



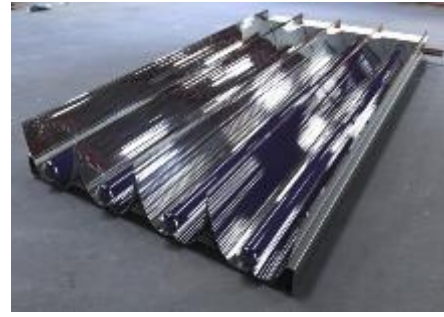
AMERICAN  
**SOLAR**  
ENERGY SOCIETY

# Solar Thermal Applications for Industrial Process Heat

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Solar Thermal Division



# Solar Thermal Technologies



## High Temperature

Electric Power Generation  
Air-Conditioning  
Industrial Process Heat



## Mid Temperature

Hot Water  
Air-Conditioning



## Low Temperature

Pool & Spa



Let me start with the latest market information

**IEA SHC Solar Academy Webinar June 2023**

**Global industrial solar heat market: challenges, trends and outlook**

**Author: Bärbel Epp, solrico,**

**[www.solrico.com](http://www.solrico.com), [www.solarthermalworld.org](http://www.solarthermalworld.org)**

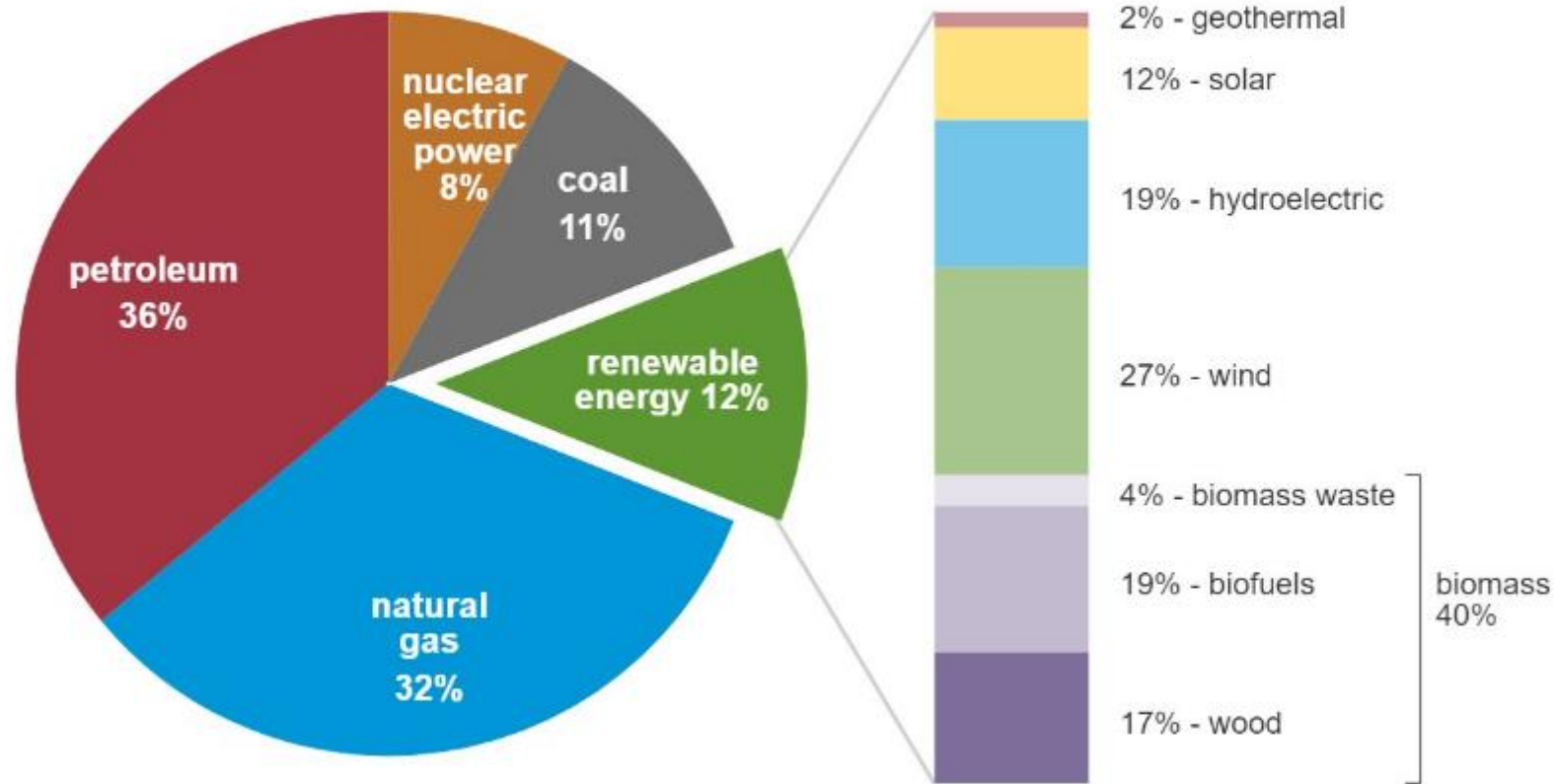
Thanks, Bärbel  
Managing Director of Solrico



# U.S. primary energy consumption by energy source, 2021

total = 97.33 quadrillion  
British thermal units (Btu)

total = 12.16 quadrillion Btu



Data source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3 and 10.1, April 2022, preliminary data

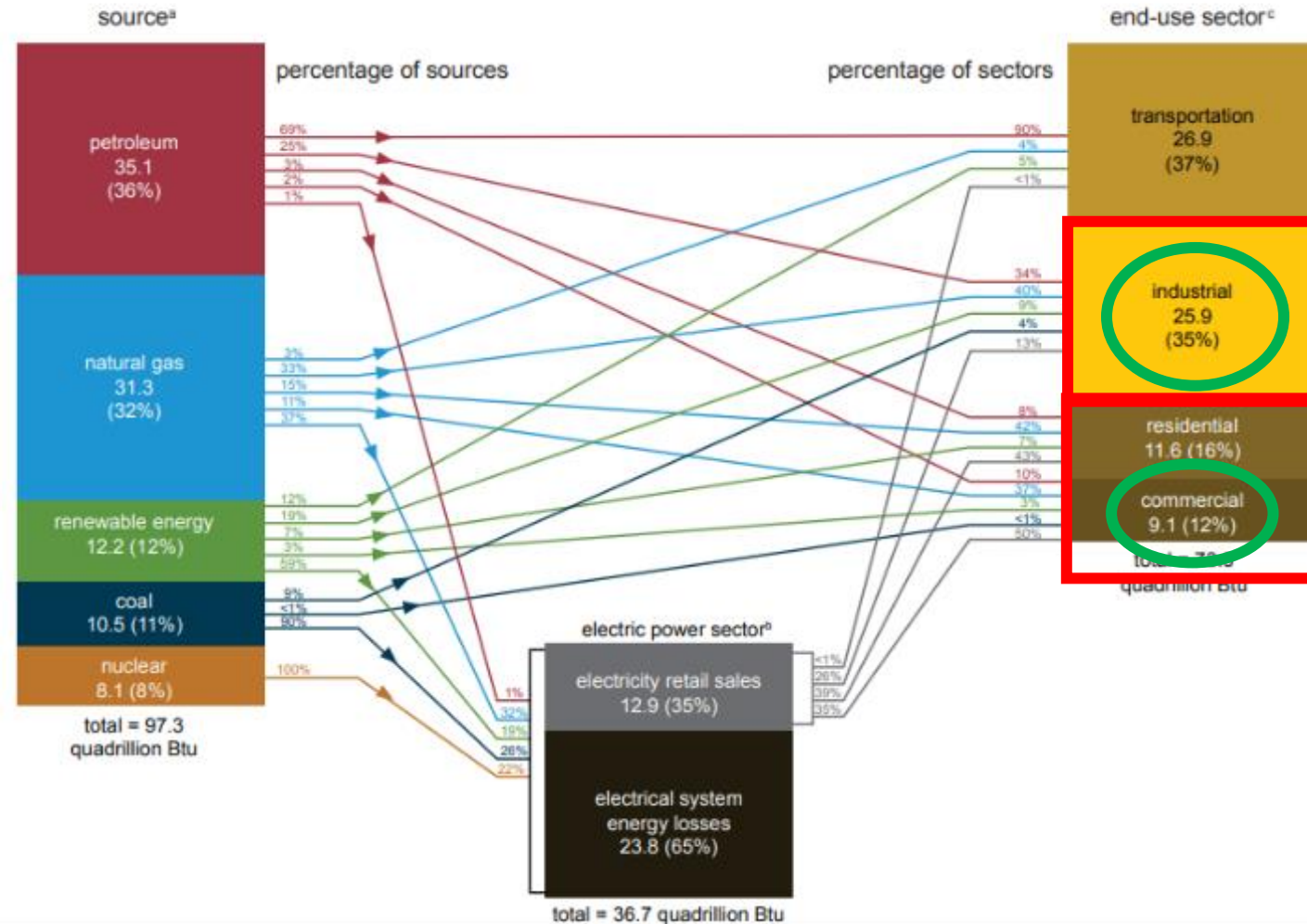
Note: Sum of components may not equal 100% because of independent rounding.



# U.S. End-use Energy Consumption Industrial & Commercial Sectors

## U.S. energy consumption by source and sector, 2021

quadrillion British thermal units (Btu)



Buildings account for about 40% of all U.S. energy consumption and a similar proportion of greenhouse gas emissions.

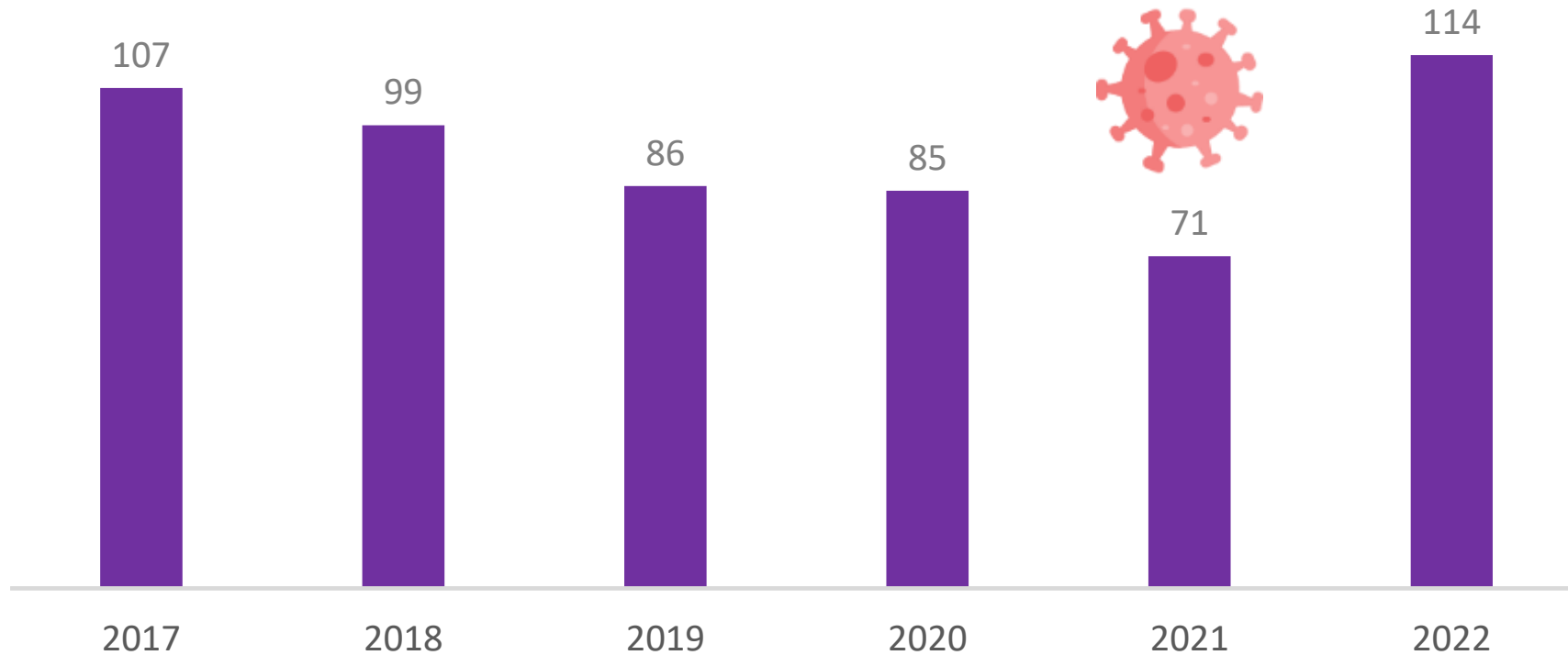
What do they use ?

industrial 25.9 (35%)	40% Natural Gas 34% Petroleum (Diesel) 9% Coal
residential 11.6 (16%) commercial 9.1 (12%)	37% Natural Gas 10% Petroleum (Diesel) <1% Coal



# 2022: more Solar Heating Industrial Processes (SHIP) systems than ever

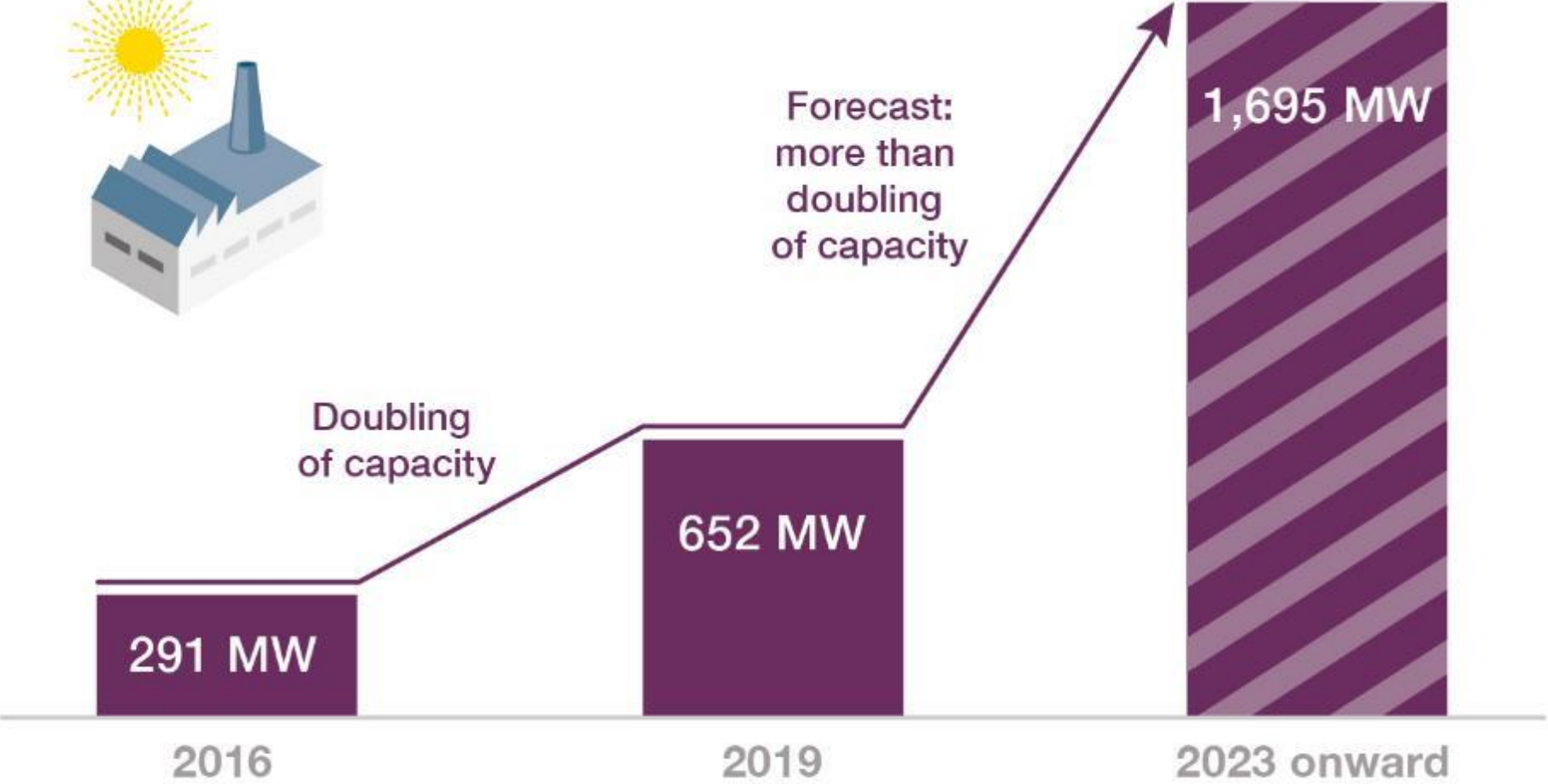
Number of SHIP projects commissioned per year



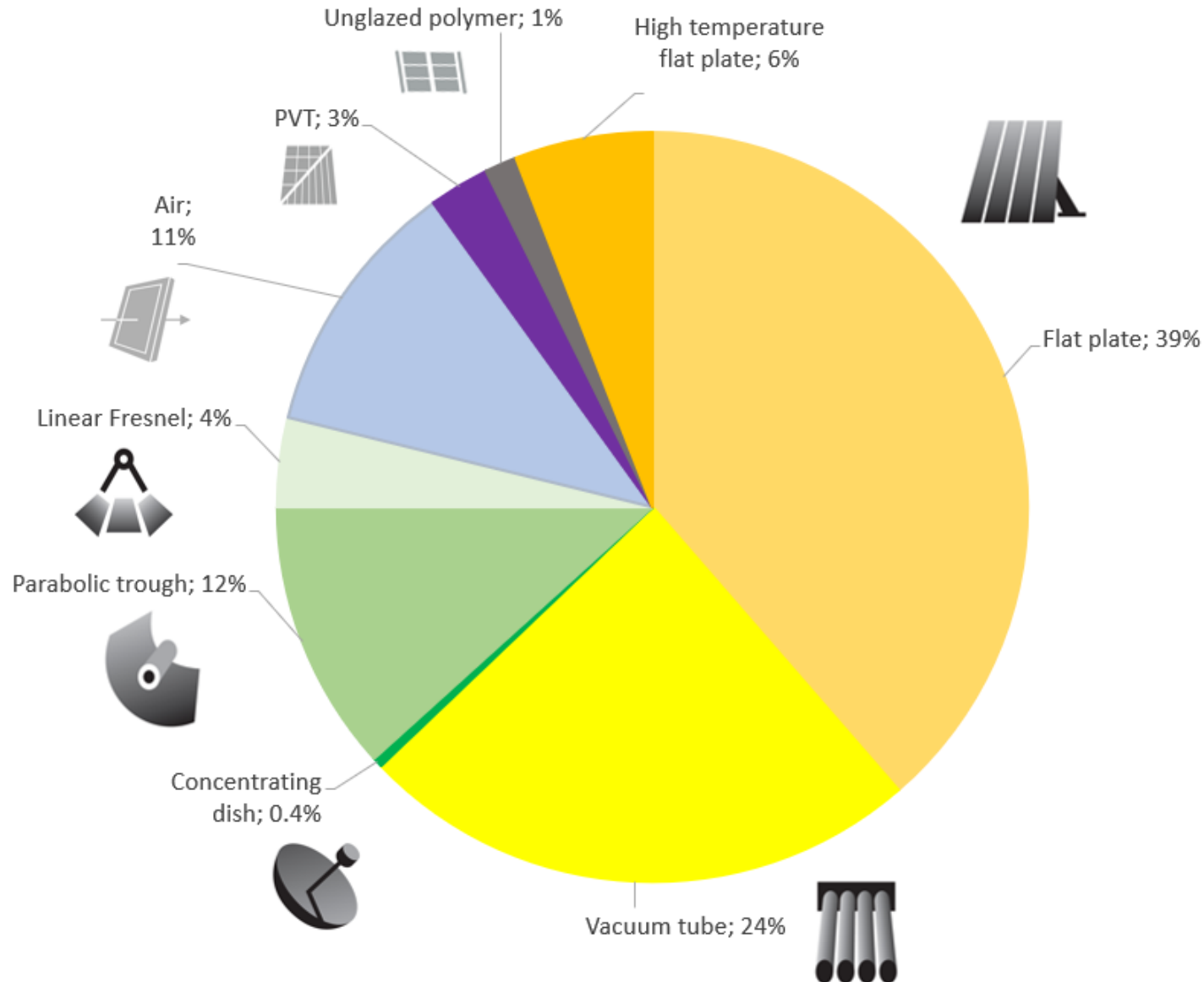
Source: annual SHIP surveys since 2017



# Solar Industrial Heat Outlook



# Diversity of SHIP systems is growing

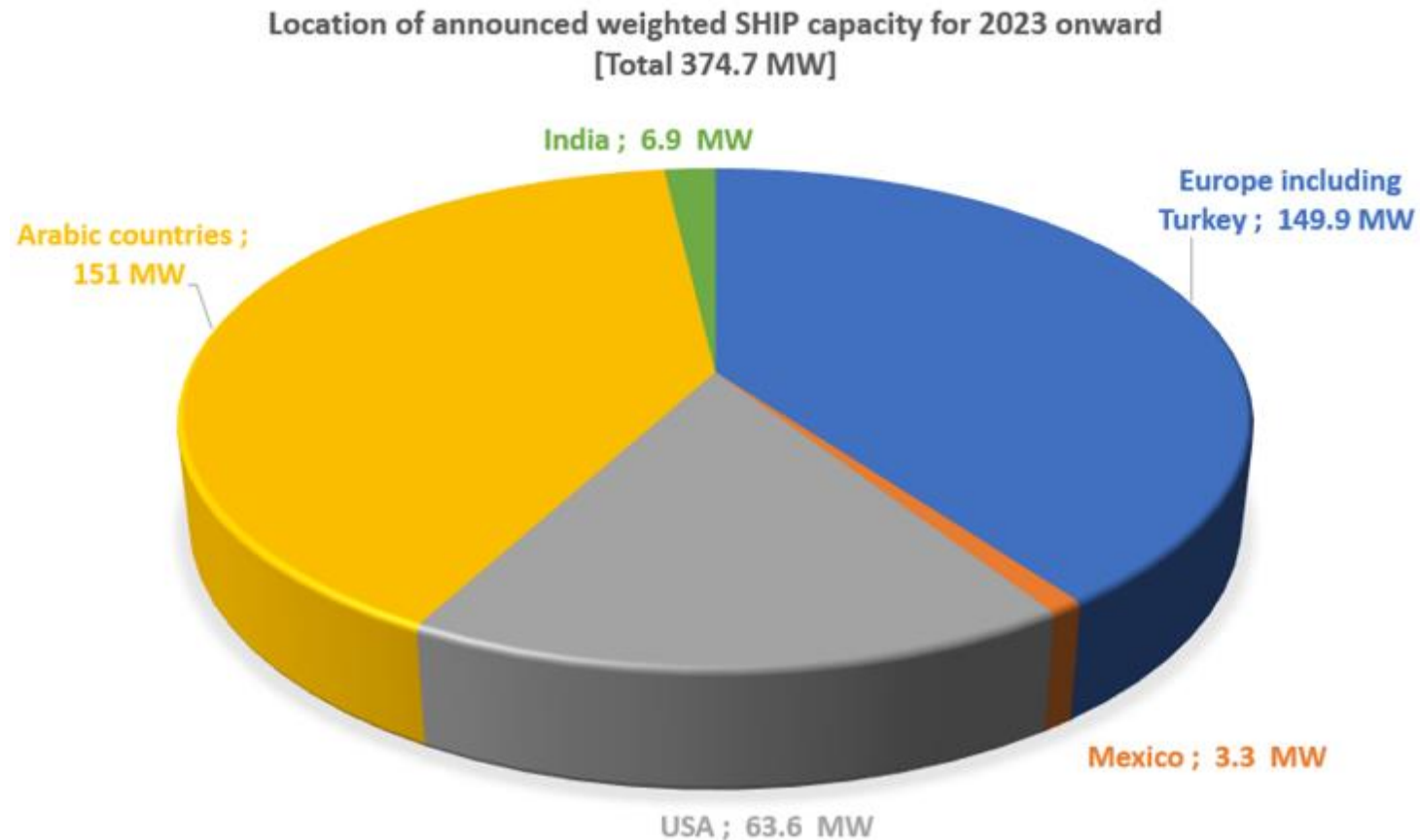


Distribution of collector type area in the SHIP World market 2022 [30 MW in total]

Only seven SHIP plants among 114 had operating temperatures above 100 °C (212°F)



# Every manufacturer of a Solar Thermal Technology has a role in the forecasted growth of Industrial and Commercial Heating & Cooling



# “U.S. Solar Thermal Manufacturers and Contractors have a huge opportunity ”

## COMMERCIAL APPLICATIONS

- Steam, Industrial Process Heat & Hot Water
- Steam Boilers
- Water Treatment/Desalination
- Evaporation of Process Wastewater
- Dehumidification/Drying
- Pasteurization/Sterilization
- Oil & Gas: Steam Injection for Extraction
- Metals and Plastics Pre-Heating
- Waste Treatment
- Thermochemical Processes
- Cooking
- Electric Generation
- On-Site Electricity Generation (using ORC Heat Engine Generators or Steam Engines)
- A/C and Refrigeration
- Single or Double-Effect Absorption Chillers using LiBr or Ammonia
- Hybrid Solar Thermal with Gas or fossil burners for 24/7

## INDUSTRIES SERVED

- Manufacturing Plants (Steam)
- Brewery & Distilled Beverage Processing
- Food & Beverage Processing
- Meat & Poultry Processing
- Dairies & Milk Product Processing
- Water/Waste Processing
- Hotels/Resorts
- Multifamily Housing
- Incineration
- K-12 Schools
- Universities: Dining Halls & Dormitories
- Retirement Homes
- Hospitals
- Corrections (Federal, State & County)
- Commercial Laundries
- Agriculture (Fast growing)



# Typical Consumption or Demand

- Commercial
  - Restaurant 2.4 gallons per meal
  - Fast food = .79-gallon/meal
  - Office Building = 1 gallon/person/day
  - Laundry each machine = 45/gpl
  - Hospital = 52-gallons per bed/day
  - Hotel
    - Business Hotel = 14/gpd
    - Resort Hotel = 20/gpd



# High Temperature Applications 100°C to 200°C

- Steam
- Drying
- Cooling
- Hot Water
- Evaporation
- Desalination
- Space Heating
- Pasteurization
- Boiler Pre-heat
- Dehumidification



# Industrial Process Heat Preheating Boilers

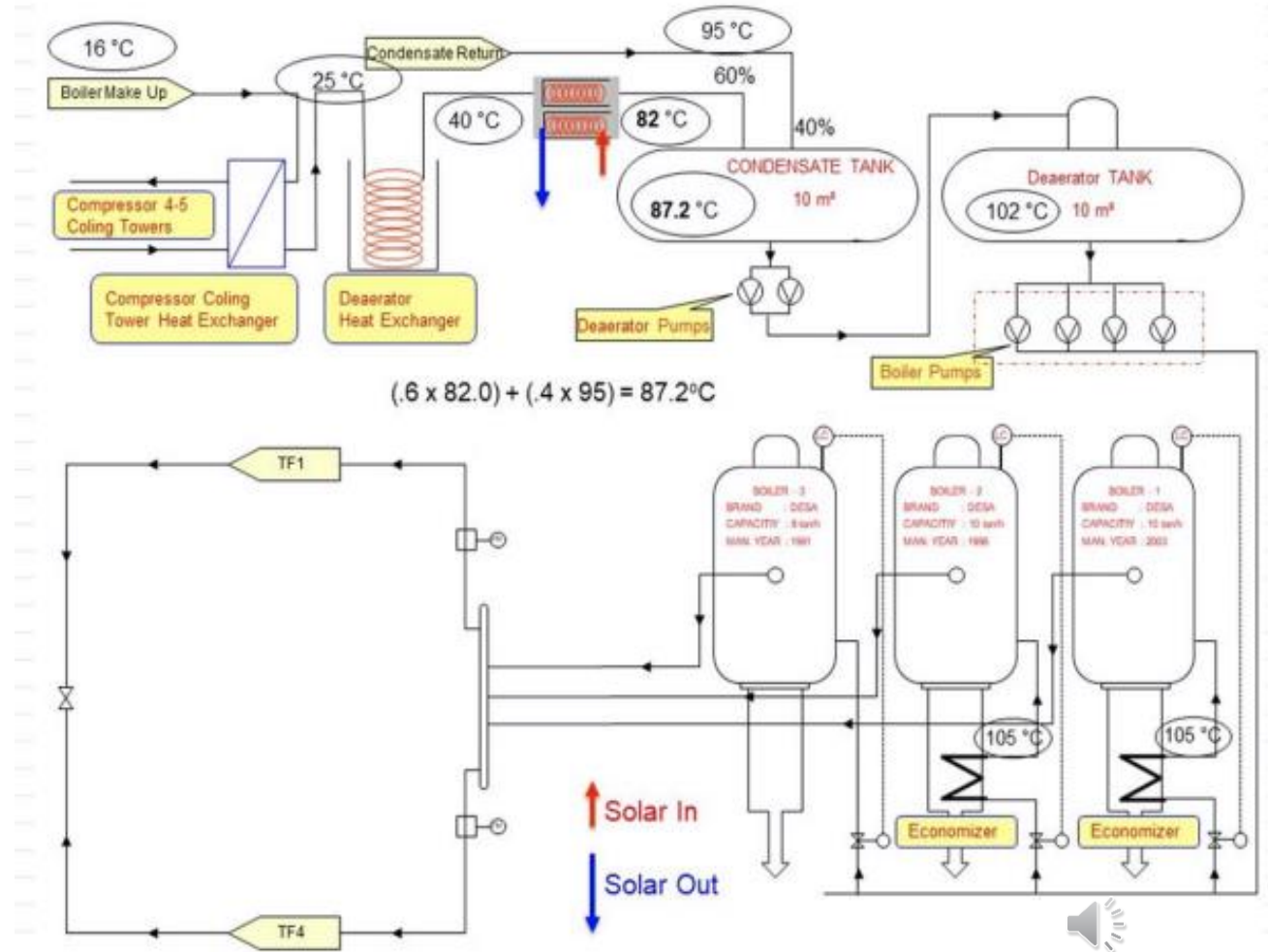
- Any temperature below 212°F can be supplied to boilers.
- Economics depend on the Delta-T of the make-up water.
- Volume of make-up water or re-heating circulation loop must be known – hourly and daily.
- Integrate Solar Heating System where the highest efficiency can be realized (after HR).
- Determine system performance for daylight hours or 24/7 operations.
- Know the fuel cost of the Gas- Electricity- Diesel.
- Determine energy savings and GHG reductions.
- Remember, every Solar Thermal technology can provide pre-heating.



# Example of Boiler integration with Heat Recovery

## 84m<sup>3</sup> - 22,301 gallons of make-up water per day

- 61°F – (16°C) Ground water
- 61°F to 77°F (25°C)  
Compressor Cooling Tower (Heat Recovery #1)
- 77°F to 104°F (40°C)  
Deaerator Heat Exchanger (Heat Recovery #2)
- 104°F to 180°F (82°C)  
**Solar Heating contribution to Condensate Tank**
- Make-up water now @ 180°F (82°C) = 60%
- Condensate Return @ 203°F (95°C) = 40%
- Blended Condensate Tank Temperature = 189°F (87°C)
- 345 Collectors required – 288 used in calculations
- 83% of daily load
- 6,698,257,564 BTU/yr = ~ 6.7 MMcf Savings



# My ask!

- Join The ASES Solar Thermal Division
- Submit your commercial projects for the Website
- Volunteer to host an educational webinar
- Learn to use the NREL System Advisor Model (SAM)

# Thank you!

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