

# National Conference on “ Post Paris Climate Action” India’s INDC: Technological Options, Renewables and Challenge of Balancing

12 July 2016, New Delhi



- **Minimizes discounted total energy system cost**
- **The Model balances every hour demand and supply**
- **Issues addressed**
  - **What would be the structure of power sector**
  - **Role of renewables and balancing power**
- **Time horizon: 2012 to 2047**

- **INDC targets of 175 GW and 40% Non-fossil fuel capacity by 2030 reaching 55% by 2047**
- **Maximum Potential: Solar 748 GW & Wind 302 GW**
- **Balancing by**
  - Hydro,**
  - Renewables with Storage,**
  - Open Cycle Gas and / or**
  - Coal Flexibility**
- **Electricity Demand:**
  - 3217 BU in 2032**
  - 8496 BU in 2047**

# **Key Insights from Model Outcomes**

# Capacity Mix Share

- **Scenario 1: Coal High Flexibility (55% to 85%)**
- **Scenario 2: Coal Medium Flexibility (60% to 70%)**

**Unconstraint Run for Renewable Capacity Addition Except for 175 GW by 2022**

	2032		2047	
	SC-1	SC-2	SC-1	SC-2
<b>Total Capacity Req.</b>	<b>828</b>	<b>951</b>	<b>2069</b>	<b>2086</b>
<b>Fossil Share %</b>	<b>34%</b>	<b>30%</b>	<b>36%</b>	<b>37%</b>
<b>Non Fossil Share %</b>	<b>66%</b>	<b>70%</b>	<b>64%</b>	<b>63%</b>
<b>Renewable Share %</b>	<b>52%</b>	<b>57%</b>	<b>53%</b>	<b>52%</b>

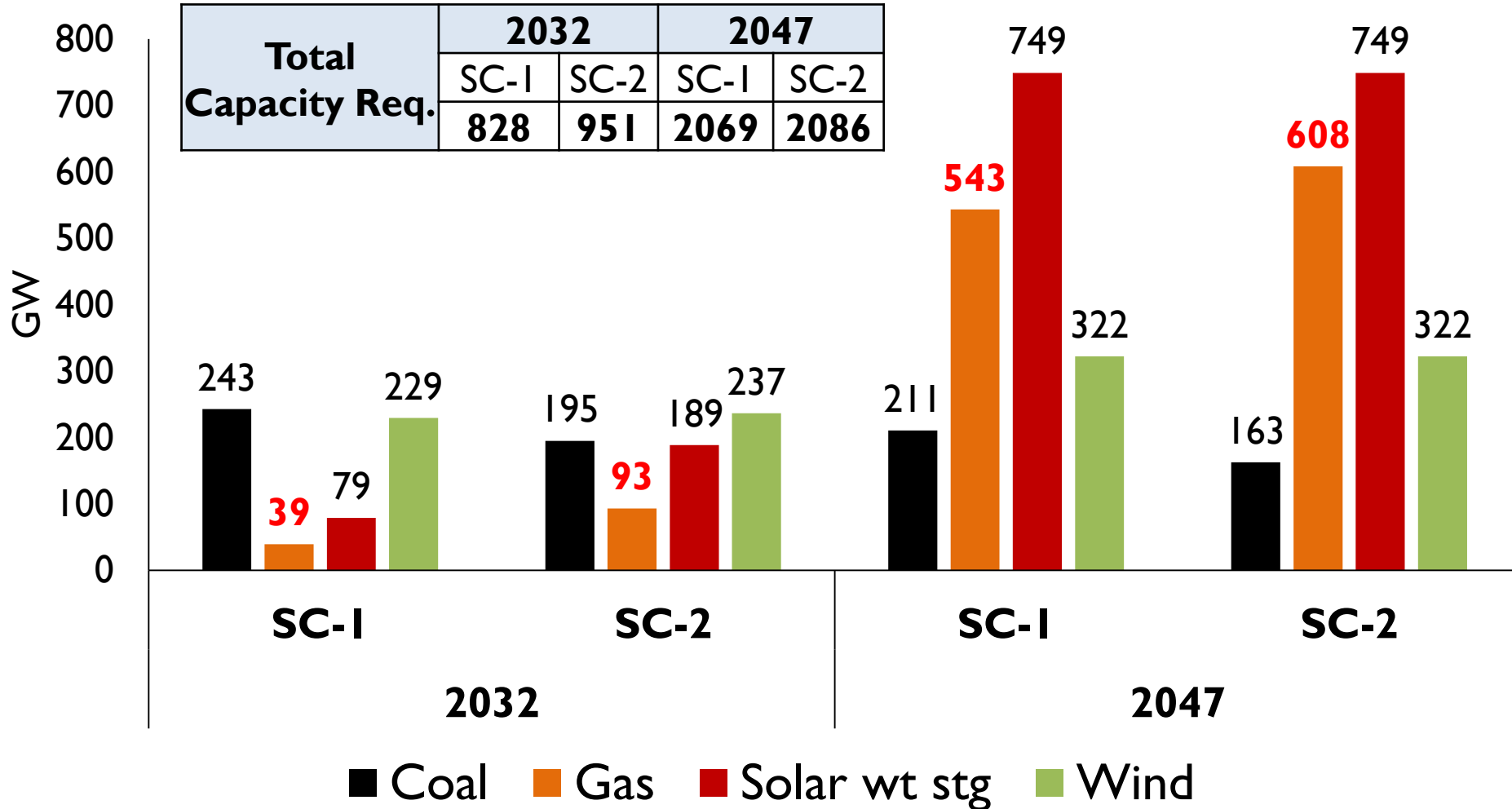
<u>2032</u>	<u>SC-1</u>	<u>SC-2</u>
▪ <b>Coal share:</b>	<b>29%</b>	<b>21%</b>
▪ <b>Gas share:</b>	<b>5%</b>	<b>10%</b>
▪ <b>Wind share:</b>	<b>28%</b>	<b>25%</b>
▪ <b>Solar share:</b>	<b>22%</b>	<b>30%</b>

<u>2042</u>	<u>SC-1</u>	<u>SC-2</u>
▪ <b>Coal Share:</b>	<b>10%</b>	<b>8%</b>
▪ <b>Gas Share:</b>	<b>26%</b>	<b>29%</b>
▪ <b>Wind share:</b>	<b>16%</b>	<b>15%</b>
▪ <b>Solar share:</b>	<b>36%</b>	<b>36%</b>

# Capacity Requirements

## Unconstraint Run for Renewable Capacity Addition Except for 175 GW by 2022

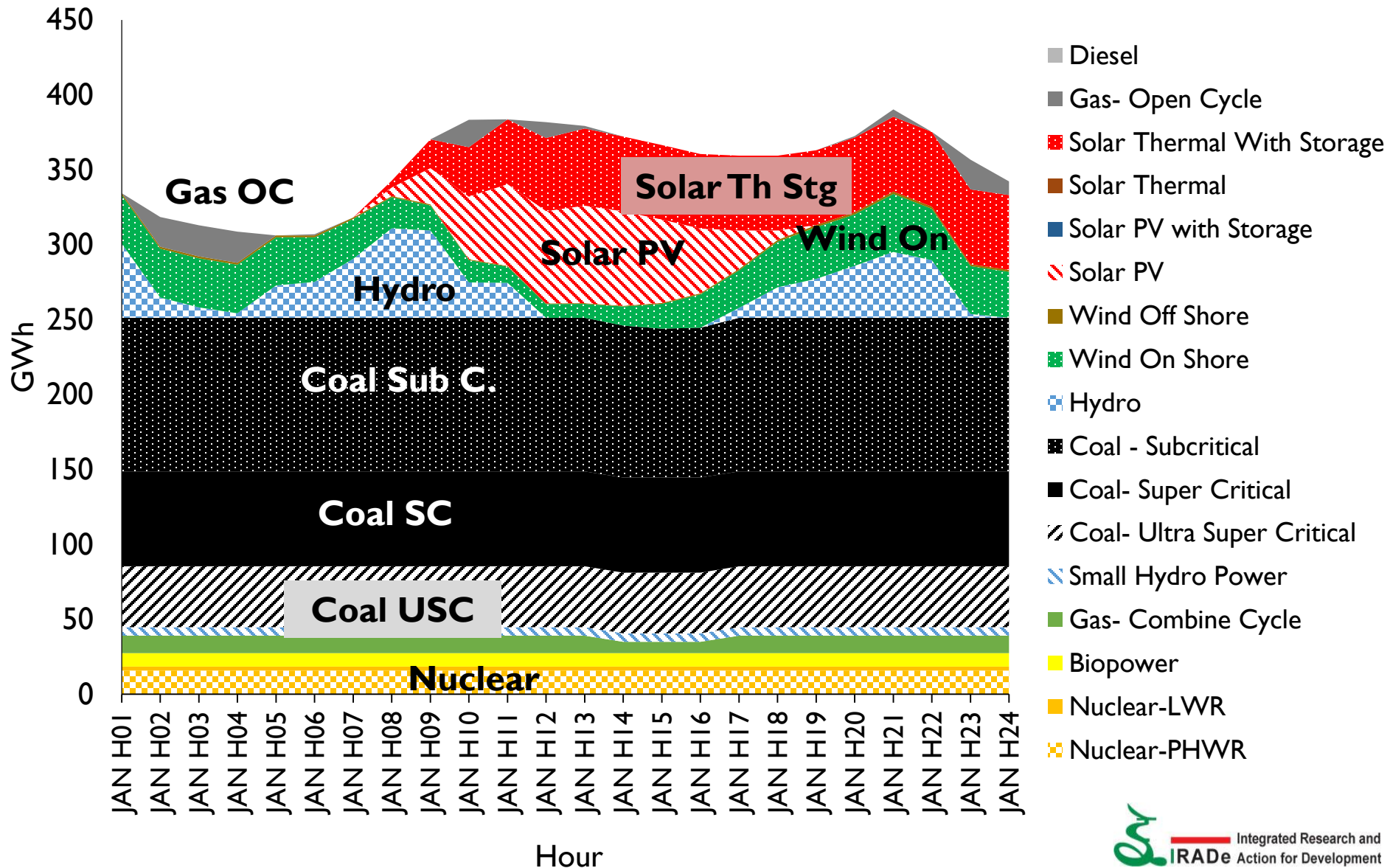
Total Capacity Req.	2032		2047	
	SC-1	SC-2	SC-1	SC-2
	828	951	2069	2086



- Increase in Gas Cap. Req. in 2032 by 137% and 2047 by 12%
- By 2047, full use of Solar and Wind Potential

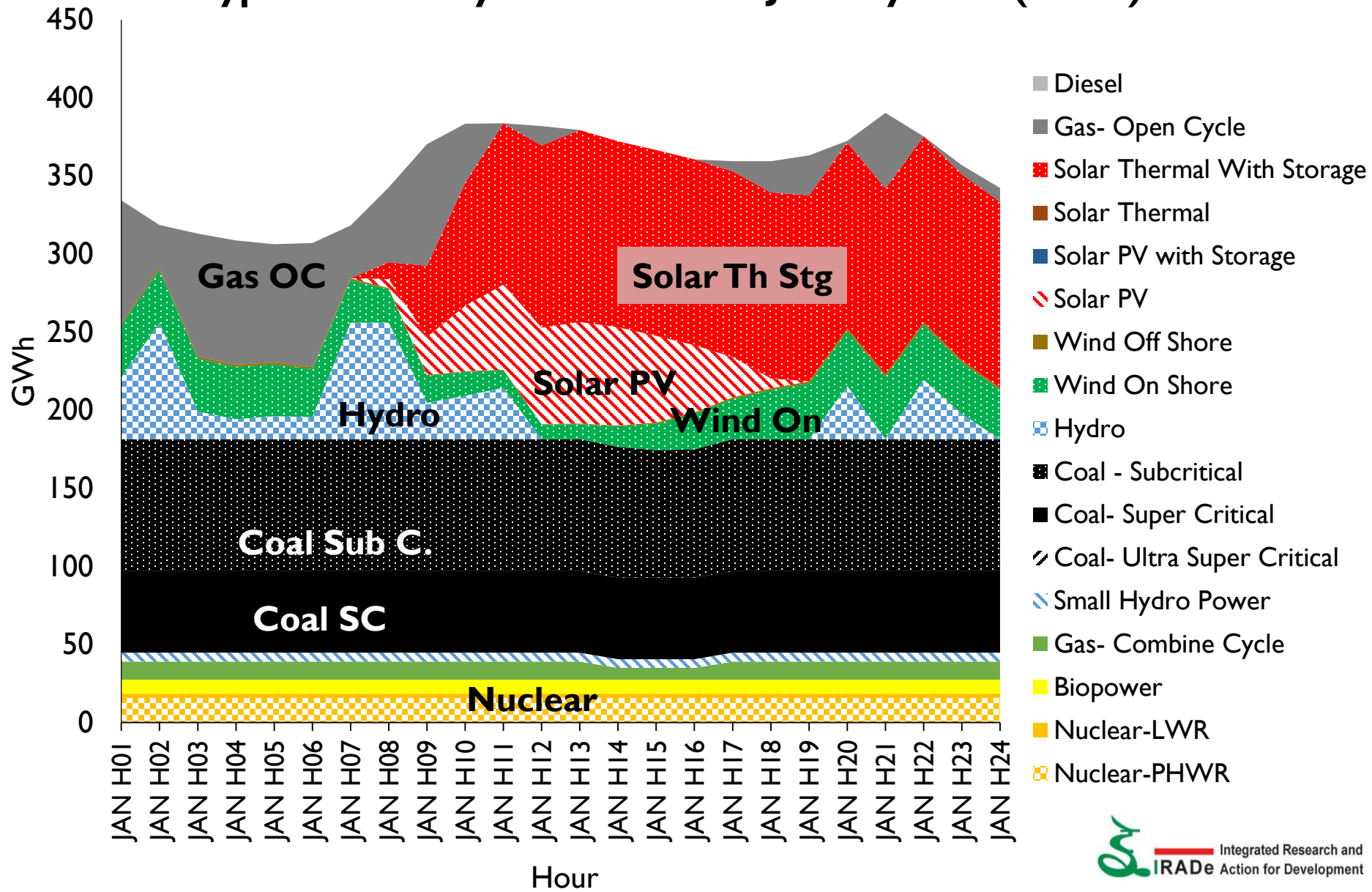
# Scenario I: Coal High Flexibility (55% to 85%)

## Typical One Day Generation in January 2032 (GWh)



# Scenario 2: Coal Med. Flexibility (60% to 70%)

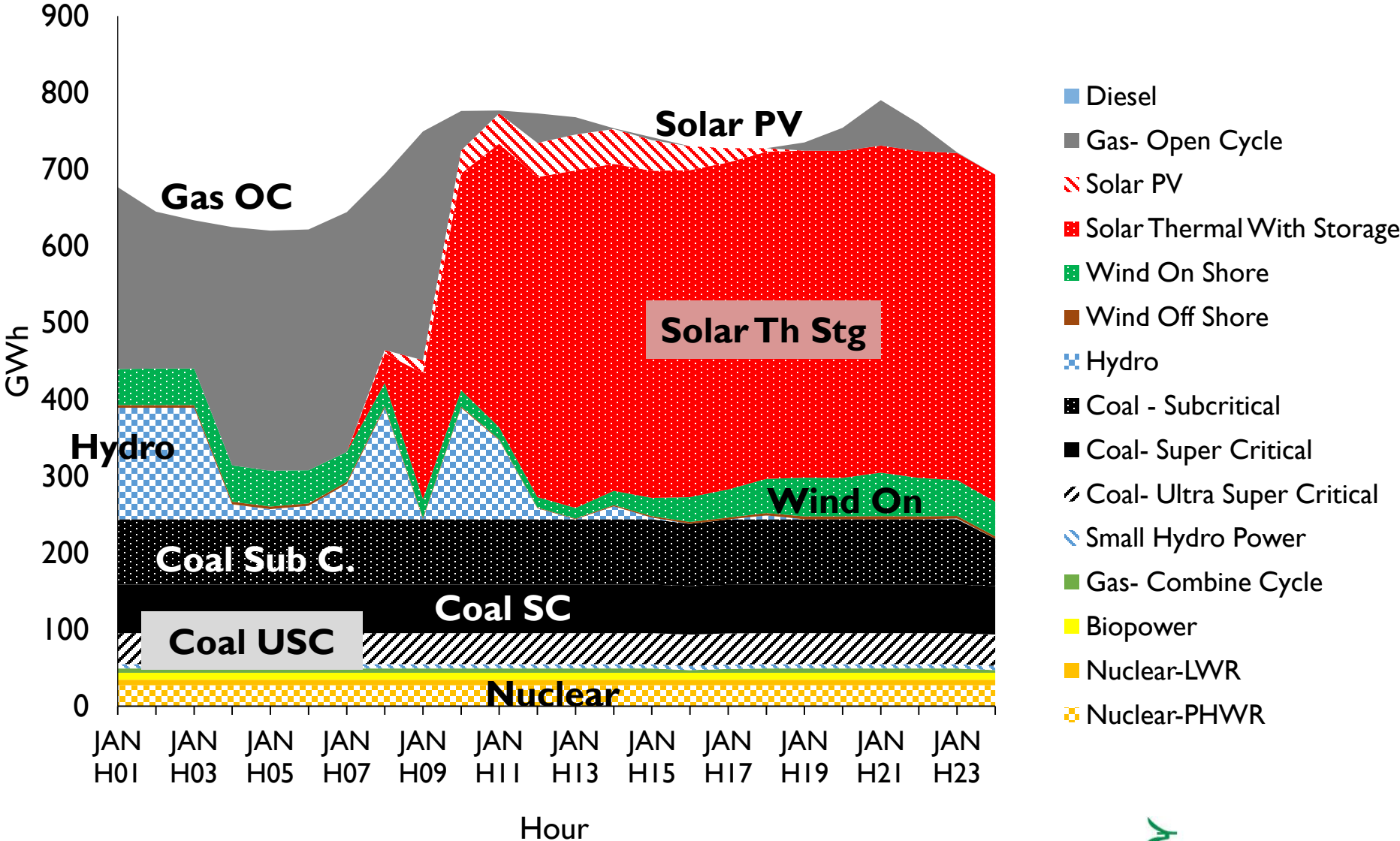
## Typical One Day Generation in January 2032 (GWh)





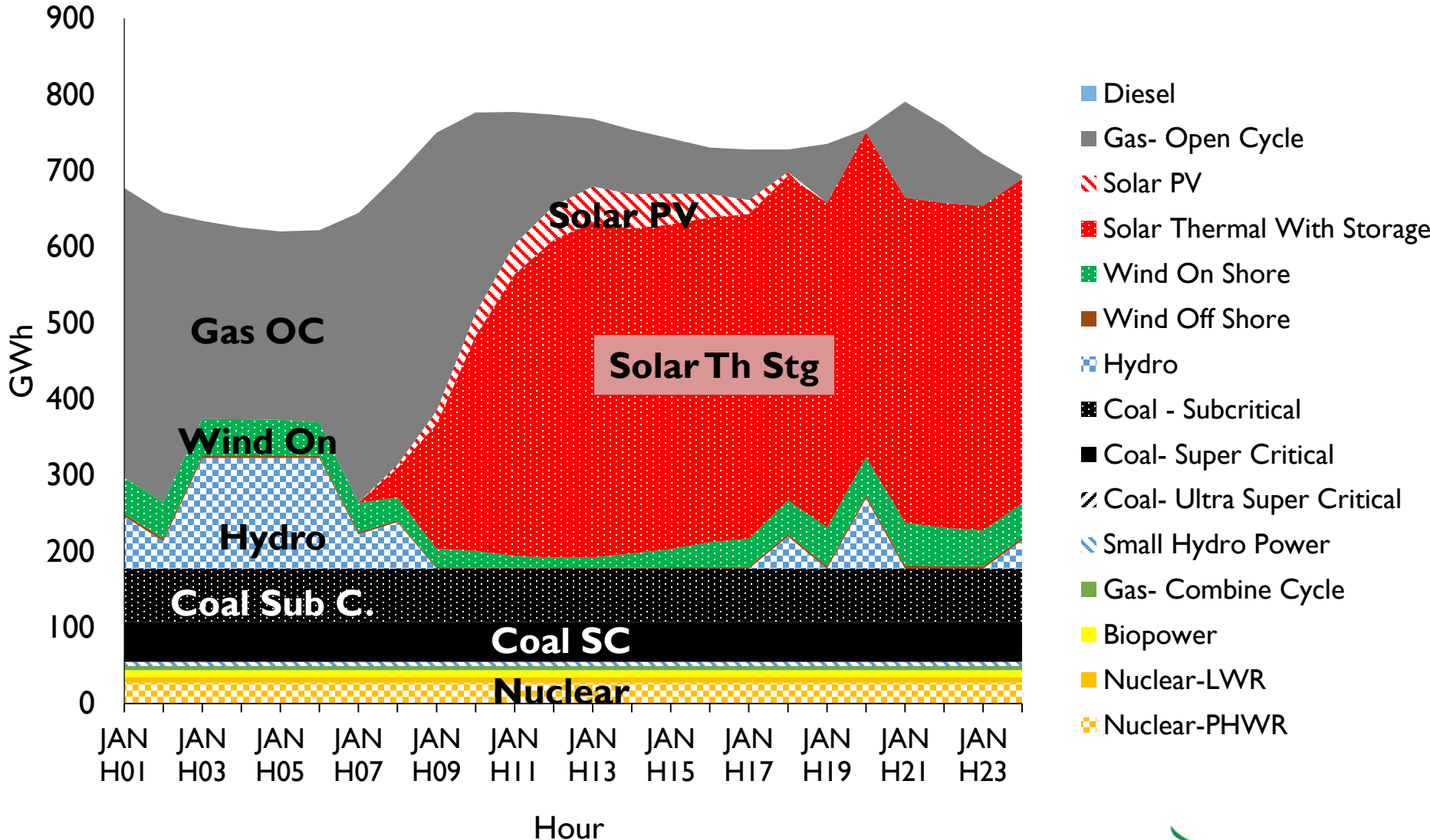
# Scenario I: Coal High Flexibility (55% to 85%)

## Typical One Day Generation in January 2042 (GWh)



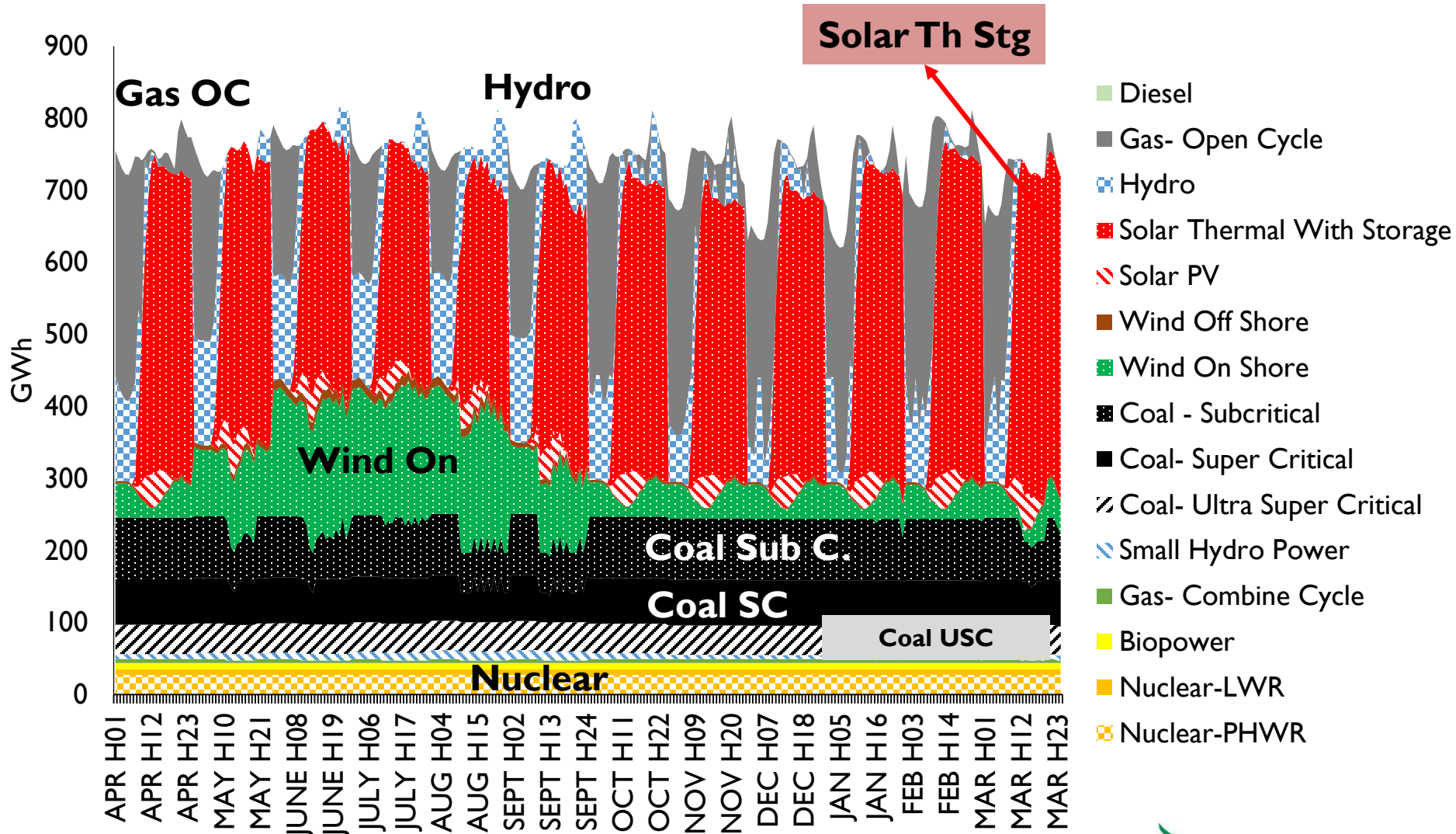
# Scenario 2: Coal Med. Flexibility (60% to 70%)

## Typical One Day Generation in January 2042 (GWh)



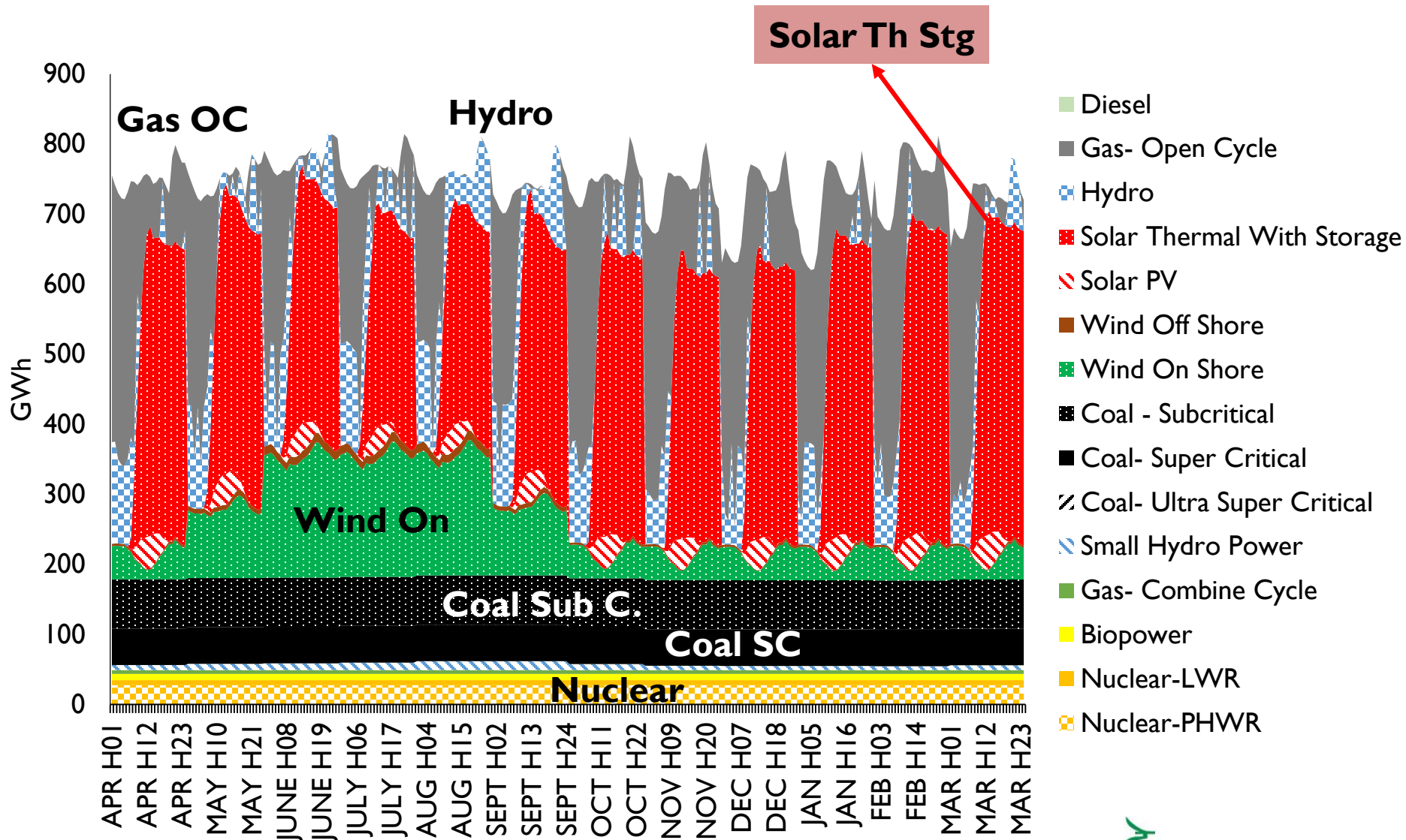
# Scenario I: Coal High Flexibility (55% to 85%)

## Hourly average for each month-Electricity Generation (GWh) - 2042



# Scenario 2: Coal Med. Flexibility (60% to 70%)

## Hourly average for each month- Electricity Generation (GWh) - 2022



- **Total capacity req. of 2069-2086 GW for meeting demand by 2047**
- **Renewable share can be as high as 61% but require gas support for balancing**
- **High Gas Support will increase overall cost of Generation**
- **Solar with storage reaches its full potential and with technological progress higher potential may be harnessed**
- **Even with full hydro capacity utilization of 145 GW, other resources are needed for balancing**

- **Integration of Indian grid with Hydro rich SAARC nation (Nepal and Bhutan) will help in absorbing higher Renewable Generation**
- **If coal capacity addition as planned by in CEA Transmission Perspective Report (2016-36) comes online than with 175 GW renewable underutilization of capacities is expected (unless GDP grows faster)**
- **Operating coal with flexibility has higher coal consumption & maintenance cost which needs to be considered**



**Thank You**