

Project Control Challenges in Renewable Energy Projects in Middle East

(Solar Photovoltaic (PV) in particular)

By: Yousef Almousa

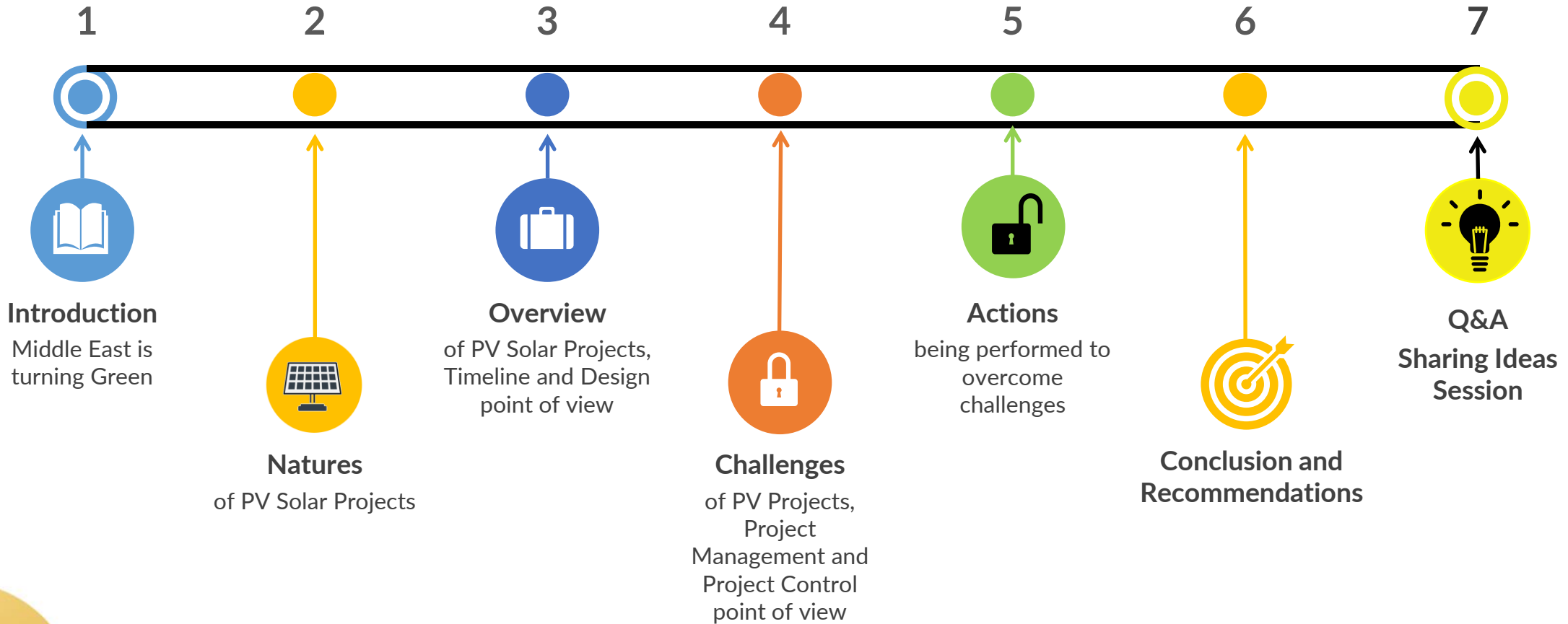


Yousef Almousa BIO

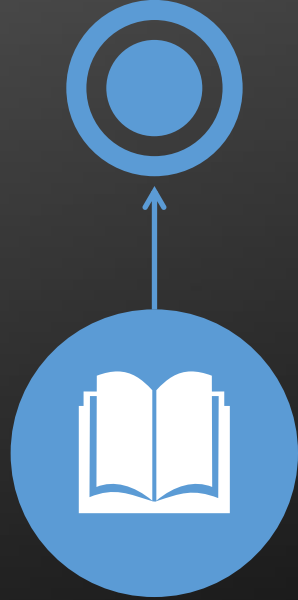
- 14+ Years of experience in Construction field, 8+ Years of experience in Project Control.
- 8+ years experience in Renewable Energy projects.
- Father of 2 kids (Mohammad and Rayyan).
- Bachelor in Civil Engineering (University of Jordan).
- Current assignment: Senior Project Control Manager at ACWA Power.
- PMP certified since 2014, and Associate at Chartered Institute of Arbitrators since 2021.
- Claims Management and Delay Analysis experienced.
- Key mega projects worked on: NEOM Green Hydrogen Project biggest of its kind in the world being built in KSA, Abu Dhabi Midfield Terminal Airport Project in UAE.
- Working currently at ACWA Power, the developer for various mega projects in renewable energy field. Exerting execution oversight role from Project Control side for different renewable energy mega projects across the Middle East, KSA, UAE, Oman, Egypt, Indonesia and Uzbekistan with a capacity of more than 10,000MW.



Agenda



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Introduction

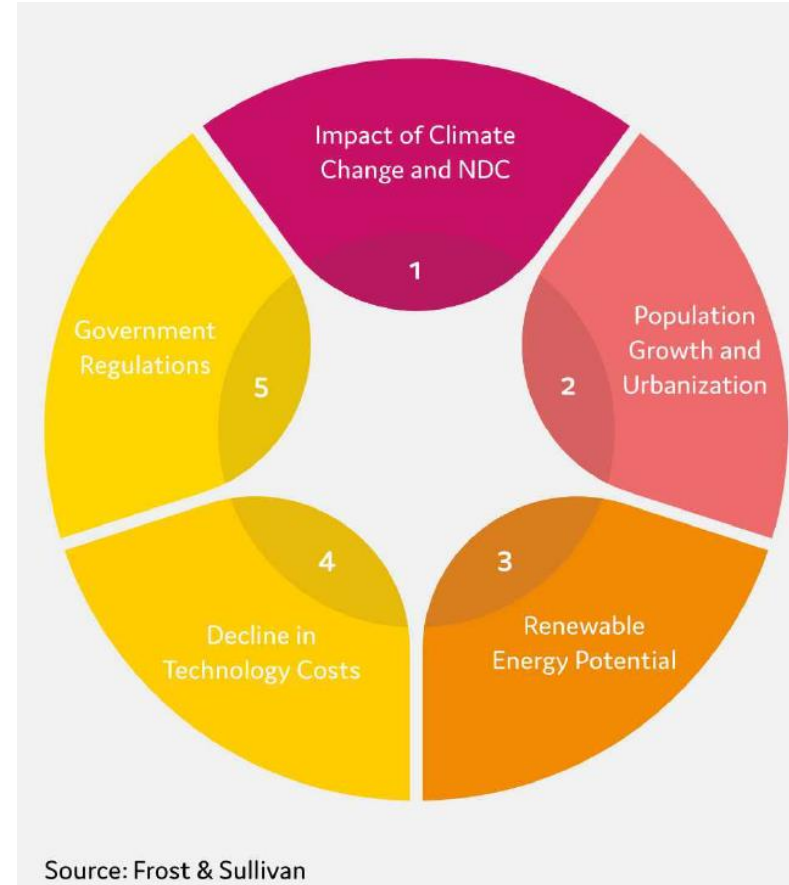
Middle East is turning **Green**



1. Introduction - The Middle East is turning Green

1

- The energy sector is undergoing a major transition toward a decarbonized and digitalized future.
- This transition is now steadily making its way over to the Middle East.



Drivers for Energy evolution in the Middle East

What's an NDC?!

an NDC, or Nationally Determined Contribution, is a climate action plan to cut emissions and adapt to climate impacts. Each Party to the [Paris Agreement](#) is required to establish an NDC detailing what they will do to help meet the global goal to pursue 1.5°C, adapt to climate impacts and ensure sufficient finance to support these efforts.

1. Introduction - The Middle East is turning Green

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- Power generation across the Middle East and North Africa (MENA) has doubled in the past 15 years, from around **842 TWh in 2005** to **1,635 TWh by 2020**, according to data compiled by BP.
- The biggest producers of electricity in the region are Saudi Arabia, Iran, Egypt, UAE and Iraq.

	Total	Of which, renewables
Saudi Arabia	340.9	1.0
Iran	331.6	1.0
Egypt	198.6	9.7
UAE	138.4	5.6
Iraq	131.3	0.4
Kuwait	74.9	0.2
Qatar	50.5	0.1
Oman	38.9	0.2
Other Middle East	84.4	4.5

Source: BP

Electricity Generation by Country, 2020 (TWh)

1. Introduction - The Middle East is turning Green

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	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Solar	0.1	0.2	0.4	0.7	1.3	1.8	2.8	3.9	6.0	11.9	16.4
Wind	0.2	0.2	0.2	0.2	0.2	0.4	0.7	0.8	1.3	1.6	1.9
Hydro	17.4	18.3	21.4	23.5	19.9	16.8	20.1	20.6	14.3	33.2	25.4
Biomass	0.1	0.2	0.2	0.2	0.3	0.2	0.3	0.3	0.3	0.3	0.3
Oil	291.8	330.6	349.4	372.0	361.8	365.0	338.0	319.9	358.0	363.9	357.5
Natural gas	529.4	504.5	534.4	548.4	634.7	692.6	750.5	815.4	799.2	813.7	836.1



Source: BP

Middle East Electricity Generation by Type (TWh)

1. Introduction - The Middle East is turning Green

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IRENA's Renewable Energy Roadmap (REmap)

International Renewable Energy Agency (IRENA) has explored two energy development options to the year 2050 as part of the 2019 edition of its global energy transformation report:

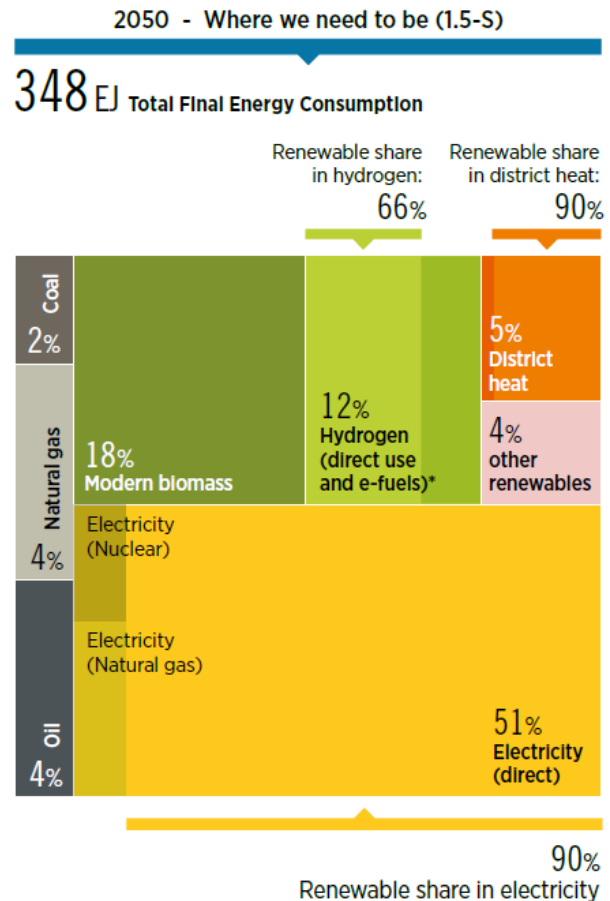
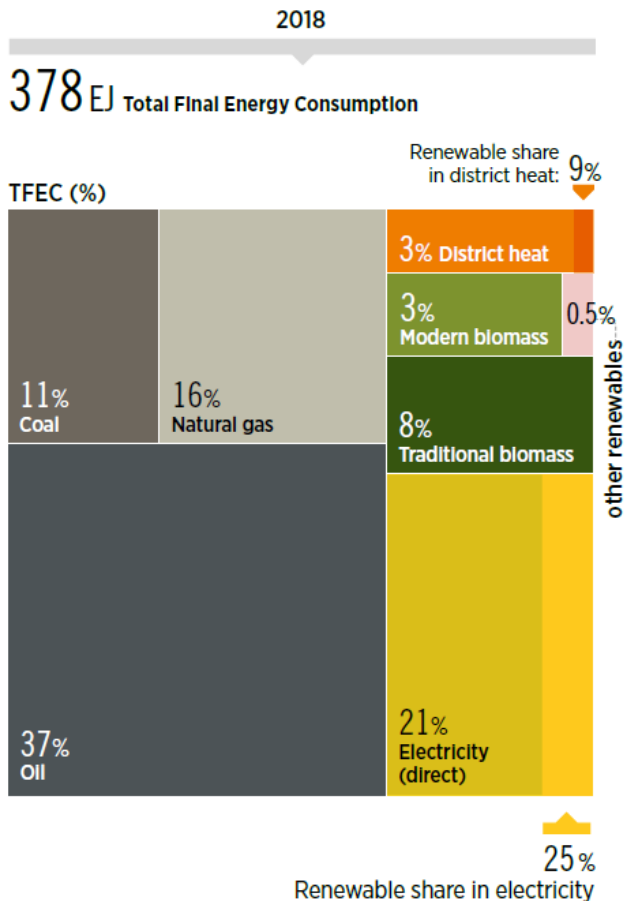
1. **The Reference Case**; that is an energy pathway set by current and planned policies.
2. **The REmap Case**; a cleaner climate-resilient pathway based largely on more ambitious, yet achievable, uptake of renewable energy and energy efficiency measures which limits the rise in global temperature to well below 2 degrees and closer to 1.5 degrees, aligned within the envelope of scenarios presented in the 2018 report of the Intergovernmental Panel on Climate Change (IPCC).

IRENA's Renewable Energy Roadmap (REmap Case)



Electricity becomes the main energy carrier in energy consumption by 2050

Breakdown of total final energy consumption (TFEC) by energy carrier in 2018 and 2050 (EJ) in the 1.5°C Scenario (1.5-S)

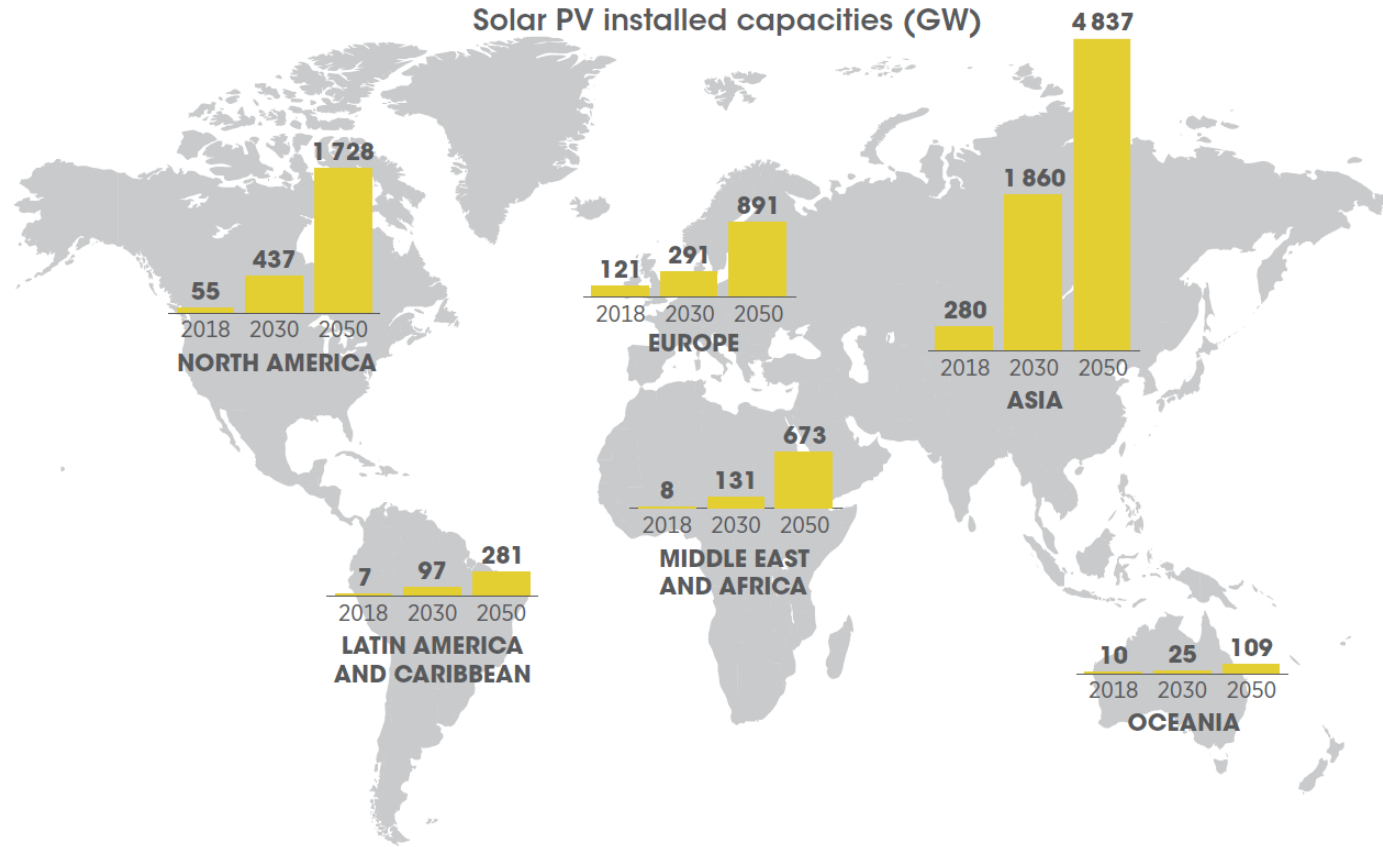


Note: The figures above include only energy consumption, excluding non-energy uses. For electricity use, 25% in 2018 and 90% in 2050 is sourced from renewable sources; for district heating, these shares are 9% and 90%, respectively; for hydrogen (direct use and e-fuels), the RE shares (i.e., green hydrogen) would reach 66% by 2050. The category "Hydrogen (direct use and e-fuels)" accounts for total hydrogen consumption (green and blue) and other e-fuels (e-ammonia and e-methanol). Electricity (direct) includes all sources of generation: renewable, nuclear and fossil fuel based. DH = district heat; EJ = exajoules; RE = renewable energy.

Source: IRENA, 2021



IRENA's Renewable Energy Roadmap (REmap Case)



Disclaimer: The designations employed and the presentation of material herein do not imply the expression of any opinion on the part of IRENA concerning the legal status of any region, country, territory, city or area or of its authorities, or concerning the delimitation of frontiers or boundaries

Sources: Historical values based on IRENA's renewable energy statistics (IRENA,2019c) and future projections based on IRENA's analysis (2019a).

Carbon Zero targets are set

Ahead of the 26th UN Climate Change Conference of the Parties (COP 26) summit in Glasgow in November 2021, a handful of Middle East governments announced the first net-zero emissions target for the region.

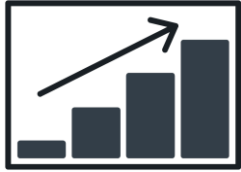
- The first country to do so was the UAE in October 2021, who pledged to cut the country's domestic emissions to net zero by **2050**, while also unveiling plans to invest some **AED 600 billion (USD 163 billion)** in clean and renewable energy sources.
- Saudi Arabia and Bahrain also announced net zero targets by **2060**.

Source: Informa Markets



Middle East to become major producer of green hydrogen

The Middle East is one of the better positioned regions to take advantage of:



Rising global demand



Cost reductions via Innovation



Pre-existing conditions suitable for production and transportation of green hydrogen

Middle East to become major producer of green hydrogen



In KSA, **NEOM Green Hydrogen Company** completed Financial Close at a total of investment value of **USD 8.4 Billion** in the World's Largest Green Hydrogen Plant. Expected to **start operation in 2025** in Neom.



Hydrogen roadmap, released November 2021. The UAE is aiming to have a **25% share** of the global market in low-carbon hydrogen projects by **2030**.
Masdar has also signed a **USD 5 Billion** deal with French utility company Engie to create a green hydrogen hub in the UAE, with the aim of developing projects with a capacity of at least **2GW by 2030**.



In January 2022, Oman signed an agreement with BP to develop green hydrogen projects by 2030. Under the partnership, the oil major will evaluate wind and solar data from 8,000 square kilometres of land to identify optimal locations.



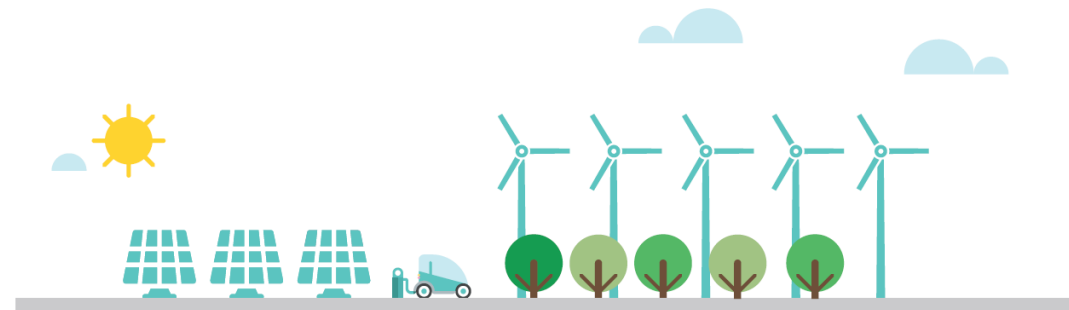
The green hydrogen strategy was unveiled in 2022.
Egypt has racked up more than 20 memoranda of understanding with major companies, that are poised to invest **USD 83 Billion** in green hydrogen projects in Egypt.

Sources: WFES, NGHC, zaway.com, hydrogeninsight.com

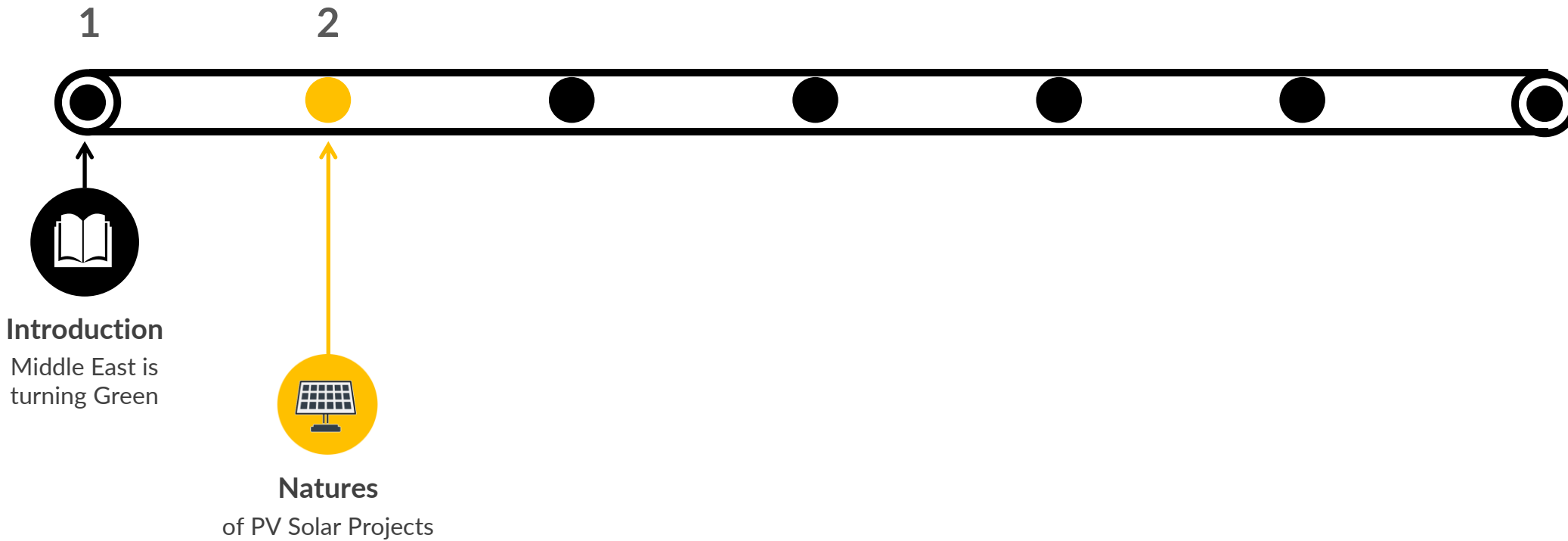


Middle East to become major producer of green hydrogen

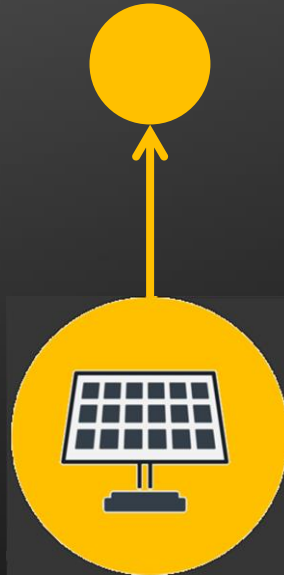
Carbon Zero targets for countries, and Green Hydrogen production and investment plans will have direct impact on creating further opportunities for Solar projects in Middle East in the next 20 years. This will require proper planning for such projects in all aspects (Financial and Commercial, resourcing, logistics...etc.).



Agenda Roadmap



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Natures of PV Solar Projects



2. Natures of PV Projects – Duration and Mega Scale

2

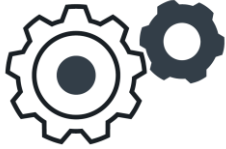


- **Duration** for utility scale PV Power Plant Projects from EPC Contract signature till Commercial Operation Date is currently range between 1 to 2.5 Years.



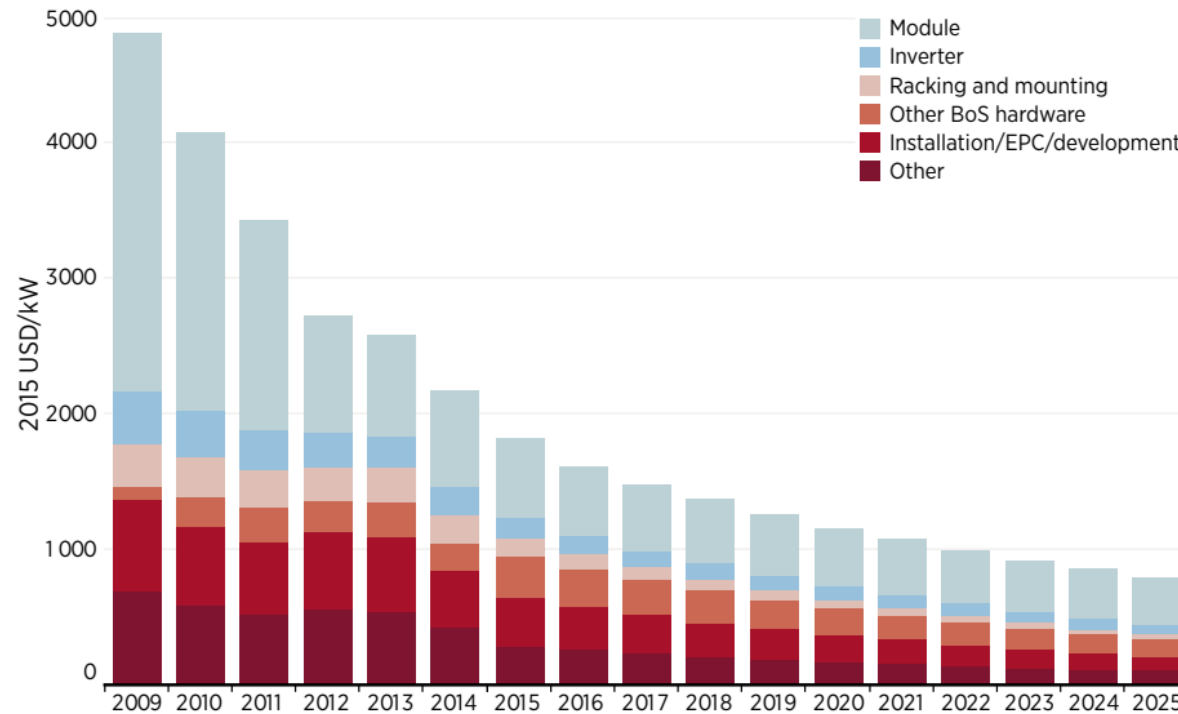
- **Mega scale projects in the region** – for most utility scale Solar projects in the region, EPC Contracts value range between USD 200 Million to USD 1.5 Billion. Single Project capacity range between 300MW into 2,000MW.

2. Natures of PV Projects – Materials Price



- **Most of project cost is coming from materials price;** mainly PV Modules, Inverters, Racking System and Balance of System hardware. Materials price (including shipping cost) contributes around 65% of project cost.

FIGURE ES 1: GLOBAL WEIGHTED AVERAGE UTILITY-SCALE SOLAR PV TOTAL INSTALLED COSTS, 2009-2025



Source: IRENA and Photon Consulting, 2016

Note: Graph doesn't reflect COVID-19 impacts



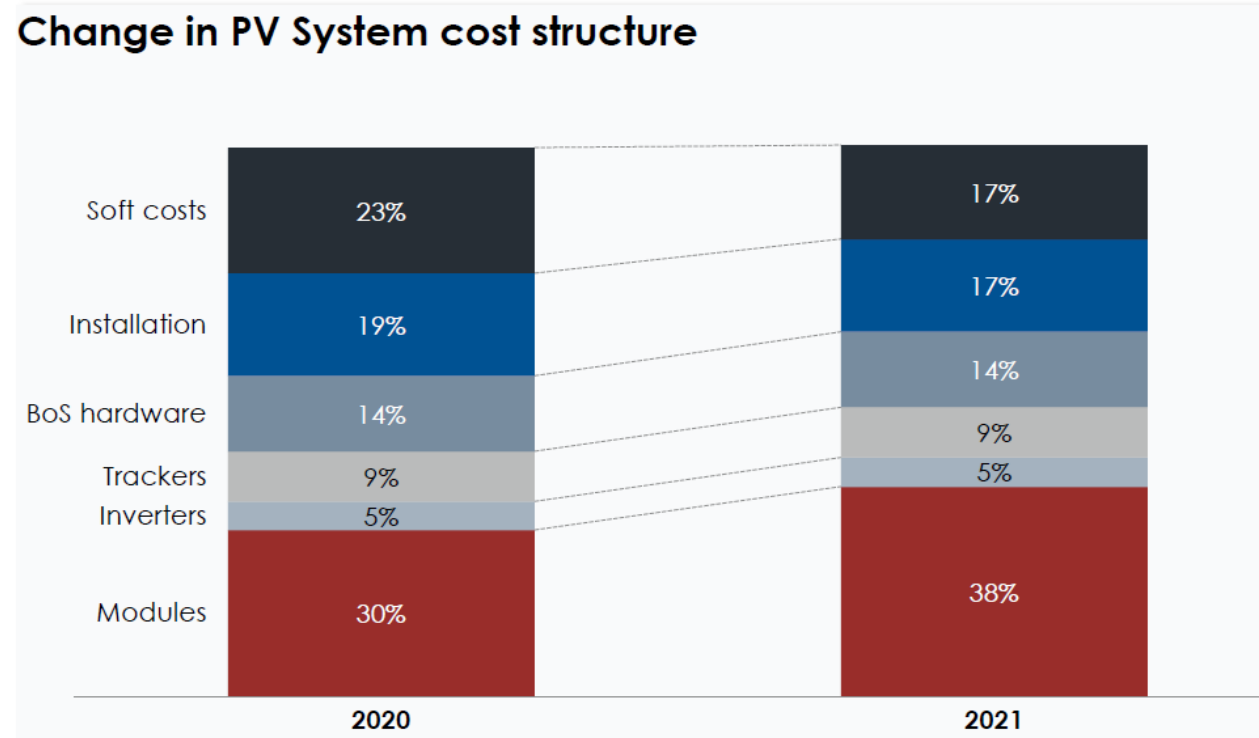
2. Natures of PV Projects – Materials Price

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- Cost of PV Projects get affected more with materials price after COVID-19, especially for PV Modules



Change in PV System cost structure

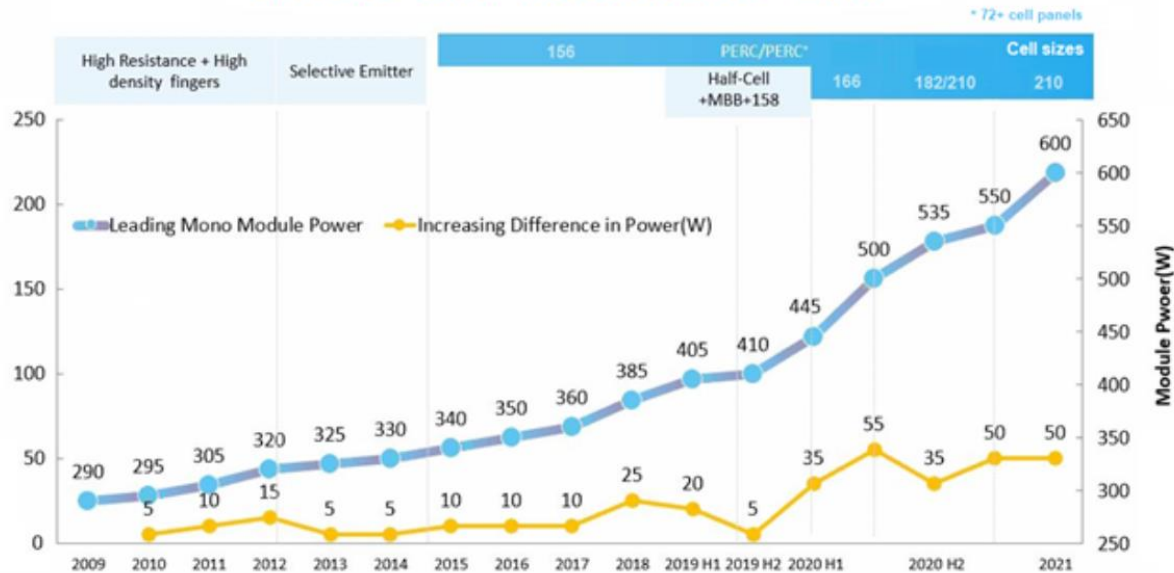


Source: IRENA, BCG Analysis

2. Natures of PV Projects – PV Module efficiency

- **Efficiency of solar panels** is defined as the energy output from a given surface area of the solar panel. The higher the energy output from a given surface area, the higher the efficiency. As solar panels get more and more efficient over time, manufacturers can increase not only the efficiency of the solar panel but also the rated power capacity of the solar panel.

Module Power Increase: 2009 - 2021 *



PV Modules increase in efficiency (2009 – 2021), Report produced by TRINASOLAR

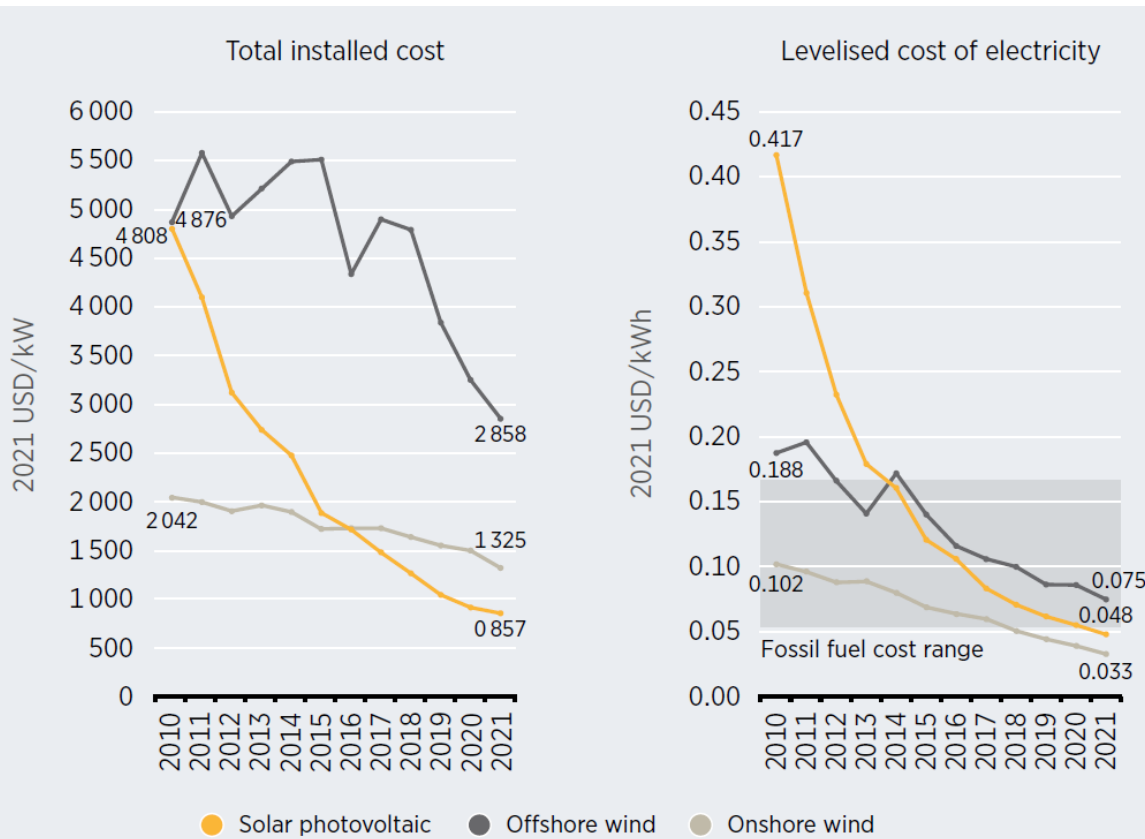
- **Research and Development** in Solar are extensive, and innovations and improvements are very quick.

2. Natures of PV Projects – Big decrease in Projects Prices

2



- Big decrease in Projects Prices



- The period 2010 to 2021 has witnessed a seismic shift in the balance of competitiveness between renewables, and fossil fuel and nuclear options.
- The Global weighted average Levelized Cost of Electricity (LCOE) of newly commissioned utility-scale solar PV projects declined by **88%** between 2010 and 2021.



Global weighted average total installed costs and LCOE of newly commissioned utility-scale solar PV, onshore and offshore wind, 2010-2021

Source: IRENA



2. Natures of PV Projects – Huge Area of Sites

- **Huge Area of Sites:** Despite this increase in efficiency in solar panels (almost doubled over a decade), solar projects still require huge area of land.

Project	Size (MW)	Area (Km2)
Project 1	700	13.5
Project 2	2,000	33.5
Project 3	1,425	32.5

Source: ACWA Power



2. Natures of PV Projects – Repeatable Works

- Most of Project works are “Repeatable Works”:

Below is example of main elements of PV project of a capacity of **2,000MW**, with PV Modules rating of **615Wp**. As clearly noticeable all main key equipment have large quantities. These elements are installed in all PV Area power blocks, and most of installation works are usually symmetrical if project land allows for that.

Key Equipment	Quantity	Unit
PV Modules	3,660,488	No
Trackers Posts	554,078	No
Trackers	14,962	No
Inverters	248	No
Cleaning Robots	5,906	No
Solar DC Cables	16,650	km
LV DC Cables	4,291	km
MV Cables	1,904	km

Source: ACWA Power

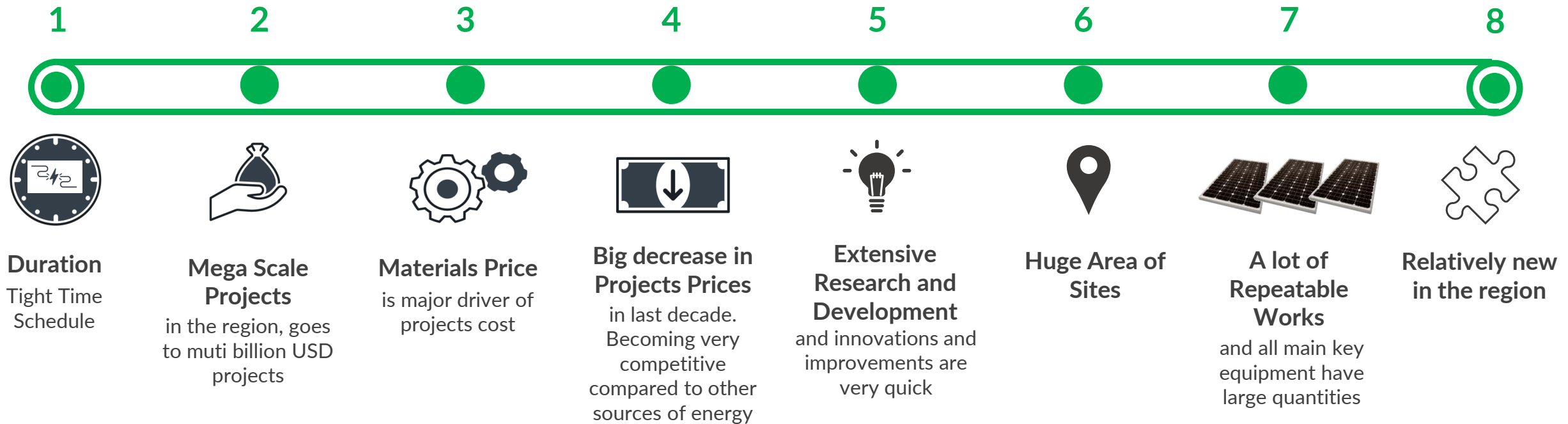
2. Natures of PV Projects – New in the region

- **Relatively new in the region**

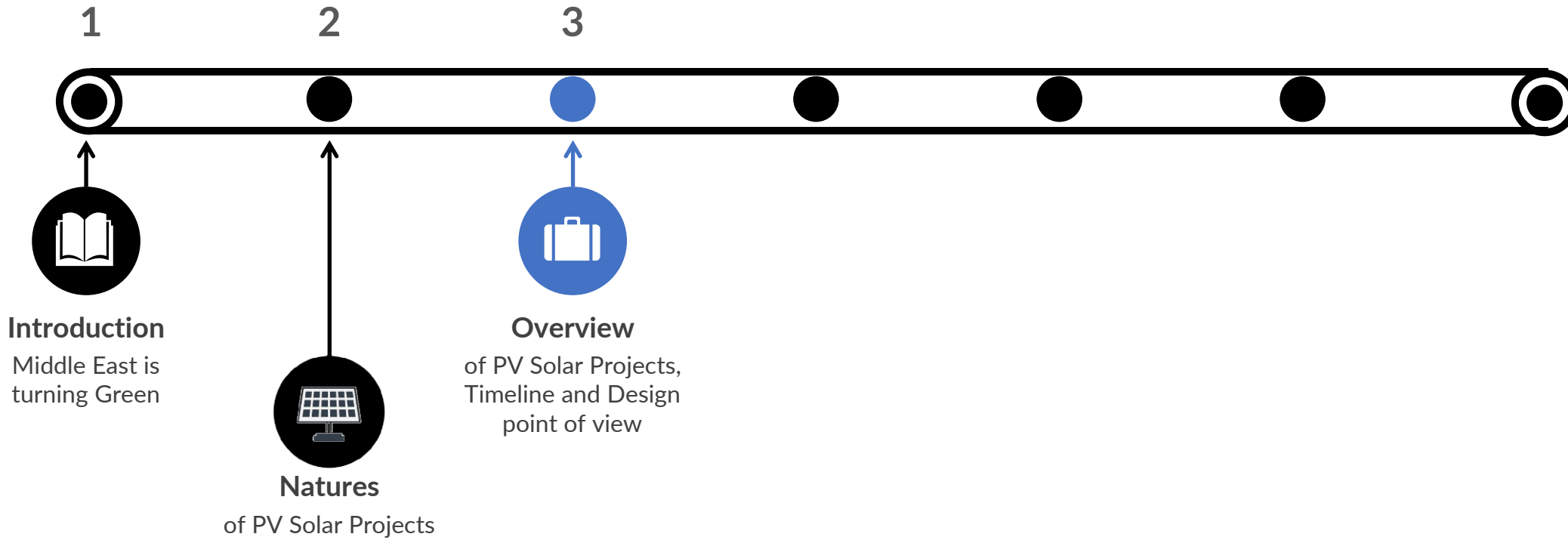
Large scale projects started in the region since less than 10 years. Government laws, regulations and specifications for Renewable Energy are relatively new, and they also include high coordination requirements with local authorities and electrical grid operators, and sometimes include local content requirements.

2. Natures of PV Projects (summary)

2



Agenda Roadmap



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Overview of PV Solar Projects

Timeline and Design point of view



3. Overview of PV Projects – Main Components



**PV Modules Mounting
Structure Posts**

Source: ACWA Power



PV Modules Mounting Structure



3. Overview of PV Projects – Main Components



Cable Works



PV Modules

Source: ACWA Power



3. Overview of PV Projects – Main Components



Inverters and MV Stations

Source: ACWA Power



3. Overview of PV Projects – Main Components



Automatic Cleaning Robots

Source: ACWA Power



3. Overview of PV Projects – Main Components



Substation and Interconnection Equipment

Source: ACWA Power



3. Overview of PV Projects – Main Components



**Complete PV Plant,
(Sudair PV Plant, KSA, 1500MW)**



Source: ACWA Power

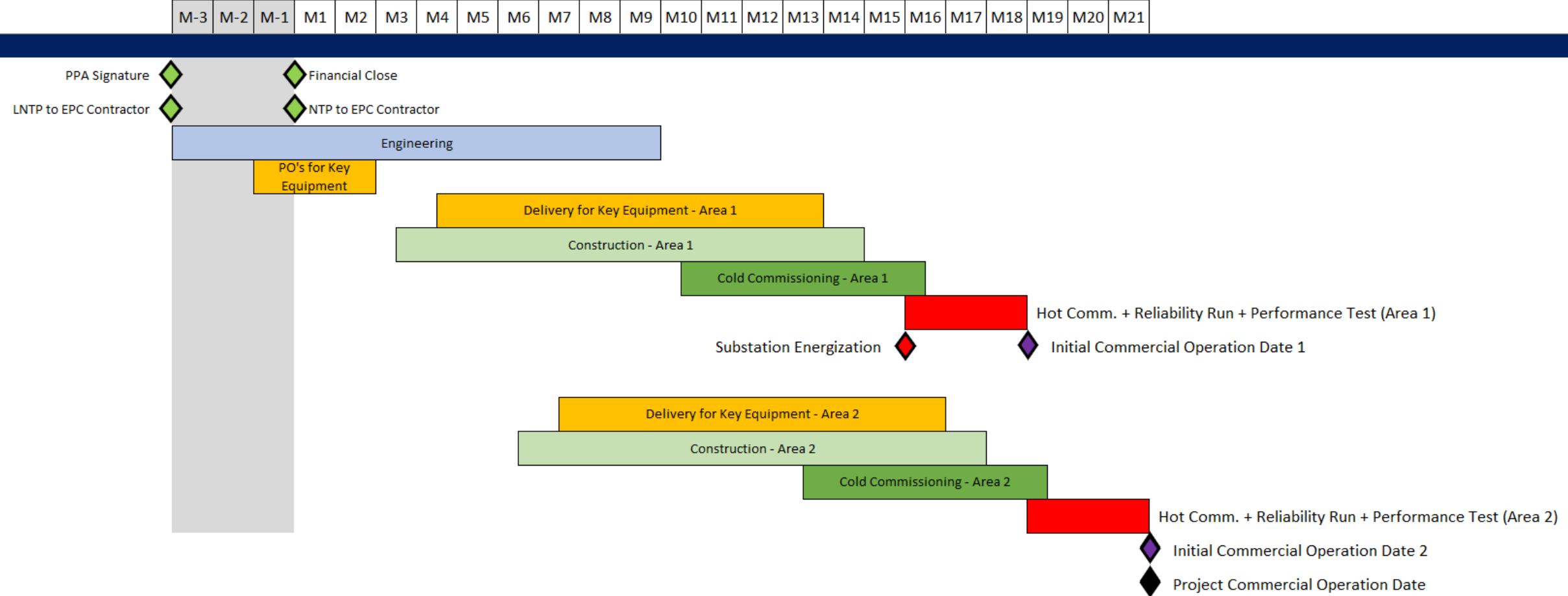


3. Overview of PV Projects – Layout

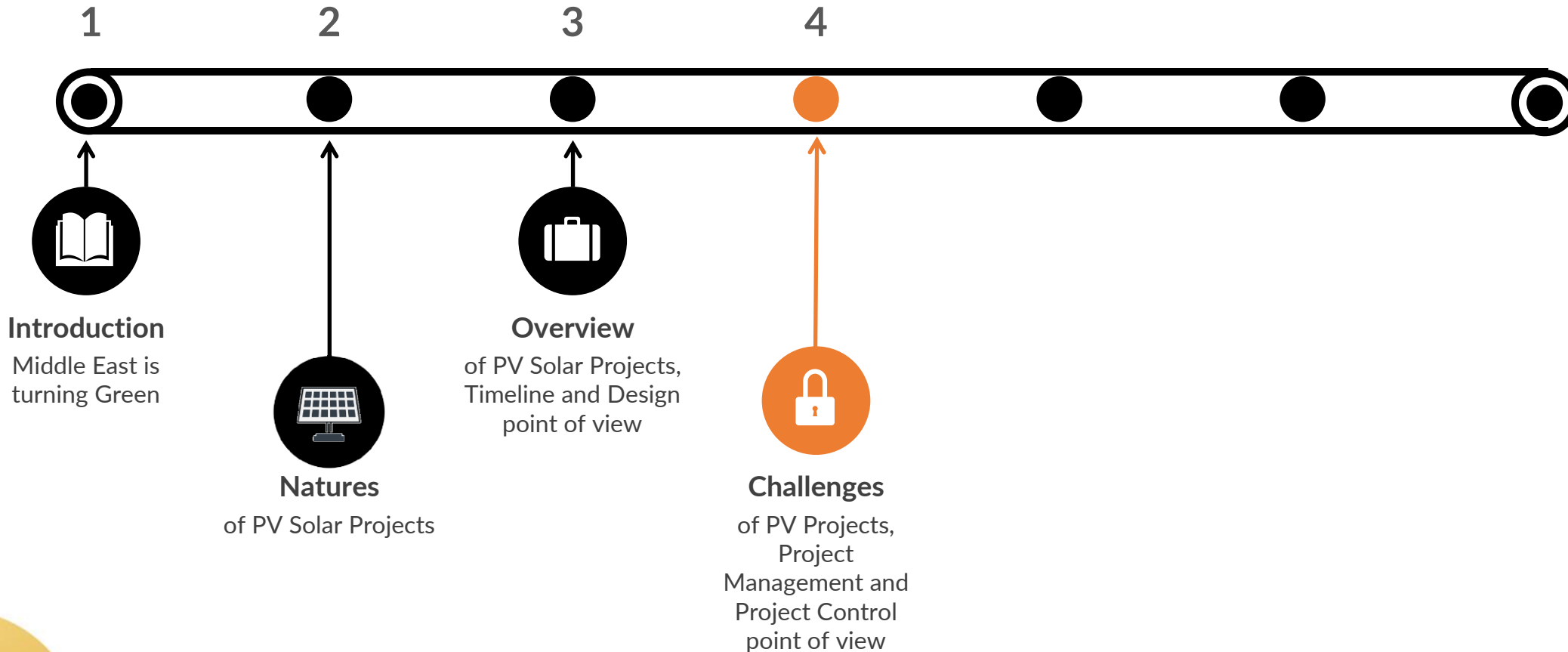
- PV Arrays
- MV Stations
- Fence
- Roads
- MV Loops



3. Overview of PV Projects – Timeline



Agenda Roadmap



4



Challenges of PV Solar Projects

from Project Management
and Project Control point of view



4. Challenges of PV Solar Projects



Big decrease in
Projects Prices



Extensive
Research and
Development



Relatively new
in the region

Big competition in the market that has caused price of projects to go into very low levels

Record Low Solar Tariffs at Auction

Year	Country	\$ per MWh
2017	Qatar	24.2
2018	Saudi Arabia	23.4
2018	Chile	21.5
2019	Brazil	17.5
2019	Portugal	16.5
2020	Qatar	15.6
2020	UAE	13.5
2020	Portugal	13.0
2021	Saudi Arabia	10.4

Source: rethinkresearch.biz

4. Challenges of PV Solar Projects

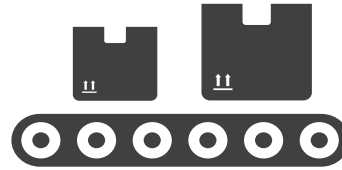


Relatively new in the region



Mega Scale Projects

in the region, goes to multi billion USD projects



Limited manpower resources who have experience in PV projects, and challenging to arrange **enough machineries/ equipment** especially with such mega scale projects



Huge liabilities on Contractors (e.g. bank guarantees) impose that **only specific EPC Contractors** can cope up with such projects scale

Renewable Energy Deployment in Saudi Arabia by 2030

(Updated November 2023)

(Updated November 2023)

REPDO Projects:

1st Round

Tendered: 2017
Under Operation
Total = 700 MW



Sakaka PV : 300 MW
Dumat Al Jandal Wind : 400 MW

2nd Round

Tendered: 2019
Partially Under Operation
Total = 870 MW



Rabigh PV : 300 MW
Qurayyat PV : 200 MW
Rafha PV : 20 MW
Madinah Solar: 50 MW
Jeddah PV : 300 MW

3rd Round

Tendered: 2020
Under Construction
Total = 1,211 MW



Ar Rass PV : 700 MW
Wadi Aldawaser PV : 120 MW
Saad PV : 300 MW
Layla PV : 91 MW

4th Round

Tendered: 2022
PPA Signed for PV
Total = 3,300 MW



Waad Al Shamal Wind: 500 MW
Al-Henakiyah PV : 1,100 MW
Al Ghat Wind : 600 MW
Yanbu Wind: 700 MW
Tabarjal PV : 400 MW

5th Round

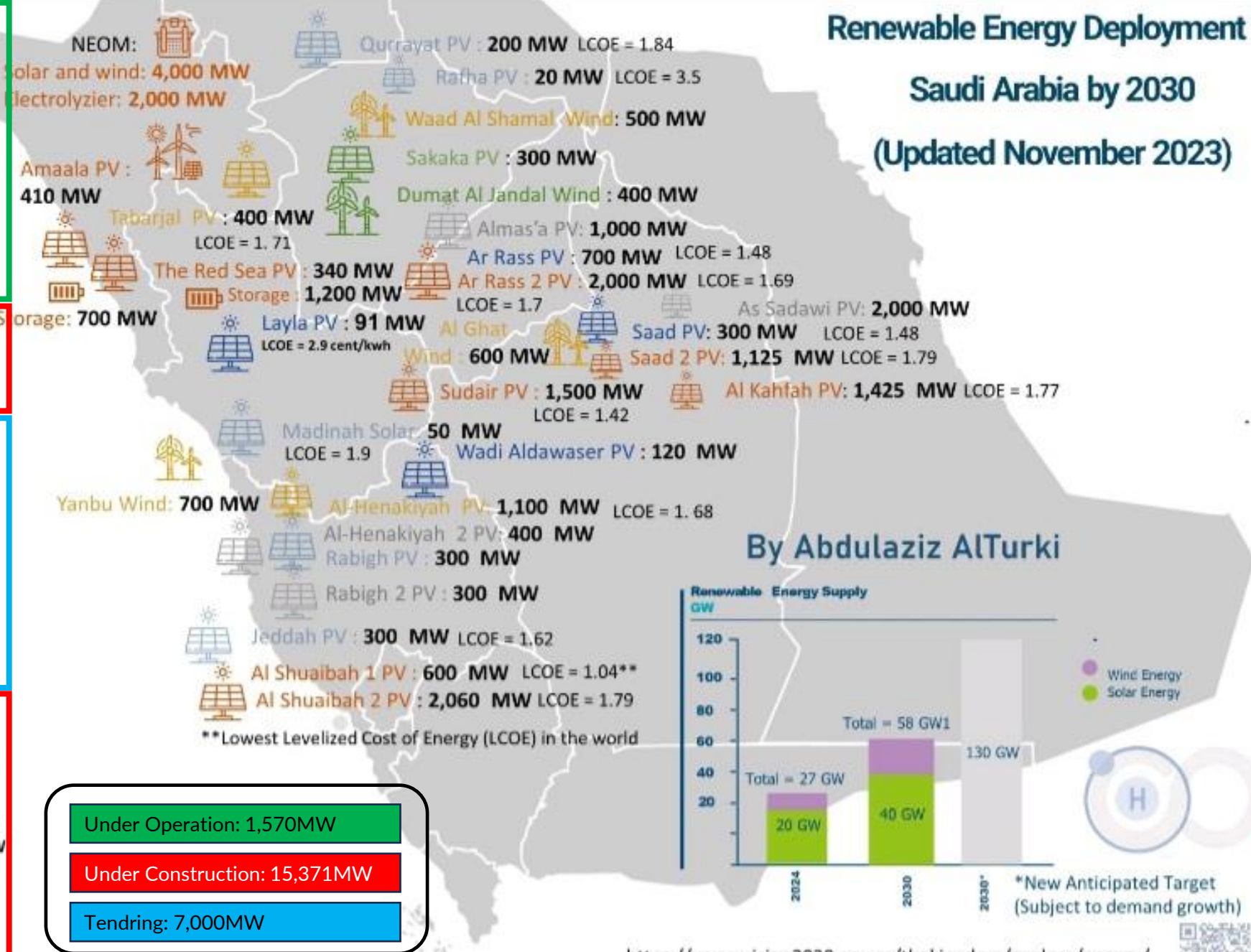
Tendered: November 2023
RFQ Released
Total = 3,700 MW



Al-Henakiyah 2 PV : 400 MW
As Sadawi PV : 2,000 MW
Rabigh 2 PV : 300 MW
Almas'a PV : 1,000 MW

ACWA Power & others besides NRE above:

Red Sea Project	340 MW
Shuaibah PV 1&2	2,660 MW
Sudair PV	1,500 MW
Ar Rass 1 PV	700 MW
Ar Rass 2 PV	2,000 MW
Saad 2 PV	1,125 MW
Al Kahfah PV	1,425 MW
NEOM PV & Wind	4,000 MW
Amaala PV	410 MW
Total	= 14,160 MW



By Abdulaziz AlTurki



Under Operation: 1,570MW

Under Construction: 15,371MW

Tendering: 7,000MW

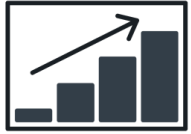
Total Renewable Energy Capacity = 23,941 MW

<https://www.vision2030.gov.sa/thekingdom/explore/energy/>

<https://acwapower.com/en/projects/assets/>



4. Challenges of PV Solar Projects



Multiple mega projects to be executed at same time



Government laws, regulations and specifications for Renewable Energy are relatively new

Coordination with local authorities is key success factor for projects, especially for the success of on engineering and commissioning for interface works.

Local Authorities (mainly grid operators) are aligning the renewable energy regulations with other local regulations, and should have the capacity to serve all these projects in reliable manner.

4. Challenges of PV Solar Projects



Materials Price
is major driver of
projects cost



**A lot of Repeatable
Works**
and all main key
equipment have
large quantities



**Multiple mega
projects to be
executed at same
time**

Secure materials on time is challenging

Because Manufacturers have a lot of commitments for China market and rest of world

Secure materials with the required price is challenging

Due to the high demand

Managing logistics and delivery for key equipment is challenging

Key equipment need to be delivered in continuous and synchronized manner to allow works to proceed smoothly



Major project materials are being procured from Chinese manufacturers

4. Challenges of PV Solar Projects



Extensive Research and Development and innovations and improvements are very quick



Limited vendors are in the Approved List for projects



Relatively new in the region



Engineering phase has become very challenging to be completed as per the planned timeline, especially for Engineering works that drive Purchase Orders issuance and manufacturing clearance to key vendors.

4. Challenges of PV Solar Projects

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A lot of
Repeatable
Works
and all main key
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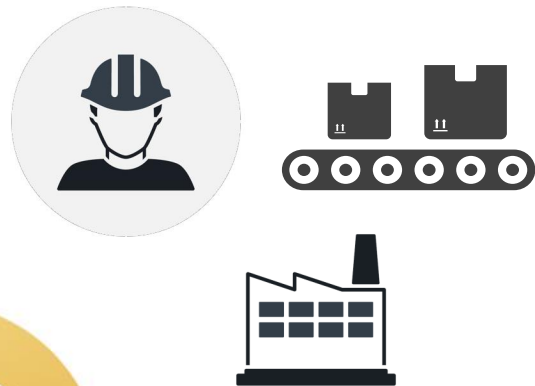
Many companies (EPC Contractors and developers) underestimate the value of Project Control in these projects

If works are done repeatedly with same Quality, they are either getting done RIGHT for numerous times, or getting done WRONG for numerous times.

4. Challenges of PV Solar Projects (Summary)



Resources and EPC Contractors challenges



Engineering and Technical Challenges



Procurement and Logistics Challenges



Project Control Challenges



Further direct Challenges on Project Control

4. Challenges of PV Solar Projects in Project Control

Impact on Engineering:

- Doing proper logical links between Engineering activities themselves, and engineering and other stages (mainly Construction and Procurement).

Examples:

- **Automatic Robotic Cleaning design** and its impact on Tracker Engineering (Structure and Communication).
- **Grid Impact Study** and its impact on overall design of the PV Plant
- **Vendor Engineering** and its impact on **Manufacturing Clearance** for equipment

4. Challenges of PV Solar Projects in Project Control

Impact on Procurement:

- Follow up on all stages of Procurement is crucial as most project elements can become critical at some stage. Follow up on multiple vendors on weekly/ bi-weekly basis is essential especially at early stages after orders issuance to follow early works (vendor engineering, manufacturing clearance issuance, sub-orders issuance, manufacturing progress, Factory Acceptance Tests progress, material release from factories, shipping, delivery to destination port and delivery to site).

Example: Complexity of follow up on Tracker materials manufacturing and logistics.

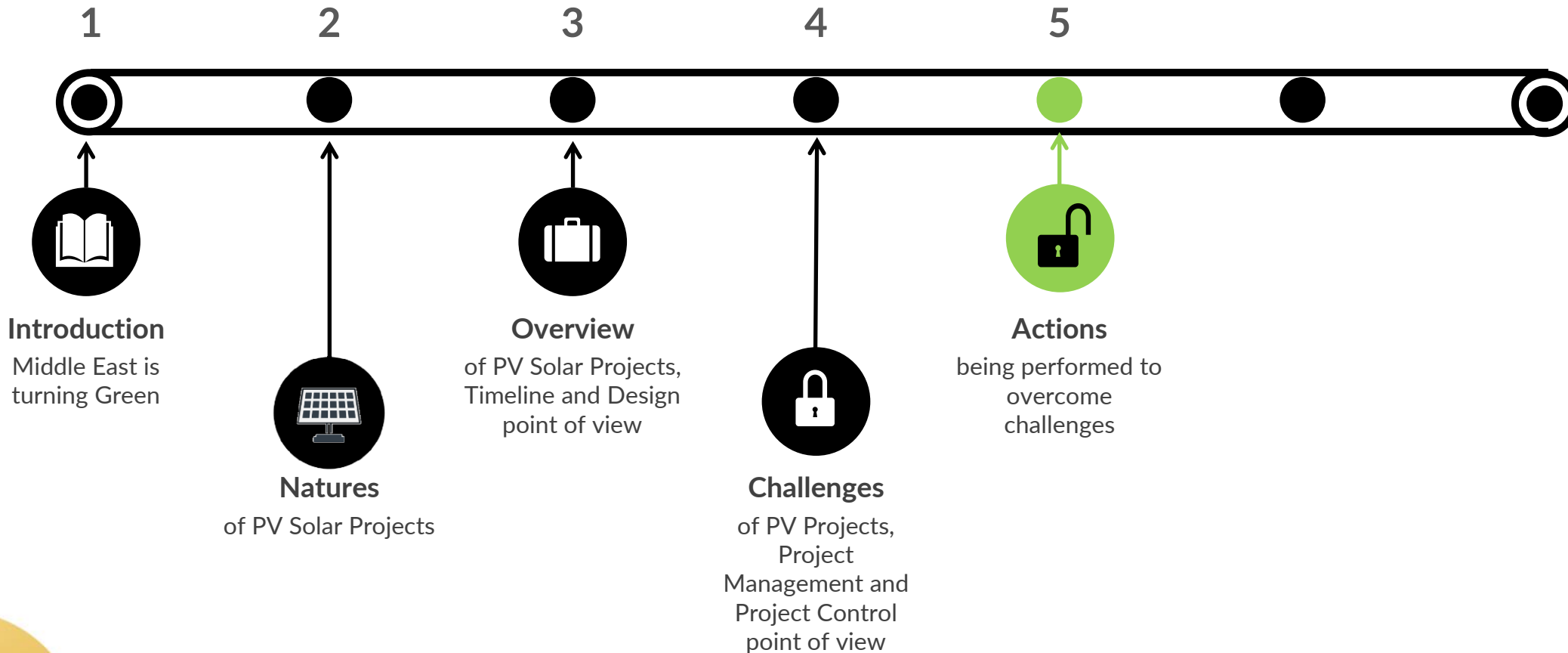
4. Challenges of PV Solar Projects in Project Control

Impact on Construction:

- Non-availability of enough qualified resources to execute the works.
- Getting works to proceed following the planned sequence and dates (**impacts on commissioning!**).
- Getting works to proceed following real actual delivered materials.
- Getting accurate progress (physical progress and approved quality inspected progress) for such huge site.

In addition, Not having enough Project Control candidates with experience in PV projects!

Agenda Roadmap



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Actions

being performed to overcome challenges



5. Actions being implemented

5

A. **Execution Strategy**, that includes Engineering Strategy, Procurement Strategy, Construction Strategy and Commissioning Strategy, should be **CLOSED** at early stage of project.

Examples:

- Push vendors to **standardize the design (where applicable)** of different elements in the project to allow for more flexibility for Construction.
- Concept of making **Mock Ups** (either at **Factory** or at **Site**) are being adopted for all numerous repeated elements, in order to confirm **Design assumptions** and **Quality** required to be achieved.
- **New Vendors** whom EPC Contractor is aiming to work with while they are out of the approved vendor list should be **closed at early stage**, in order to allow further Engineering and Procurement activities to proceed smoothly, and allow for smother process of development of Baseline Schedules, and make them more reliable to follow.
- **Subcontracting Strategy** and **Construction Sequence** is being discussed and closed as soon as project layout is developed.

5. Actions being implemented

5

B. EPC Contract Schedule to be detailed for initial period (3-4 Months), in order to allow for detailed monitoring for the works in the period till Baseline Schedule is fully developed.

C. Aiming to standardize Engineering activities, and basic links between Engineering activities themselves, and with other subsequent works.

D. Having clear Project Control requirements in EPC Contracts that require all key vendors to report weekly/ bi-weekly on all procurement stages (PO till delivery to Site).

E. Having enough and qualified Project Control resources from EPC Contractor side and key Subcontractors to properly monitor and control the projects, and able to provide and **update L4 Schedules** for their scope of work. This is being captured as well in EPC Contracts where key Project Control positions to be interviewed and approved.

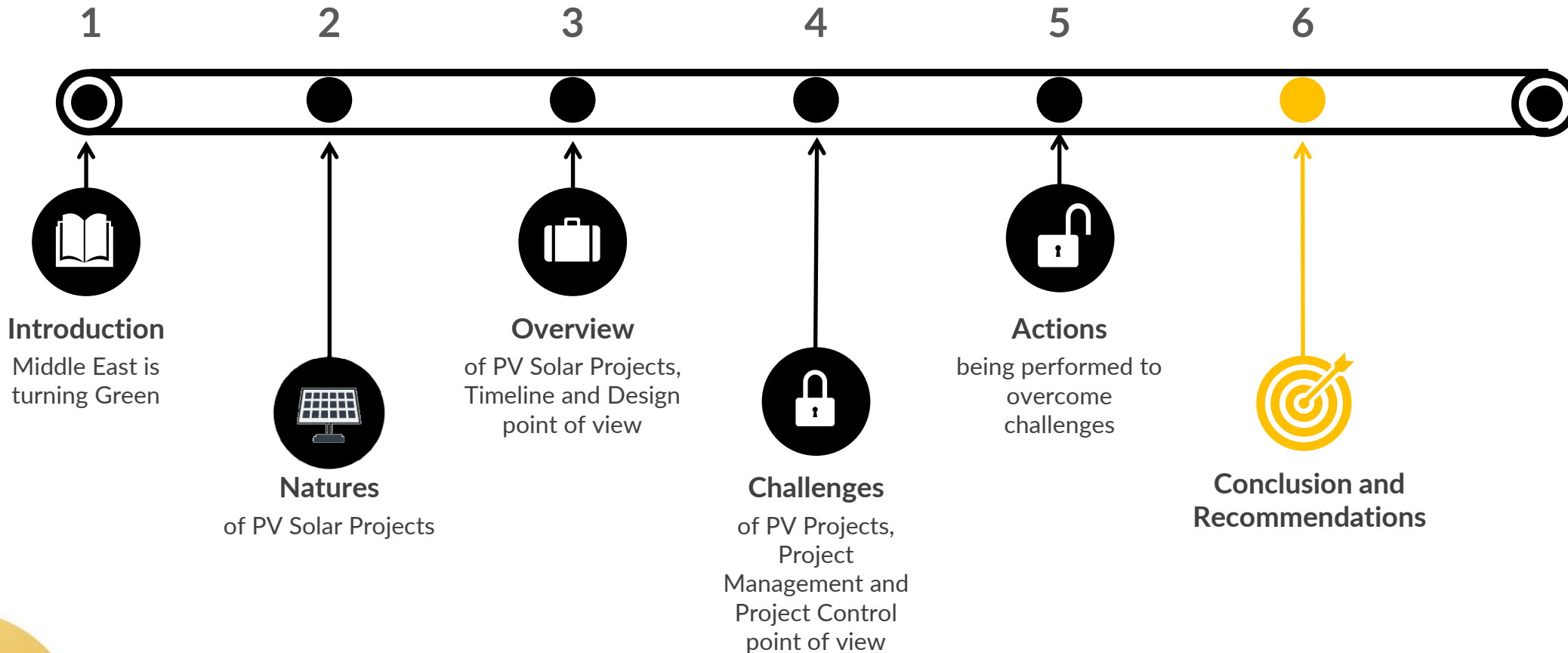
5. Actions being implemented

F. **Digitalization** initiatives are being implemented to improve Project Management and Project Control.

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Agenda Roadmap



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Conclusion and Recommendations



6. Conclusion and Recommendations

6

Conclusions:

1. PV Solar Projects are “**Deceptively Easy**” projects
2. **Renewable Energy market** (Worldwide and in Middle East) is going **into huge expansion** which require **more qualified resources at all levels**. Carbon zero targets are big driver for this expansion.
3. PV Solar Projects have a lot of challenges that start from early stage of the project. **Project Control** needs to be given attention from **early stages** to align Engineering Strategy, Procurement Strategy, Construction and Commissioning Strategy (**Project Execution Strategy**). The relatively short duration and having multiple critical paths require proper planning from early days of project. These Strategies should be able identify project risks at early stage and allow to plan mitigation plans at early stage.

6. Conclusion and Recommendations

6

Conclusions:

4. Identify **clear KPI's** to allow for proper control for each stage of the project, in order to make sure each stage of project (E-P-C and Commissioning) are very well controlled.
5. **Project Control** successful implementation is one of the **key players of success** of PV Projects.

6. Conclusion and Recommendations

6

Recommendations:

1. Deploying more Digitalization and Business Intelligence resources and involve new technologies (e.g. drones for progress tracking) to allow for more effective reporting and projects control.
2. Do not limit Project Control resources in projects to the ones who have PV experience, hybrid teams need to be deployed to enhance the talent pool of resources who have PV experience from similar markets (e.g. Power Plants, mega construction projects).
3. Deploying effective PMO teams that allow for more efficient knowledge and lessons learned sharing.

6. Final Wrap Up!

6

Project Control Manager should be playing key role in EPC Projects:

- **Right hand** for Project Manager (**The Integrator**)
- Should be **involved/ participate** in all project key meetings and decisions
- **Risks identifier** and **follower**
- **Proactively** analyzing **delays, cost overruns and claims.**
- Defining the **suitable and practical project control tools** for project success

6. Final Wrap Up!

6

The Project is a **Car**, The Project Manager (PM) is the **Owner**, and Project Controls Manager (PCM) is the **Chauffeur!**

If the project is a car and the PM owns the car but the PCM is the chauffeur then the car goes nowhere without both being in alignment.

The PM as the owner provides the destination and deadlines while the PCM as subject matter expert navigates the fastest, safest and most economical route.

The car does not move without the PMs instruction and the car can not move easily without the PCM who holds the keys.

Source: projectcontrolsonline.com

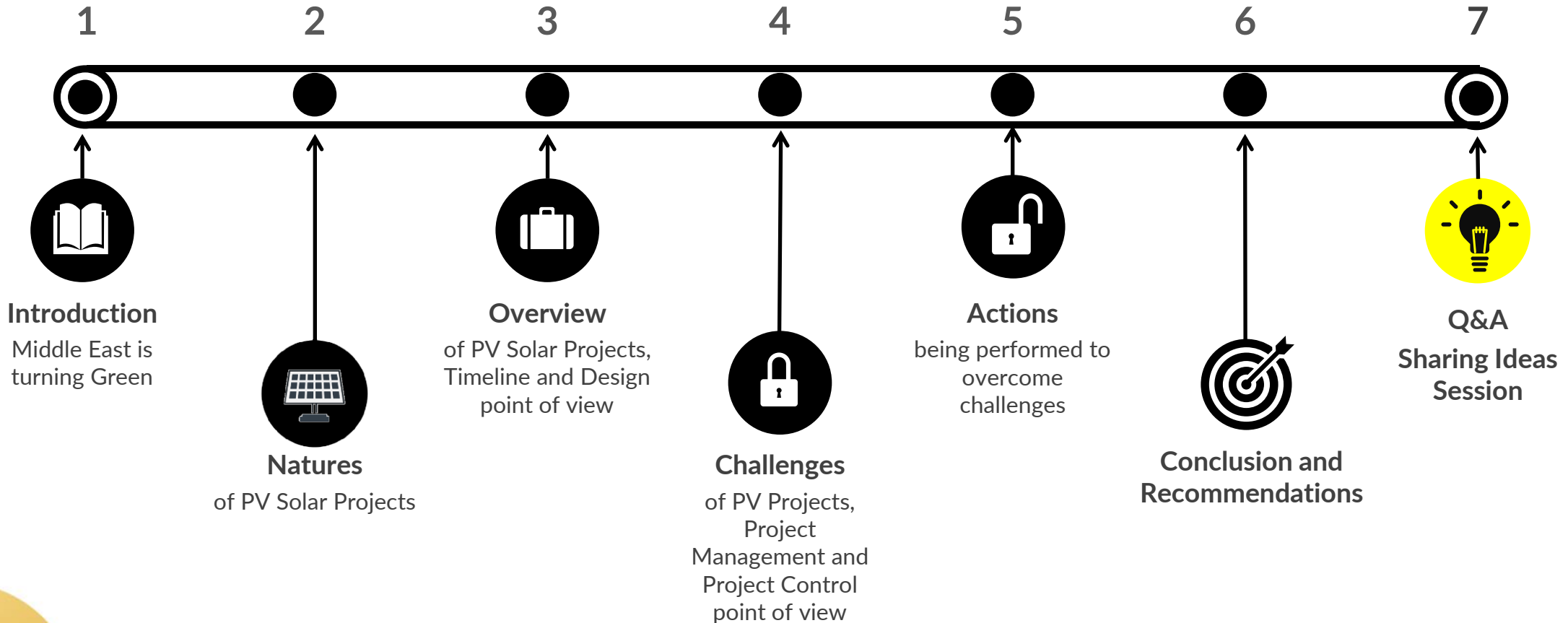




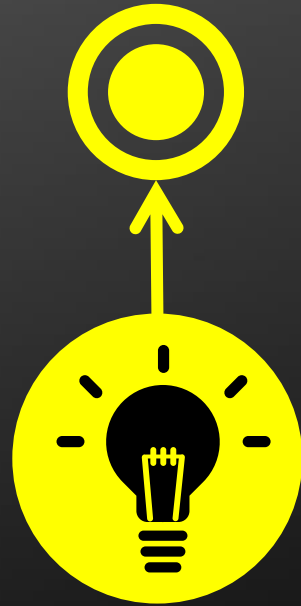
THANK YOU



Agenda Roadmap



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Q&A

Sharing Ideas Session



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