

# A Diversified Energy Portfolio for SEWA's Water Processes

---

ISABELLE CHAN, BRENDAN TRAIN, VERONIKA ENIS, SARAH TARIQ, UROOJ ILYAS



**WPI**

**AUS**

الجامعة الأميركية في الشارقة  
American University of Sharjah



هيئة كهرباء ومياه الشارقة  
Sharjah Electricity & Water Authority

# Agenda

---



Problem



Methods



Findings



Moving Forward

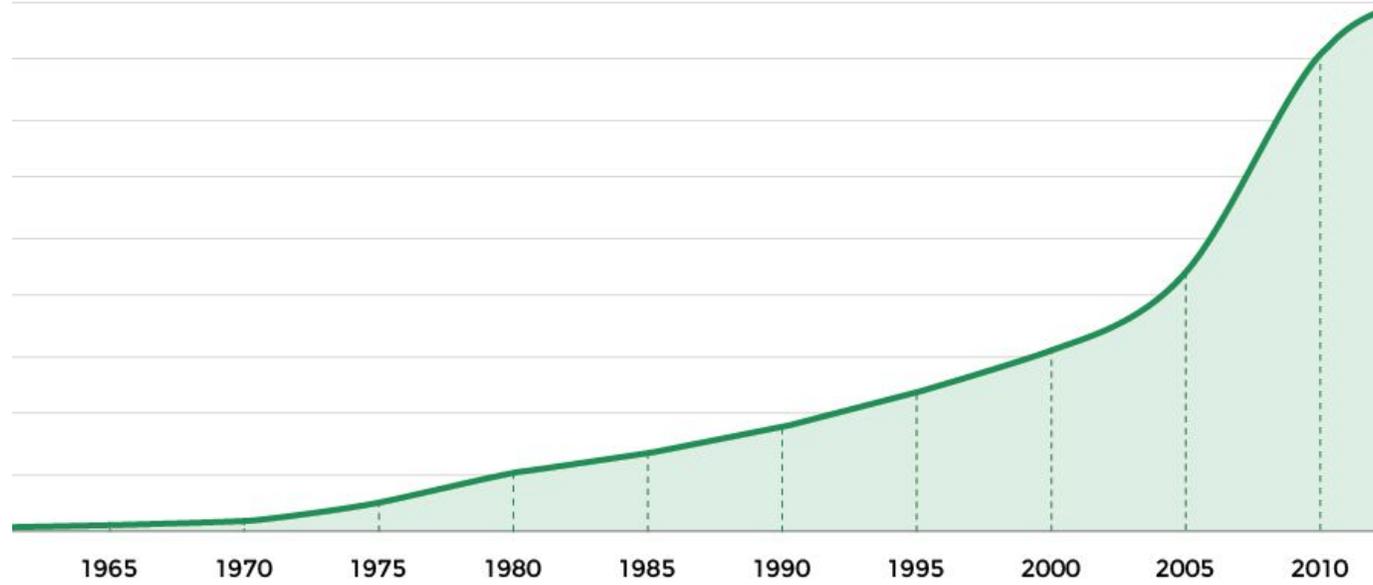
# Problem

---

# Problem Statement

SEWA is looking to create a diversified energy portfolio for their water processes that includes renewable energy. WPI-AUS students will work with the appropriate SEWA department to identify which potential renewable energy sources are most appropriate for Sharjah.

## Population of the UAE, 1960 to 2016 (in millions)



orlbank.org

© 2018 World Education Services  
wenr.wes.org

# Population of UAE

---



# Water & Energy

---

Uses a lot of energy for both processing and transportation of water

Powered by 100% natural gas

Desalination Plant (60MIGD) consumes 720MWh/day

About 91 million gallons of desalinated water per day

# Methods

---

# Objectives

---



Understand the advantages and disadvantages of using certain types of renewable energy



Create a diversified energy portfolio for SEWA's water processes that includes renewable energy for both 2020 and 2050



# Data Collection

---

Delphi Method

Participant Criteria

- Experts in the field of Renewable Energy, Energy Production, or SEWA's Water Processes

Qualtrics

Pilot Test

# Delphi Method



Set of surveys or questionnaires



Round 1: Broad Questions



Round 2: Narrow down options



Round 3: Agree/Disagree

Company/Department	Number of Participants
AUS Civil Engineering	2
AUS Electrical Engineering	6
AUS Mechanical Engineering	2
WPI Environmental Engineering	2
WPI Chemical Engineering	1
Al Mostajed Technologies Co. L.L.C.	1
Bee'ah	2
Etihad ESCO	1
Griffin Consultants	2
Honeywell UOP	1
IDOM Consulting	1
Total	21

# Initial Participant Breakdown

# Findings

---

Please choose the types of energy sources you would like to include in an **ideal** energy profile for 2020. If you would like to suggest an energy source that is not included on this list, please select "OTHER" and specify in the next question.

Wood & Agricultural Products	Oil (Petroleum)
Biomass	Coal
Standard Inland Wind Turbines	Natural Gas
Offshore Wind Turbines	Nuclear Energy
Solar Thermal (Heating)	Maritime Energy
Solar Photovoltaic (PV)	Geothermal
Solar Concentrating Solar Power (CSP)	OTHER

# Round 1

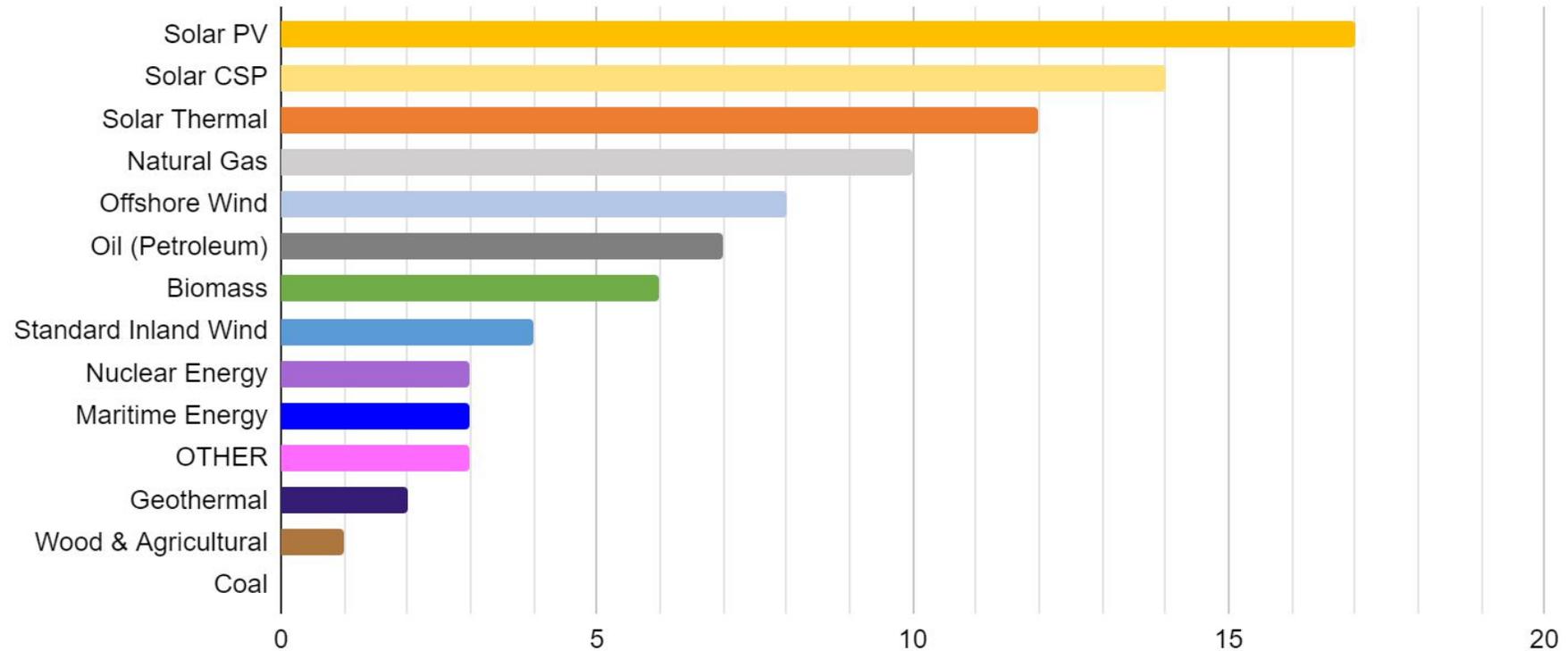
OPEN-ENDED BRAINSTORMING

# RESPONSES: 21

# Round 1: 2020

## Frequency of Energy Source (2020)

- Solar Energy
  - Irradiance Level
  - Precedent
- Fossil Fuels
  - Currently 100%

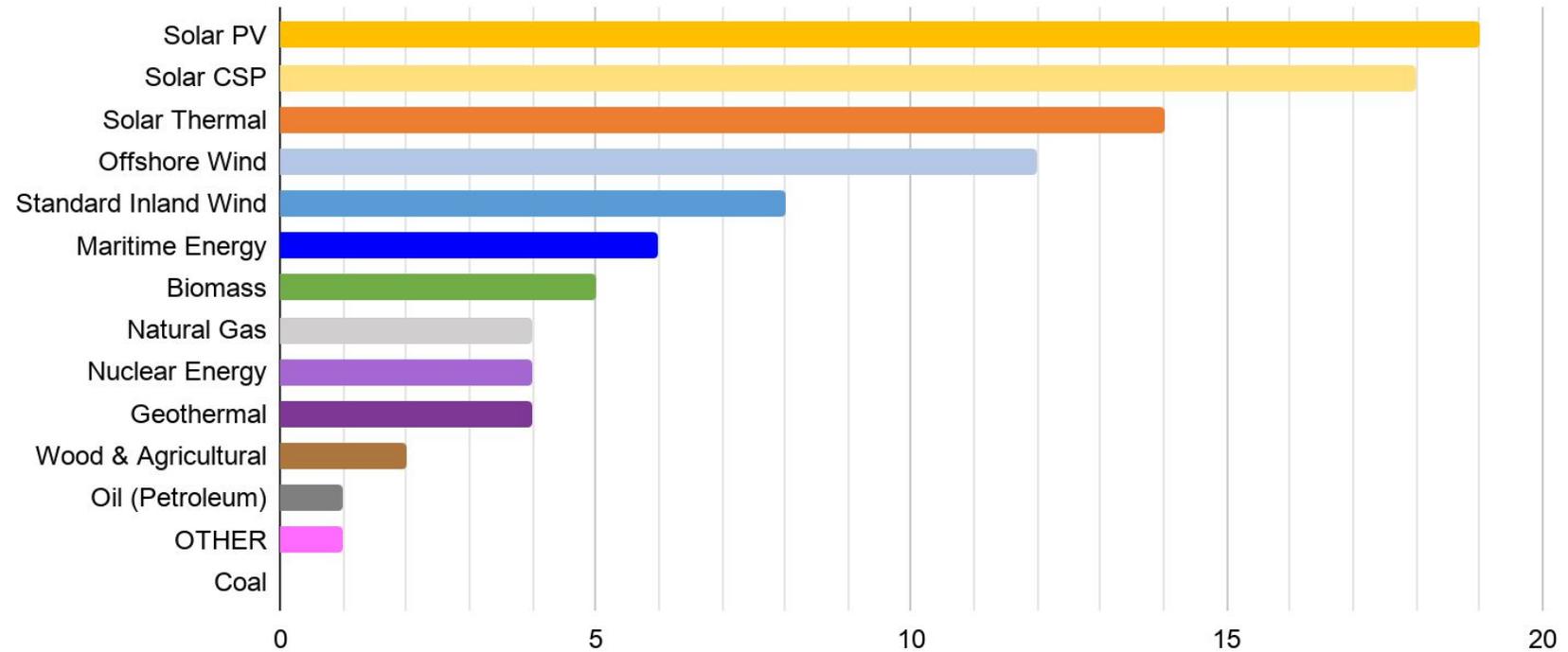


# Round 1: 2050

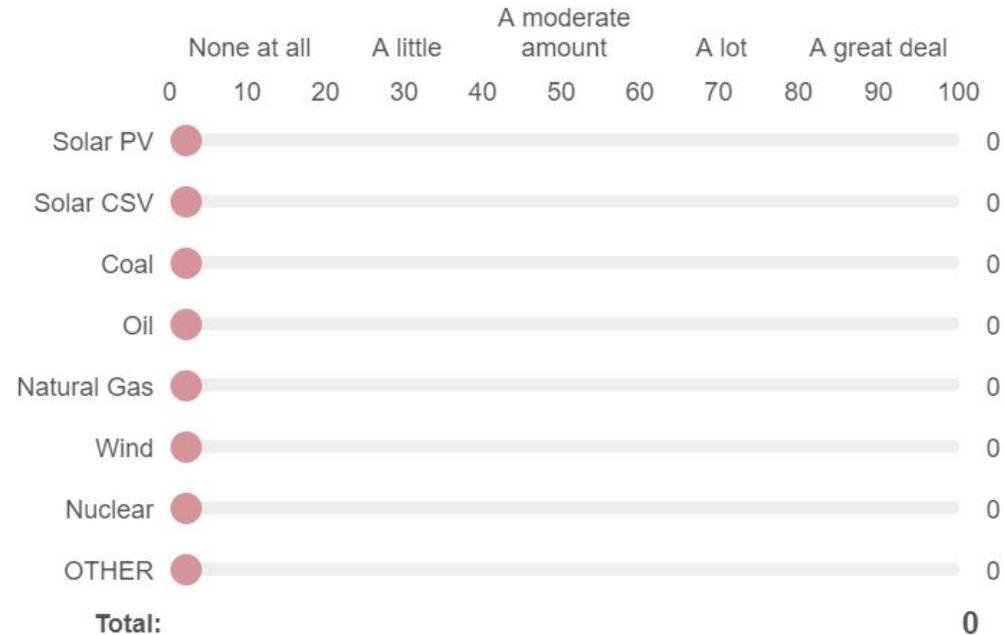
---

- Solar Energy Still Favored
- Inland vs Offshore Wind
  - Space Constraints
  - Wind Speeds
- Round 1 Report
  - Graphs
  - Expert Explanations

## Frequency of Energy Source (2050)



Using the given renewable energy sources, please allocate points based on how much you expect the energy source to contribute to the entire portfolio for 2020. You have exactly 100 points to distribute. **You may use no more than and no less than 100 points.** The survey software will prevent you from going above 100 points, and moving on if your total is below 100 points. There is a counter at the bottom displaying the total number of points you have already used.



## Round 2

NARROWING DOWN THE OPTIONS

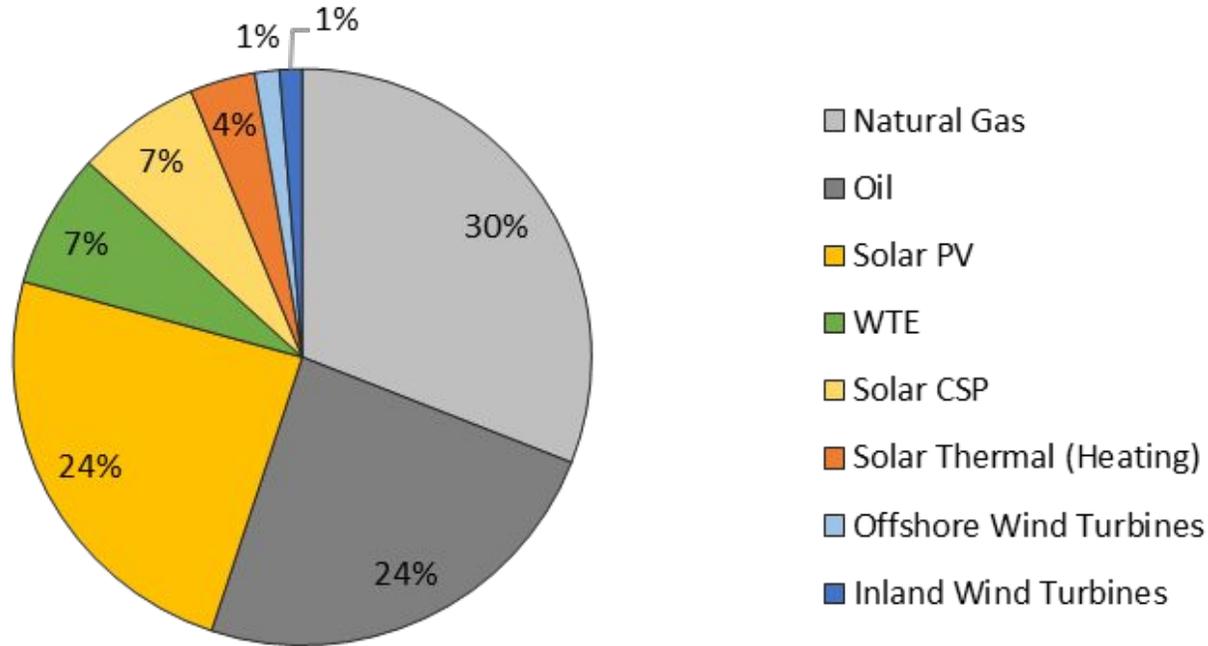
# RESPONSES: 17

ATTRITION RATE R1 to R2: 20%

# Round 2: 2020

---

R2: Proposed 2020 Portfolio

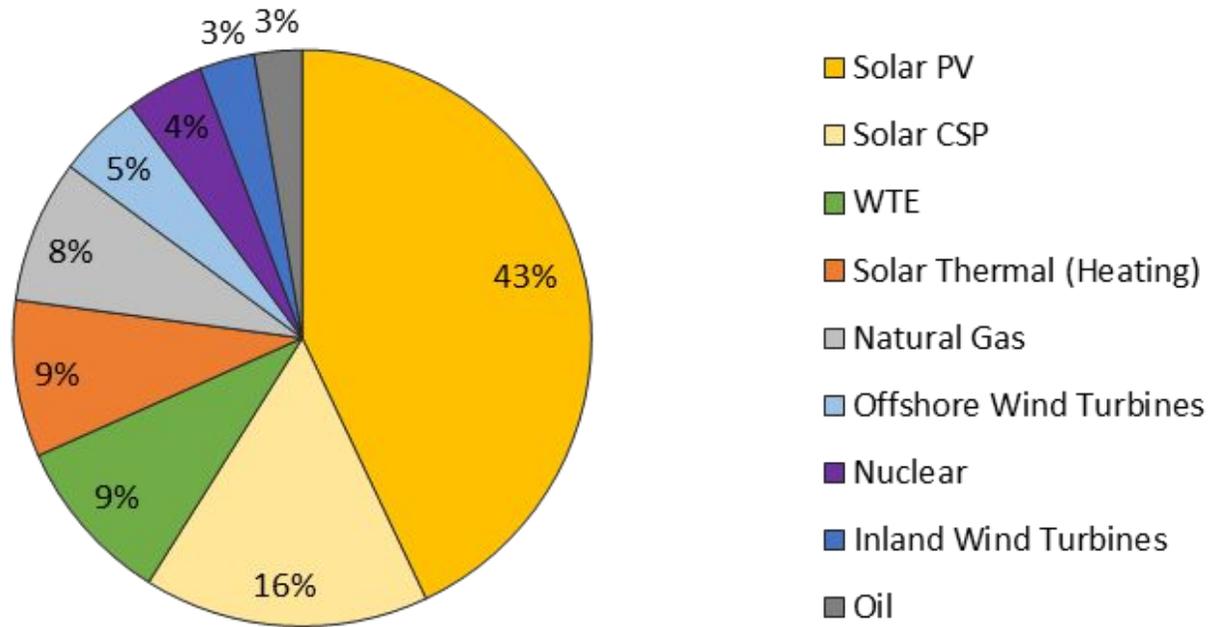


- Fossil Fuels
- Solar PV
  - economically feasible

# Round 2: 2050

---

R2: Proposed 2050 Portfolio



- Solar PV and CSP
  - technological advancements
- WTE
  - waste management
- Solar Thermal
  - heating stage of RO desalination

# Round 3

## CRITIQUE

# RESPONSES: 11

ATTRITION RATE R2 to R3: 35%

Do you believe that this is an optimal energy portfolio for Sharjah in the year 2020?

Yes, I think that this portfolio is something that Sharjah should aim to achieve for 2020.

No, I think this portfolio can be improved.

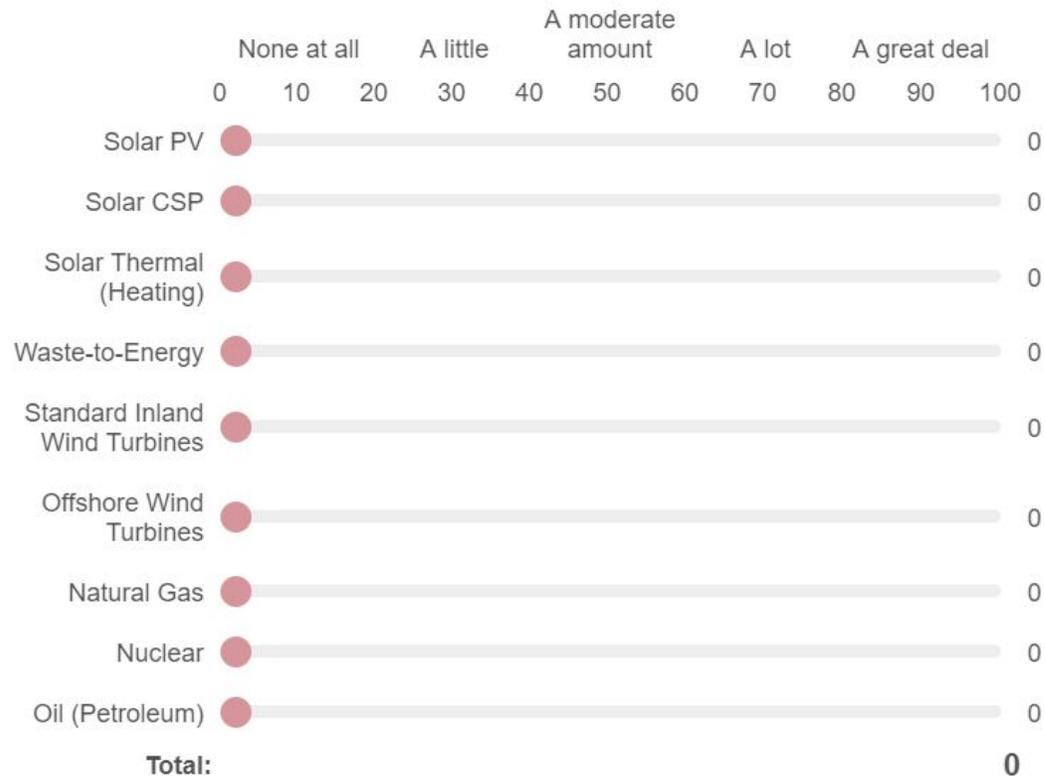
Please explain why you agree with Sharjah's 2020 energy portfolio.

Do you believe that this is an optimal energy portfolio for Sharjah in the year 2050?

Yes, I think that this portfolio is something that Sharjah should aim to achieve for 2050.

No, I think this portfolio can be improved.

Using the given renewable energy sources, please allocate points based on how much you expect the energy source to contribute to the Sharjah's entire energy portfolio for 2050. You have exactly 100 points to distribute. **You may use no more than and no less than 100 points.** The survey software will prevent you from going above 100 points, and moving on if your total is below 100 points. There is a counter at the bottom displaying the total number of points you have already used.

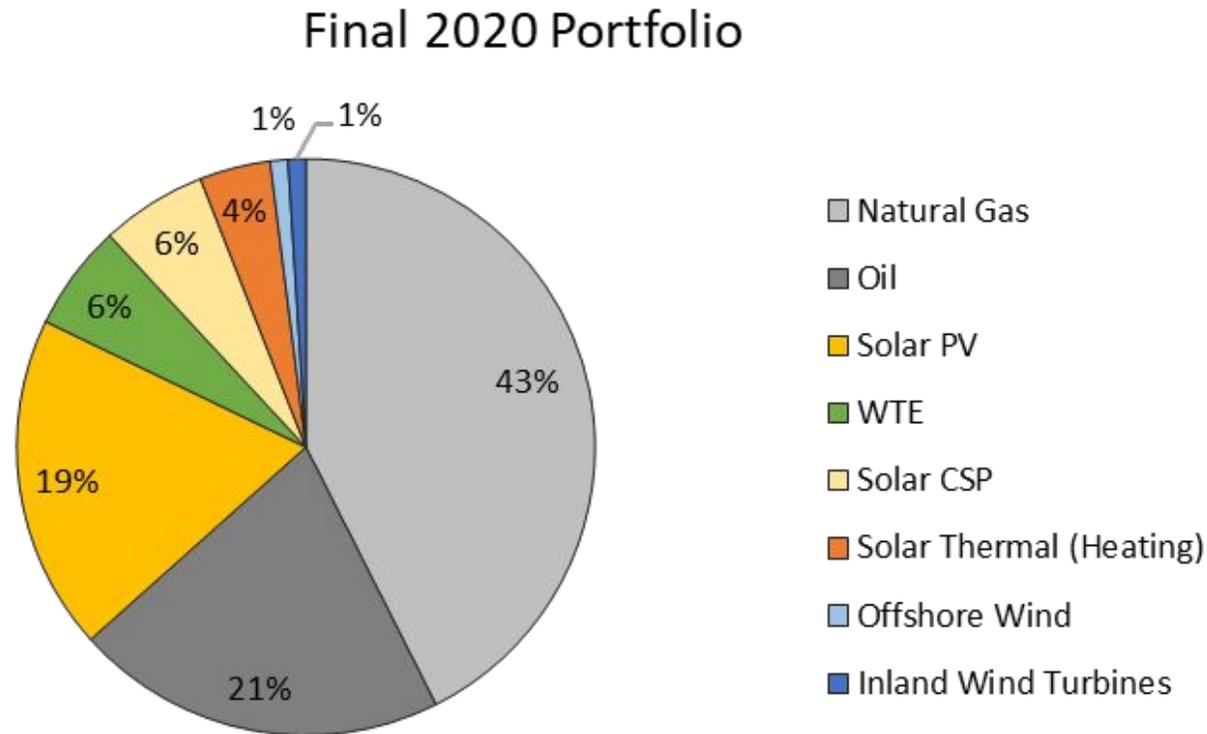


# Round 3

CRITIQUE

# Round 3: 2020

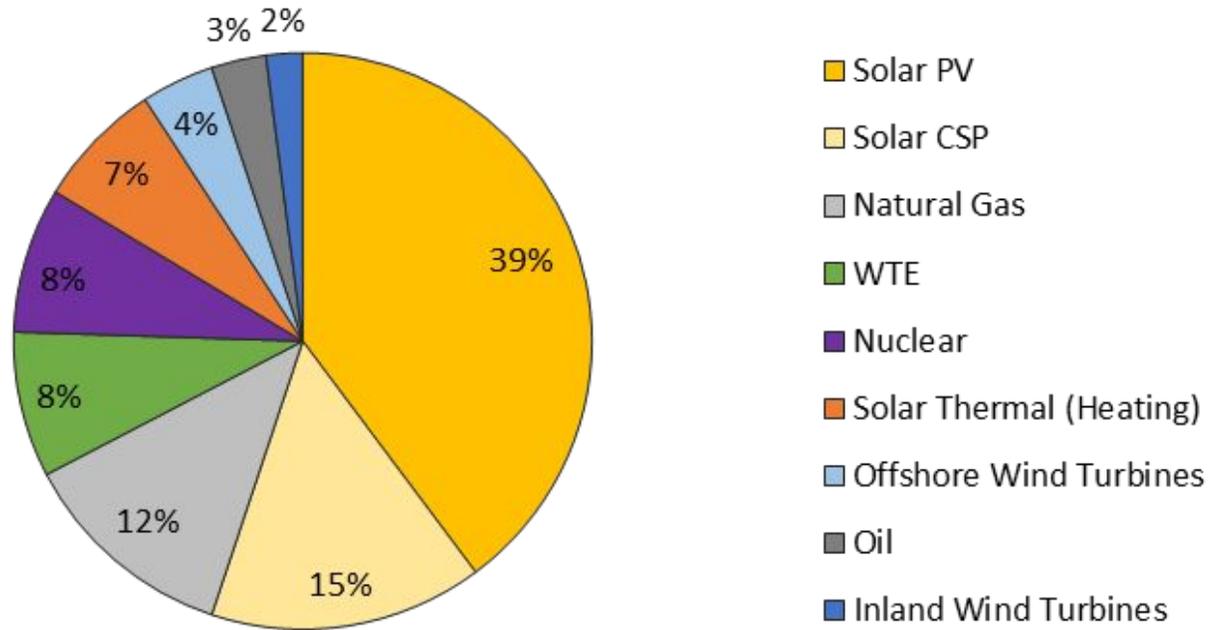
---



- Primarily fossil fuels
- Natural gas increased, others decrease
- Potentially because experts were more realistic
- PV biggest renewable source

# Round 3: 2050

Final 2050 Portfolio



- Solar PV may face difficulties due to environment
- Solar CSP may be better in future economically
- Natural gas increased from round 2 because it will be easily available
- Nuclear contentious because of ability to cover baseload but safety concerns

# Moving Forward

---

# Recommendations

---

## Continuation of this Study

- Repeat Round 3

## Feasibility Study

- More in-depth pilot test
- More diverse participant pool
- Strong and widely understood definition of "feasible"

## Further R&D

- Tool to prioritize R&D efforts
- Solar PV



# Acknowledgements

---

- ❖ Dr. AlaEldin Idris, Ms. Mayyada Al Bardan, and Mr. Waleed El Damaty
- ❖ Eng. Othman Suroor Al Mas
- ❖ Sharjah Electricity and Water Authority (SEWA)
- ❖ American University of Sharjah (AUS)
- ❖ Dr. Joseph Doiron and Dr. John Bergendahl
- ❖ Our Participants
- ❖ AUS Professors

Any Questions?

# Works Cited

---

Education in the United Arab Emirates. (2018, December 18). Retrieved from <https://wenr.wes.org/2018/08/education-in-the-united-arab-emirates>.

Peterson, B. (2017). Desalination and energy consumption. Retrieved from <https://www.energycentral.com/c/ec/desalination-and-energy-consumption>

Sharjah Electricity & Water Association. (2018). 2018 annual report of the Sharjah Electricity & Water resources. Retrieved from <https://www.sewa.gov.ae/uploads/statspdfar/Finalbook2018.pdf>

Twin, A. (2019). Delphi method. Retrieved from <https://www.investopedia.com/terms/d/delphi-method.asp>

Company/Department	Number of Participants
AUS Civil Engineering	2
AUS Electrical Engineering	6
AUS Mechanical Engineering	2
WPI Environmental Engineering	2
WPI Chemical Engineering	1
Al Mostajed Technologies Co. L.L.C.	1
Bee'ah	2
Etihad ESCO	1
Griffin Consultants	2
Honeywell UOP	1
IDOM Consulting	1
Total	21

# Round 1: Participant Breakdown

<b>Company/Department</b>	<b>Number of Participants</b>
AUS Civil Engineering	2
AUS Electrical Engineering	6
AUS Mechanical Engineering	2
WPI Chemical Engineering	1
Al Mostajed Technologies Co. L.L.C.	1
Bee'ah	2
Griffin Consultants	1
Honeywell UOP	1
IDOM Consulting	1
TOTAL	17

## Round 2: Participant Breakdown

Company/Department	Number of Participants
AUS Civil Engineering	2
AUS Electrical Engineering	2
AUS Mechanical Engineering	2
WPI Chemical Engineering	1
Al Mostajed Technologies Co. L.L.C.	1
Bee'ah	1
Honeywell UOP	1
IDOM Consulting	1
TOTAL	11

## Round 3: Participant Breakdown

# Round 1: Explanations

---

2020

“**Photovoltaic** cells is being more and more attractive with the increase in its efficiency and reduction in its costs.”

“Since the target is 2020, I would like to keep the more common source of energy, such as **natural gas** and **oil**.”

“**Nuclear energy** is a clean source and is a perfect option for baseload as renewable resources can not be dispatched.”

“**Waste-to-Energy** plant is a sustainable source of energy and does not require a huge area like a **solar** farm. Waste remains a part of our daily lives, from organic matter to petroleum-based plastic, waste comes in many forms. So as long as the community continue producing waste, the **WTE** plants continue to generate energy.”

2050

“The Gulf region is one of the world’s richest areas in **sunshine**. Average annual sun irradiation: ~ 2000 – 2200 kWh/m<sup>2</sup>.”

“Conventional and less pollutant sources, such as **natural gas**, might be still in use, just to regulate renewable ones.”

“I do believe that by 2050 these are essentially inevitable, especially **offshore wind** (again, depends on the wind resource and where the turbines would be) and photovoltaics.”

“I excluded **geothermal** because of harmful gases besides, due to the thickness of the earth's crust and the variation of temperature with depth, UAE does not lie in economically feasible areas for geothermal energy.”

# Round 2: Explanations

---

2020

“**Solar PV** and **Solar CSP** farms require a considerable area to provide the quantity of power that would be relevant to compensate for gas and petroleum based turbines currently used in conventional power plants.”

“However, a reason for its inclusion is the ample amount of [**biomass** available] as fuel for these power plants...It won't increase [overall] efficiency but will greatly impact the efficiency with respect to environment[al] conservation.”

“**Natural Gas** and **Oil (petroleum)** have been included for obvious reasons, that is the current dependence on these fuels mandates that conventional turbines are always available in energy portfolios of the immediate future, at least on a standby basis.”

2050

“Both [**solar** and **biomass**] are plentiful in this region and a good form of ensuring a clean environment and atmosphere, without the emissions that are expended from conventional power plants.”

“**Waste to energy** power plant[s] produce clean and renewable energy through thermochemical process. The energy generated from **WTE** plants, reduces the dependency on the production of power plants based [on] fossil fuels”

“**Gas** is a local resource and will become more difficult to sell as the rest of the world moves to renewables. Therefore, the producing countries will use [**natural gas**] to supply their own needs.”

# Round 3: Explanations

---

2020

"The introduction of renewable energies in the energetic mix of Sharjah will take time, **solar photovoltaic** is one of the easiest and cheapest type of energy, and should be the most important in the short term."

"**WTE** is good but it is worse than **natural gas** in producing emissions and harmful gases. **Inland wind turbines** are not economically feasible due to low wind speeds (average below 4-5 m/s) on the other hand **offshore wind** speeds just cross the boundary for having a feasible project (5.5-6.5 m/s according to NREL. 4) SEWA already has an almost 100% **[Natural] gas** system. talking about 1-year span (2020), best can be done is 5-10% renewable."

2050

"The increase in **solar energy** as a source is understandable. The **solar energy** is already been viewed as cost effective option. With huge amount of sunlight available in Sharjah, it is only reasonable that SEWA increases dependence on **solar energy**, away from other fossil fuel options."

"Fossil energies such as **natural gas** or even **oil** should disappear from the energetic mix, and be replaced by other renewable sources. Because of Sharjah's climate conditions, **solar power** must be the most important."

"**Natural gas** and **oil** will be cheap source of energy since many countries will move away from fossil fuel. Since fossil fuel will be available and cheap in this region, then you cannot remove it from the energy portfolio."