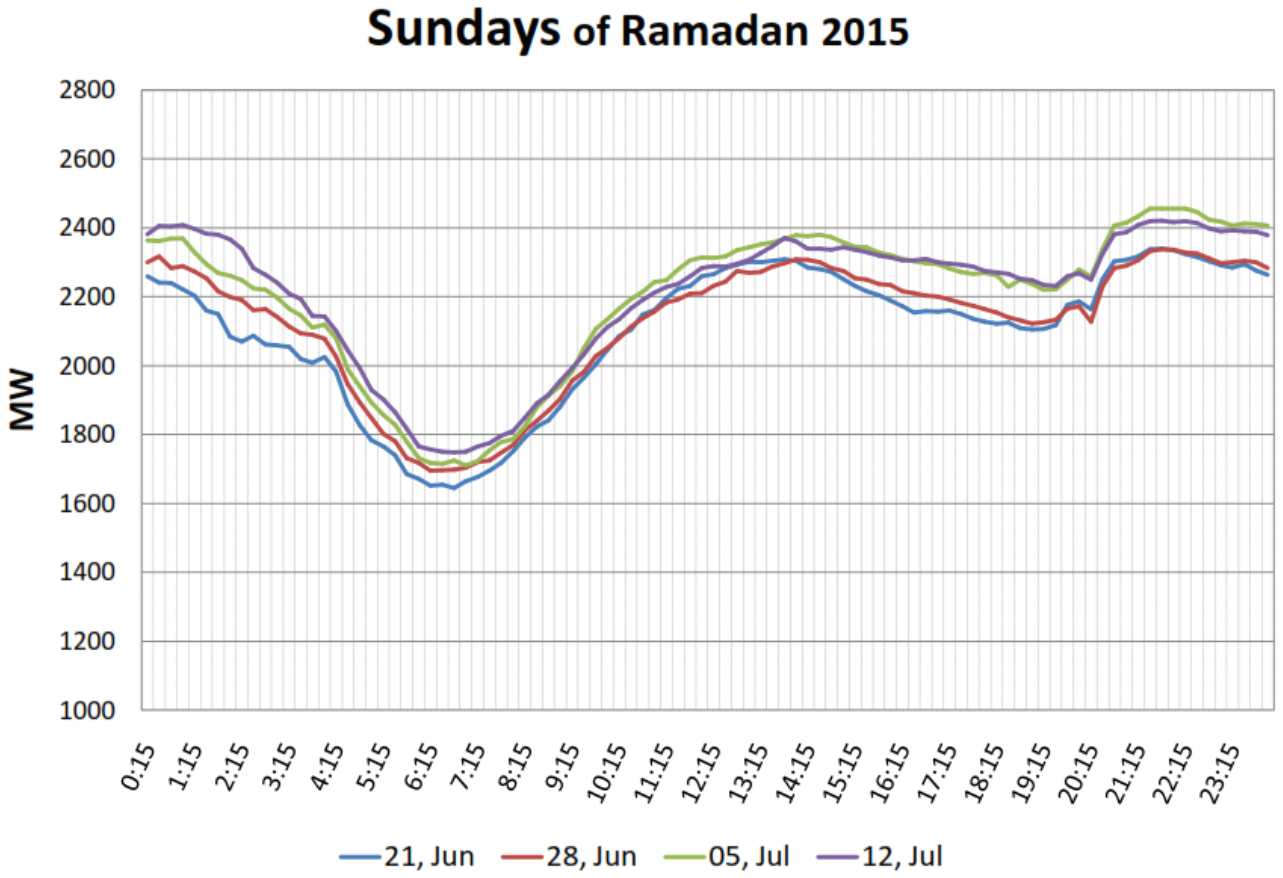
Electricity Load

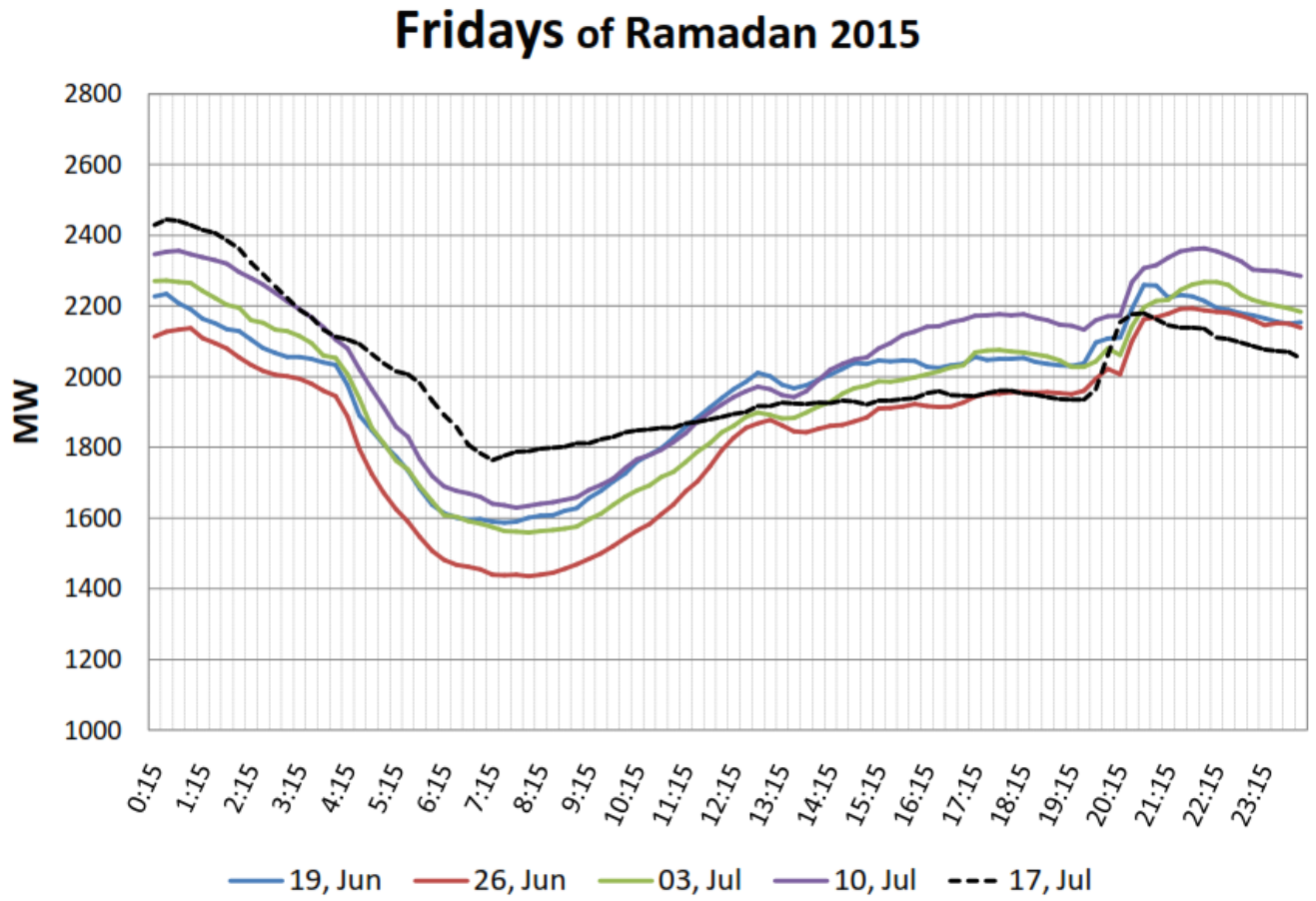



Sundays of November 2015
MW
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
0:15
1:15
2:15
3:15
4:15
5:15
6:15
7:15
8:15
9:15
10:15
11:15
12:15
13:15
14:15
15:15
16:15
17:15
18:15
19:15
20:15
21:15
22:15
23:15
1, Nov
8, Nov
15, Nov
22, Nov


Fridays of November 2015
MW
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
0:15
1:15
2:15
3:15
4:15
5:15
6:15
7:15
8:15
9:15
10:15
11:15
12:15
13:15
14:15
15:15
16:15
17:15
18:15
19:15
20:15
21:15
22:15
23:15
6, Nov
13, Nov
20, Nov
27, Nov


Sundays of August 2015
MW
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
0:15
1:15
2:15
3:15
4:15
5:15
6:15
7:15
8:15
9:15
10:15
11:15
12:15
13:15
14:15
15:15
16:15
17:15
18:15
19:15
20:15
21:15
22:15
23:15
02, Aug
09, Aug
16, Aug
23, Aug
30, Aug


Sundays of Ramadan 2015
MW
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
0:15
1:15
2:15
3:15
4:15
5:15
6:15
7:15
8:15
9:15
10:15
11:15
12:15
13:15
14:15
15:15
16:15
17:15
18:15
19:15
20:15
21:15
22:15
23:15
21, Jun
28, Jun
05, Jul
12, Jul


Fridays of Ramadan 2015
MW
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
0:15
1:15
2:15
3:15
4:15
5:15
6:15
7:15
8:15
9:15
10:15
11:15
12:15
13:15
14:15
15:15
16:15
17:15
18:15
19:15
20:15
21:15
22:15
23:15
19, Jun
26, Jun
03, Jul
10, Jul
17, Jul

Tafila Wind Farm

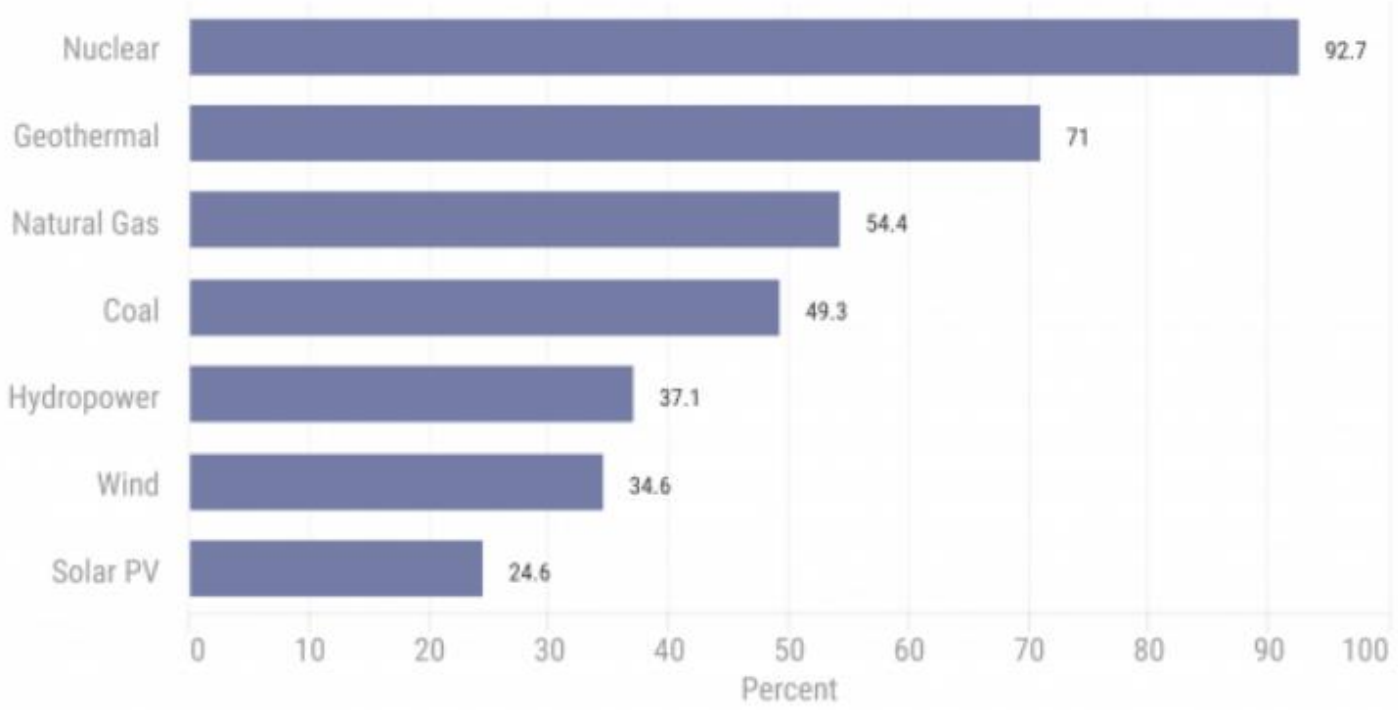
- A 117 MW wind farm located in Tafilah Governorate, Jordan.
- The farm consists of 38 turbines and was inaugurated in December 2015

Capacity factor

- The ratio of the electrical energy produced by a generating unit for the period of time considered to the electrical energy that could have been produced at continuous full power operation during the same period.

- https://www.energy.gov/ne/articles/what-generation-capacity
- https://www.eia.gov/tools/glossary/index.php?id=Capacity_factor

U.S. Capacity Factor by Energy Source - 2021



Source: U.S. Energy Information Administration

1.5 kW

POWER CAPACITY

Optimal power output
at optimal wind speed

Electrical Power: Energy Generated Over Time

POWER GENERATION FOR 1 HOUR

1.5 kW x 1 hr = 1.5 kWh

POWER GENERATION FOR 2 HOURS

1.5 kW x 2 hr = 3.0 kWh

1.5 kW: Power Output

3.0 kWh: Actual Electrical Power Generated

1.5 kW

POWER CAPACITY

At 15 m/s Wind Speed

OPTIMAL POWER GENERATION IN 1 YEAR

1.5 kW x 24 hr x 365 days = 13,140 kWh

ACTUAL POWER GENERATION IN 1 YEAR

2,628 kWh

$$\text{Capacity Factor} = \frac{2{,}628\ \text{kWh}}{13{,}140\ \text{kWh}} = 20\%$$