Indigenous Solar Value Chain

Source: FE

Why in News?

The **Ministry of New and Renewable Energy** is formulating a plan to create a fully **indigenous solar manufacturing ecosystem** by 2028, encompassing **modules, cells, wafers, and ingots**.

What is the Solar Manufacturing Value Chain?

- **About:** The **solar manufacturing value chain** encompasses the complete process of converting **raw materials** into a fully functional **solar photovoltaic (PV) module**.
  - It is a sequential workflow and the chain is generally divided into **Upstream** (high-tech, capital-intensive) and **Downstream** (labor-intensive) segments.
- **Key Stages:**
  - **Upstream Manufacturing (The Core Components):**
    - **Polysilicon:** The process begins with **metallurgical-grade silicon** derived from **quartz sand**, which is then processed into **polysilicon.**
    - **Ingots: The polysilicon is melted and crystallized into large, cylindrical blocks called ingots.**
    - **Wafers: Ingots** are sliced into **ultra-thin**, disc-shaped **sheets** using a **wire saw**. These **sheets**, called **wafers**, are the fundamental **building block** of a **solar cell**.
    - **Solar Cell:** The **wafers** undergo **doping** (adding phosphorus and boron to form an electric field), **printing** (metal contacts for electron flow), and **anti-reflective coating** to minimize light reflection. The result is a **solar cell** capable of converting sunlight into **electricity**.
  - **Downstream Manufacturing (Assembly & Installation):**
    - **Module Manufacturing:** Solar cells are interconnected, laminated, sealed between **glass** and **polymer back sheets**, and framed to form a **solar module**.
    - **System Installation & Integration:** Modules are assembled into arrays, connected to **inverters, mounting structures, and wiring**, and installed on **rooftops, fields, or solar farms.**
- **Current Status: India's solar module capacity has already touched 100 GW, but solar cell capacity is only 27 GW, while ingot and wafer capacity is just 2.2 GW, making it heavily reliant on imports, particularly from China.**
  - **India aims** to finalize a **roadmap for Swadeshi polysilicon production** in the coming years.
- **Proposed Reforms:** A key step is the proposed expansion of the **Approved List of Models and Manufacturers (ALMM)**, currently for modules, to include **solar cells, wafers, and ingots**.
  - ALMM mandates that solar project developers purchase equipment from approved models and manufacturers, promoting **domestic manufacturing** and acting as a **non-tariff barrier** to low-quality or import-dependent products.

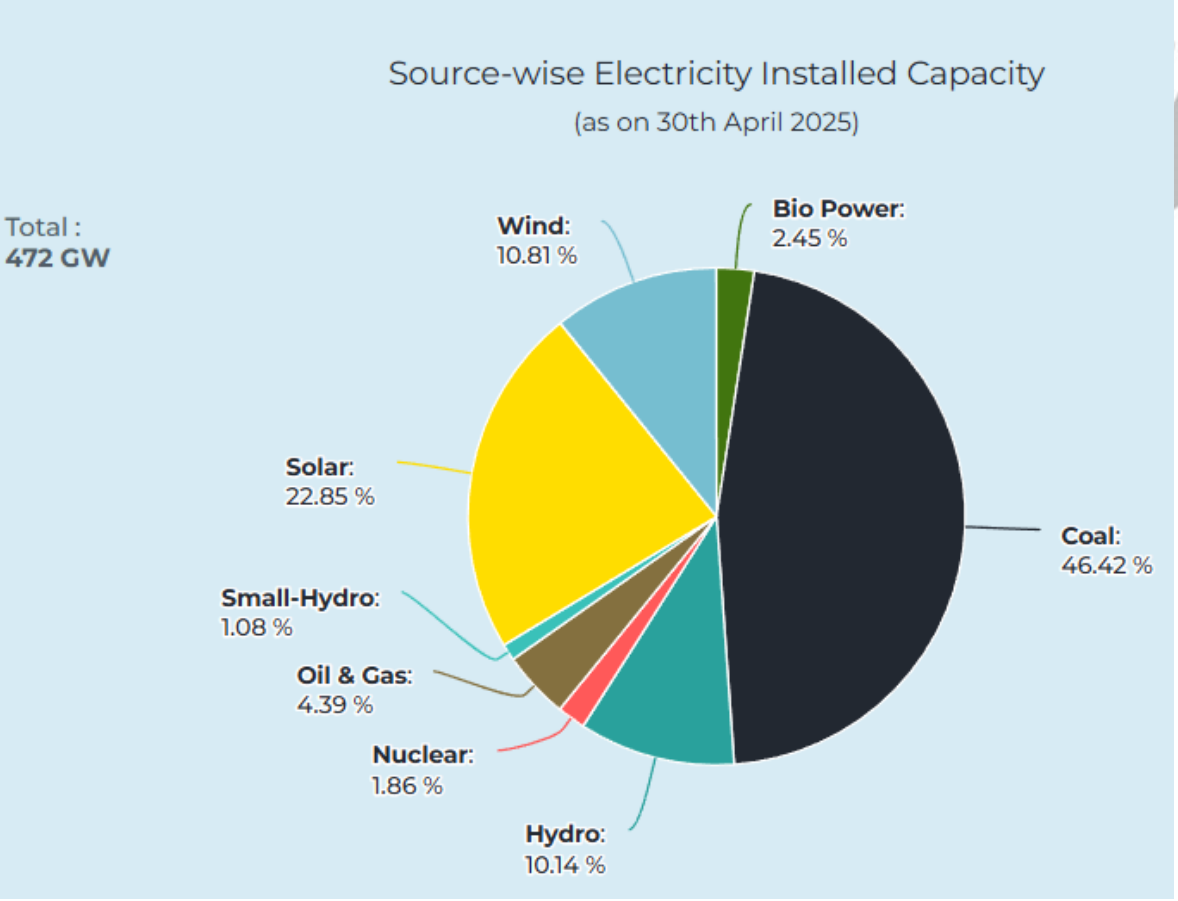
What are the Challenges in Developing the Indigenous Solar Value Chain?

Mnemonic: HURDLE

- **H – High-Cost & Scale Issues:** Indian-made components are initially **expensive** and less competitive due to **dis-economies of scale (business's cost per unit increases instead of decreasing as it expands production).**
- **U – Upstream Infrastructure Gaps: Polysilicon and wafer manufacturing** is **technology-intensive** and capital-heavy, with limited domestic experience.
- **R – RoW & Land Bottlenecks: Land acquisition** and **Right of Way (RoW)** issues block projects.
- **D – Delayed Power Purchase Agreements (PPAs):** Procurement delays by **States/Discoms** hurt project viability.
- **L – Lack of Experience:** Limited experience in advanced **solar manufacturing**.
- **E – Export/Import Dependence:** Reliance on **imports** increases vulnerability.

Achievements in Solar Energy

- **Renewable Energy:** India surpasses **251.5 GW non-fossil energy capacity**, achieving over **half of its 2030 target of 500 GW**.
- **PM Suryaghar Yojana:** India has already installed **20 lakh rooftop solar projects under the PM Suryaghar Yojana**, with expectations to cross **50 lakh installations soon**.
- **PM-KUSUM scheme:** Under the **PM-KUSUM scheme**, over **1.6 million solar pumps** have been installed or solarised, reducing **diesel use** by **1.3 billion litres annually** and cutting **CO2 emissions** by **40 million tonnes**.



What Steps are Needed to Develop a Indigenous Solar Value Chain in India?

- **Mnemonic: SHINE**
- **S – Sustained Policy Support**: Expand **ALMM**, ensure stable **PLI**, phased **customs duties**, and clear **technology acquisition** plans.
- **H – Harness Investment**: Build **Greenfield manufacturing**, provide **capital support**, and resolve **land/RoW** issues.
- **I – Innovation & R&D**: Promote **next-generation technologies** like **Perovskite** and strengthen **ancillary industries**.
- **N – Navigate Coordination**: Streamline **state-level execution**, ensure **Discom financial stability**, and align with schemes like **PM Suryaghar Yojana** and **PM-KUSUM**.
- **E – Expand Demand**: Drive **domestic solar manufacturing demand** through policy and deployment programs.

Conclusion

India's **green energy transition** is crucial to achieving **net-zero by 2070**, with targets of **1,800 GW renewable capacity by 2047** and **5,000 GW by 2070**. An integrated roadmap is needed: develop **domestic solar manufacturing**, resolve **land and RoW bottlenecks**, fast-track **PPA signings**, and institutionalize **ALMM** for **wafers, ingots, and polysilicon**, enhancing **energy security, sustainability**, and India's **global solar leadership.**

Drishti Mains Question:

Q. Discuss the challenges in establishing indigenous solar manufacturing and measures to overcome them.

UPSC Civil Services Examination, Previous Year Questions (PYQs)

Prelims

Q. Consider the following statements: (2016)

1. The International Solar Alliance was launched at the United Nations Climate Change Conference in 2015.
2. The Alliance includes all the member countries of the United Nations.

Which of the statements given above is/are correct?

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

Ans: (a)

Mains

Q. India has immense potential for solar energy though there are regional variations in its developments. Elaborate. (2020)

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