

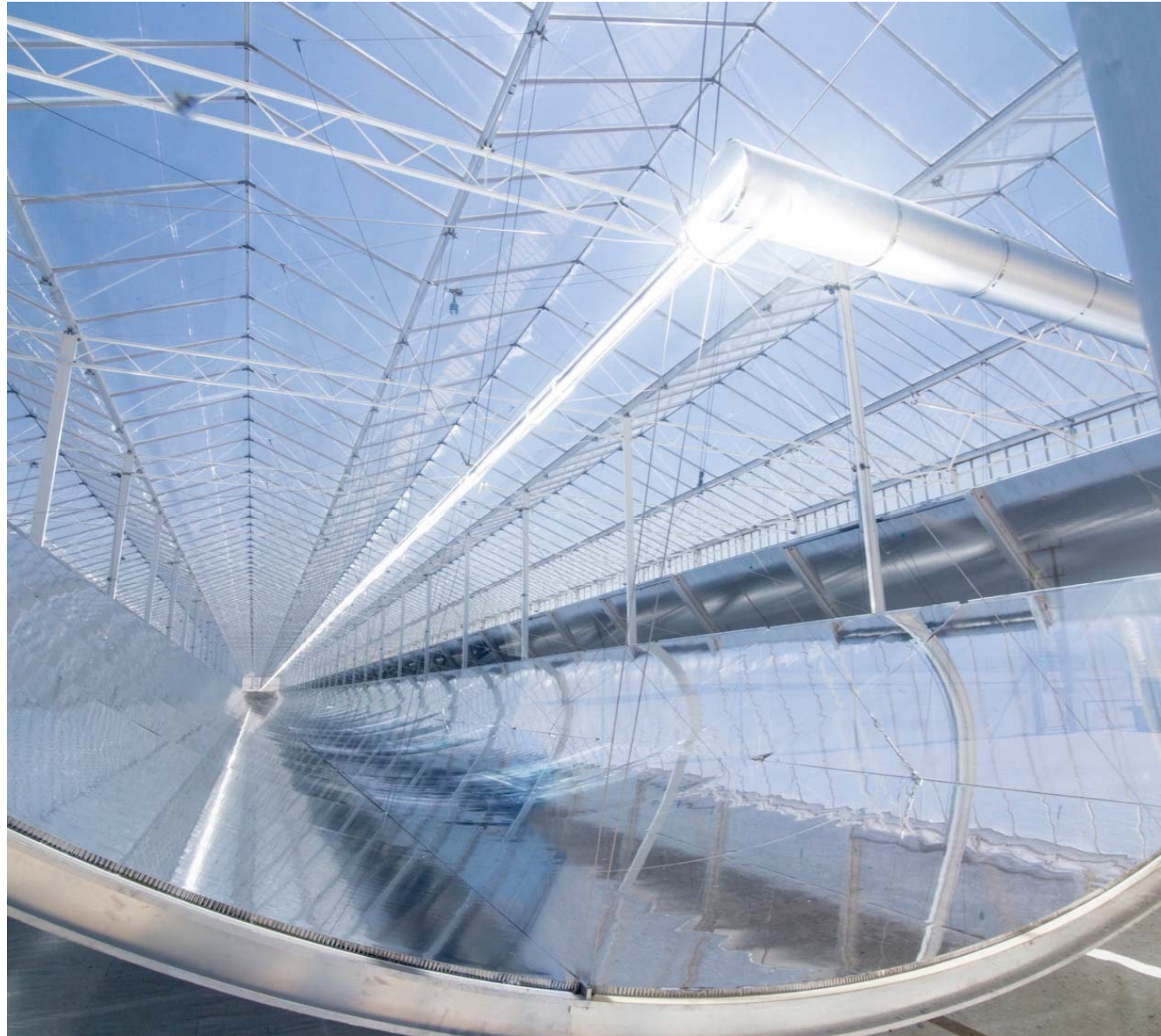


Miraah Solar Steam

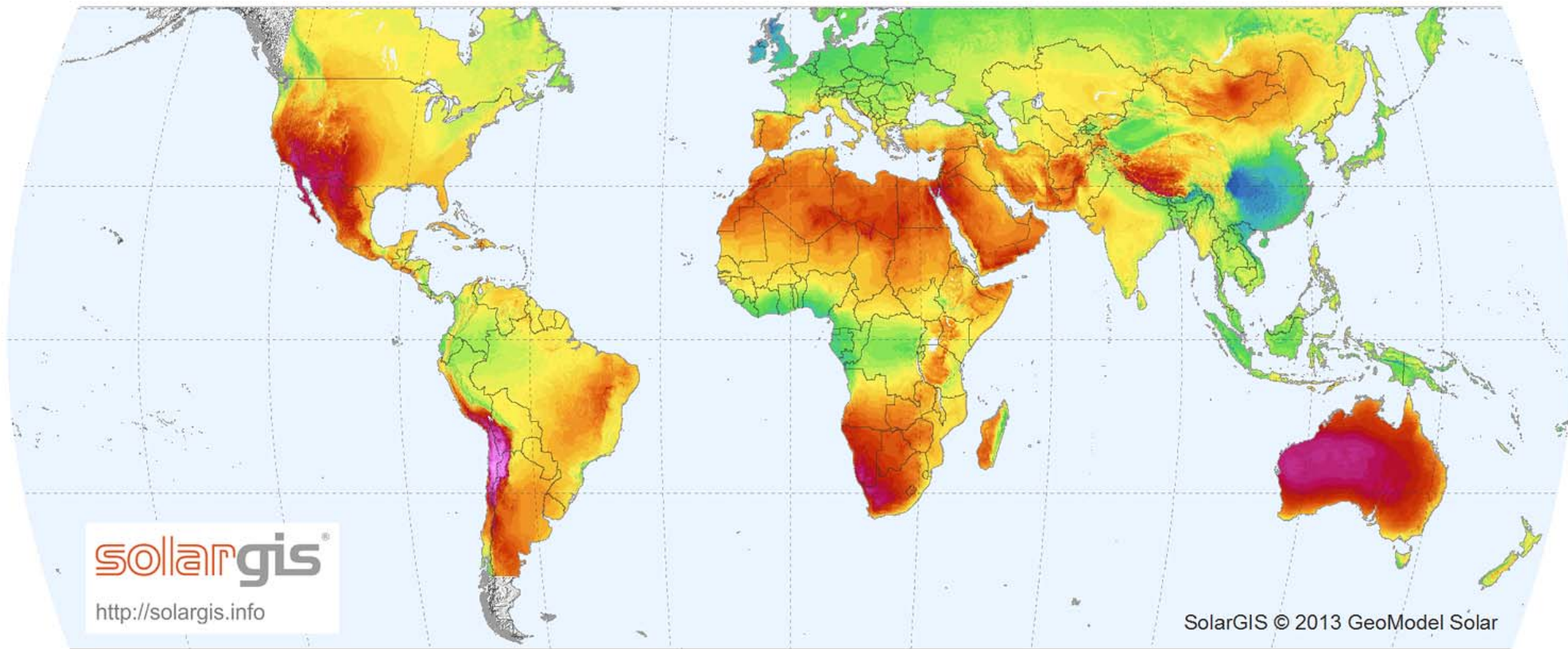
EPRI-IEA Workshop Nov 29 2016



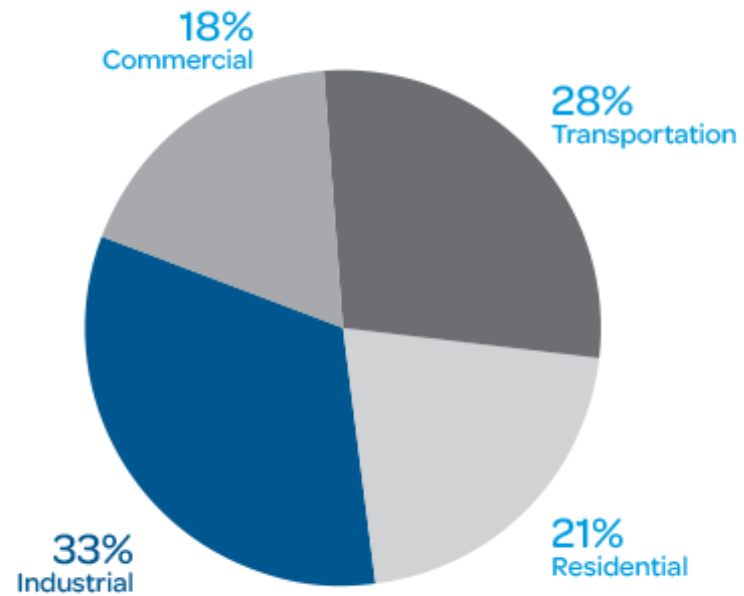
Steam from Sunshine



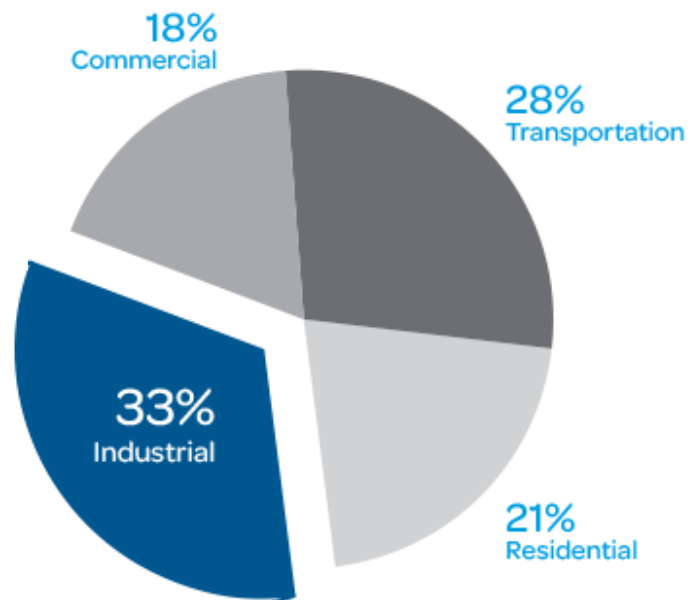
Average Direct Solar Radiation



World Energy Use

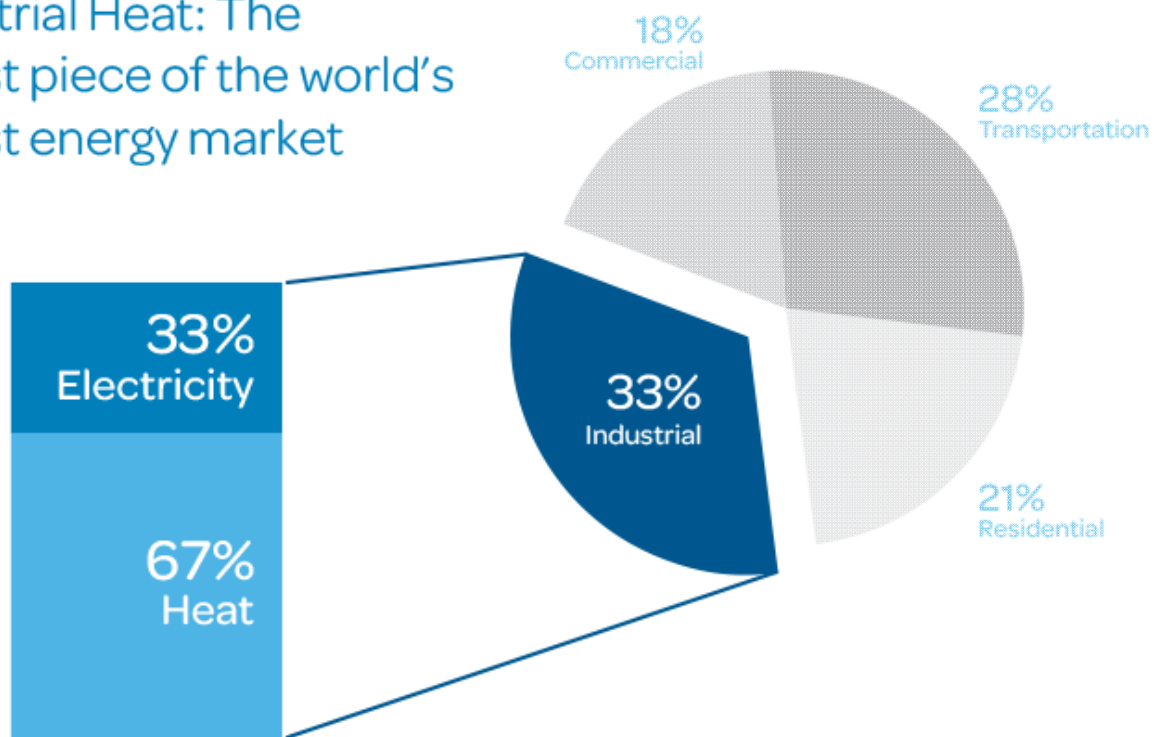


Industrial Energy Use



Industrial Energy Use: Heat

Industrial Heat: The largest piece of the world's largest energy market



Industrial Heat and Solar

Food

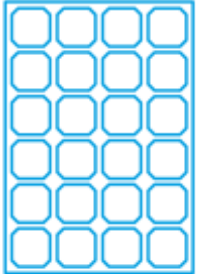
50°C

100°C

500°C



FLAT PLATE
(50-80°C)



Industrial Heat and Solar

Food

Textiles

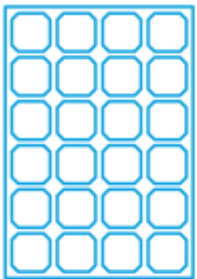
50°C

100°C

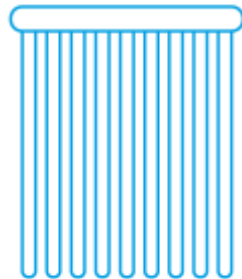
500°C



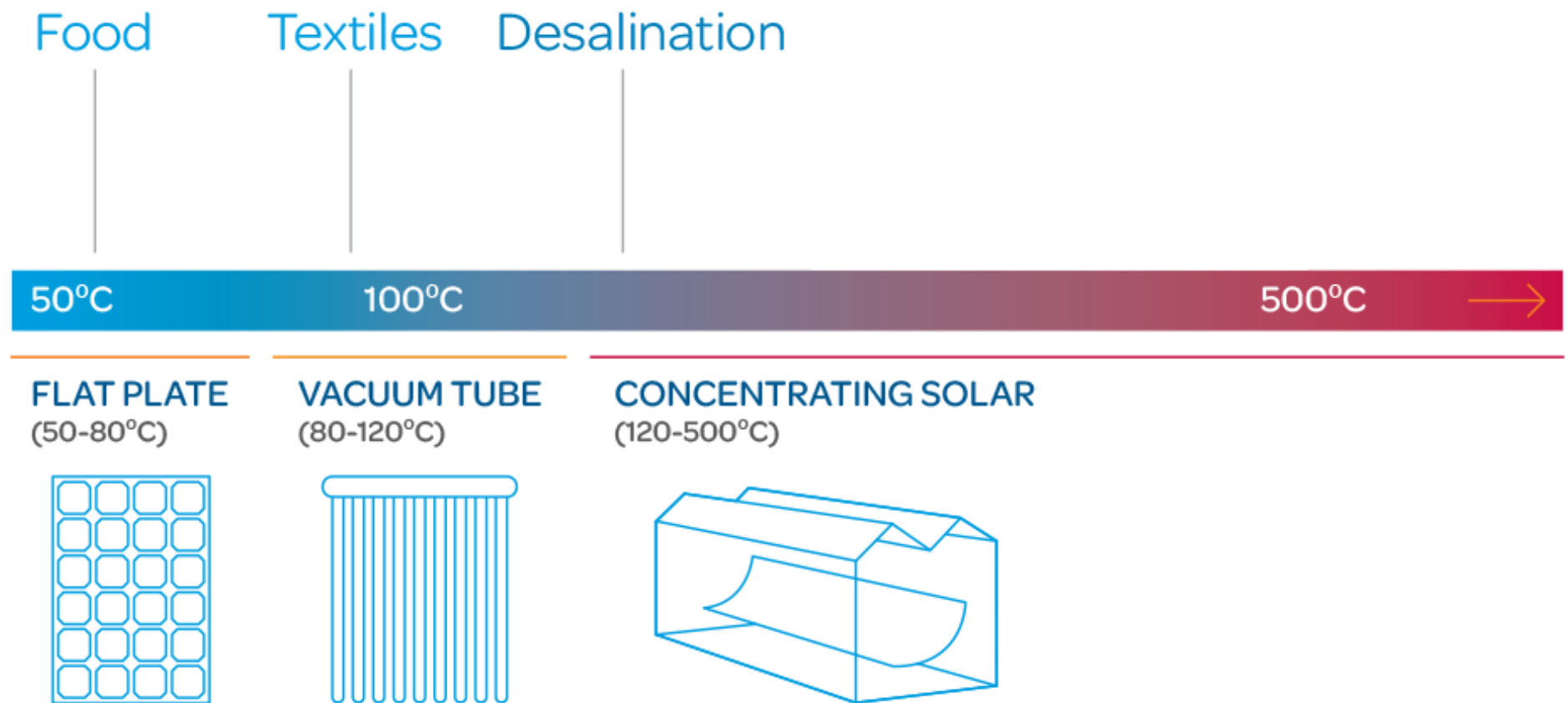
FLAT PLATE
(50-80°C)



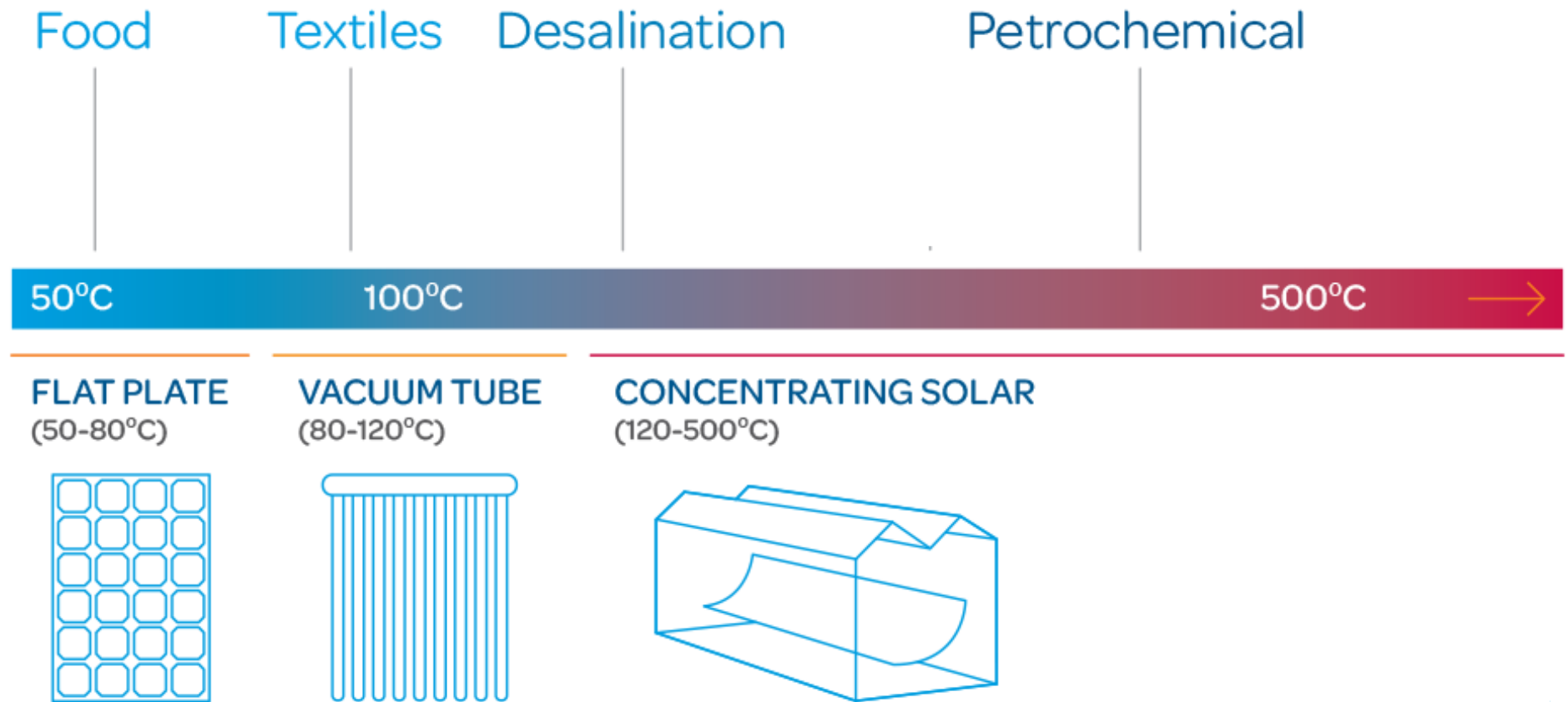
VACUUM TUBE
(80-120°C)



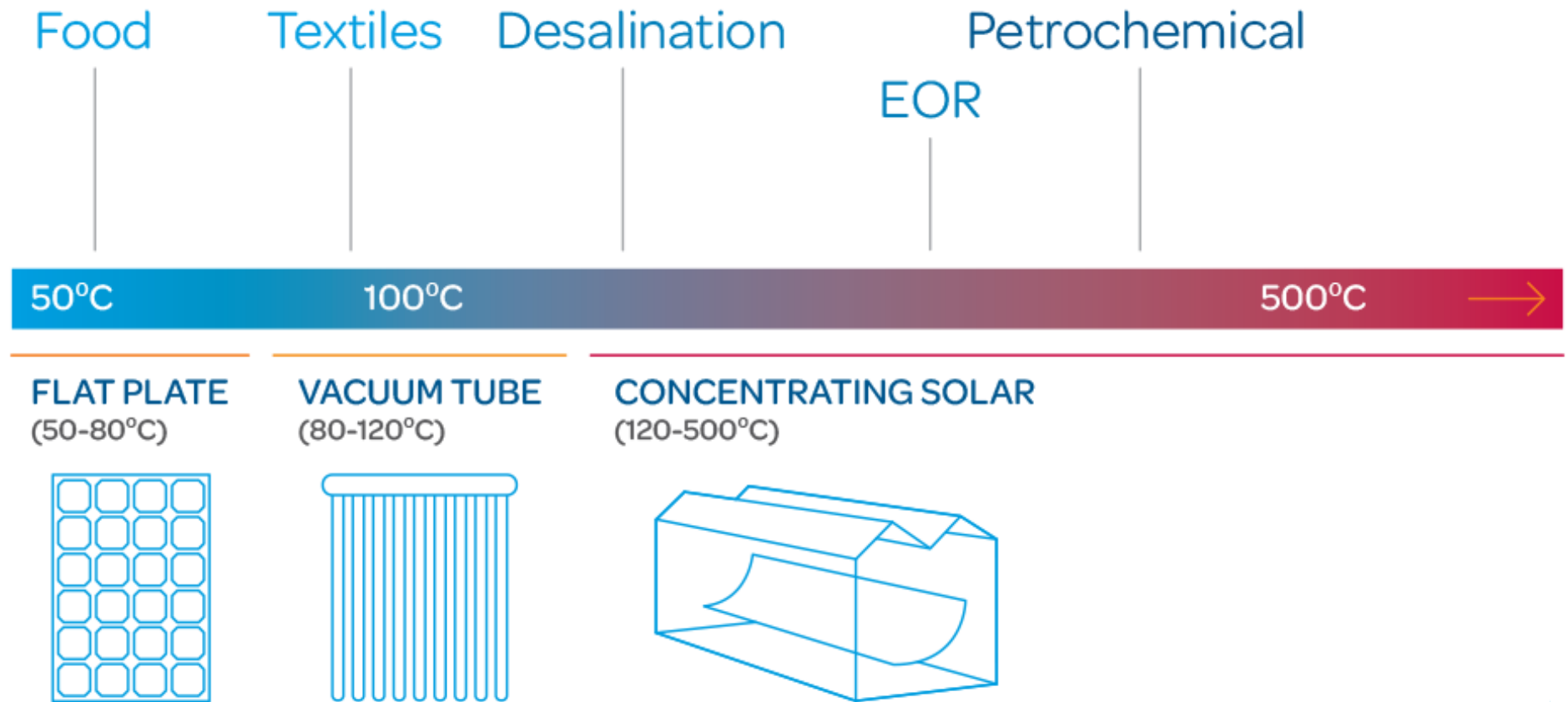
Industrial Heat and Solar



Industrial Heat and Solar

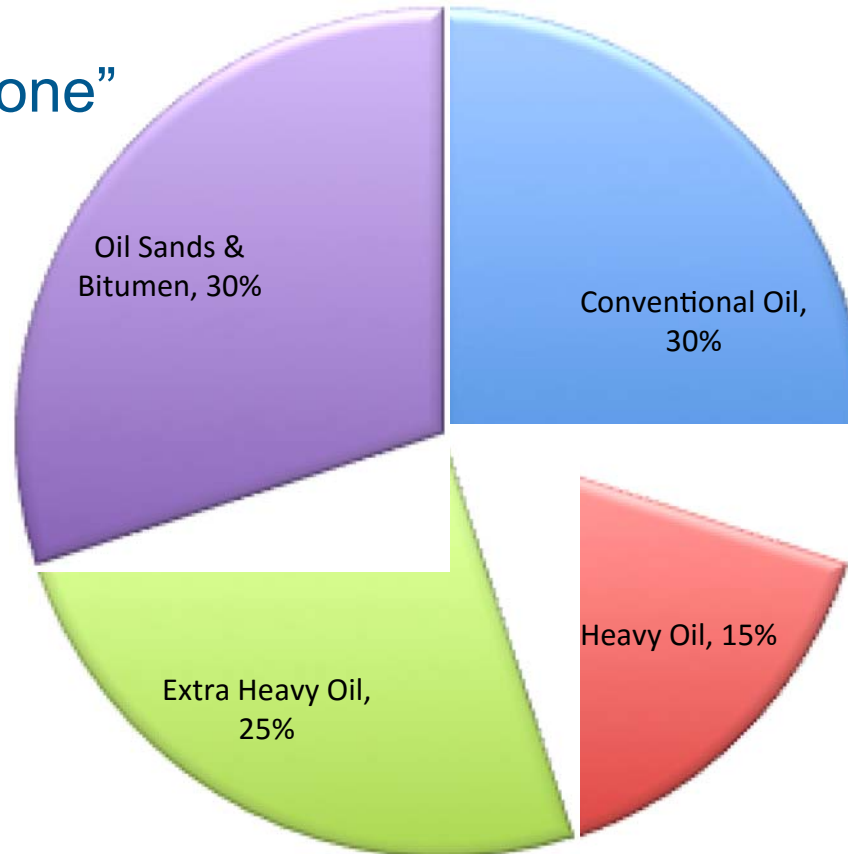


Industrial Heat and Solar



Remaining Oil Resource

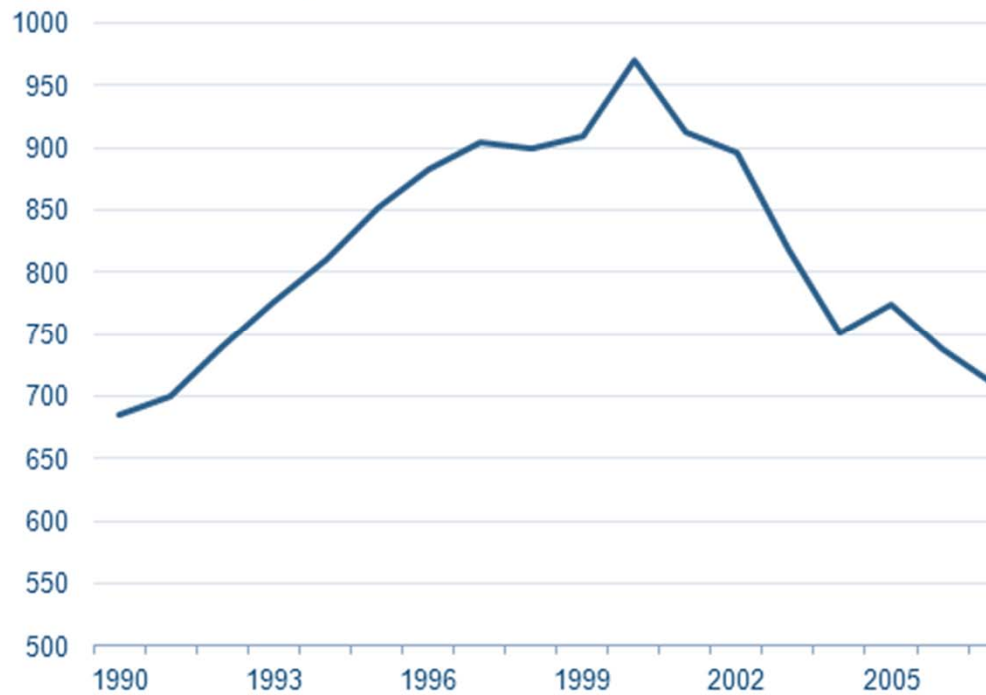
- “The Easy Oil is Gone”



Oman Oil Production

Oman Crude Oil Production, 1990-2012*

thousand barrels per day

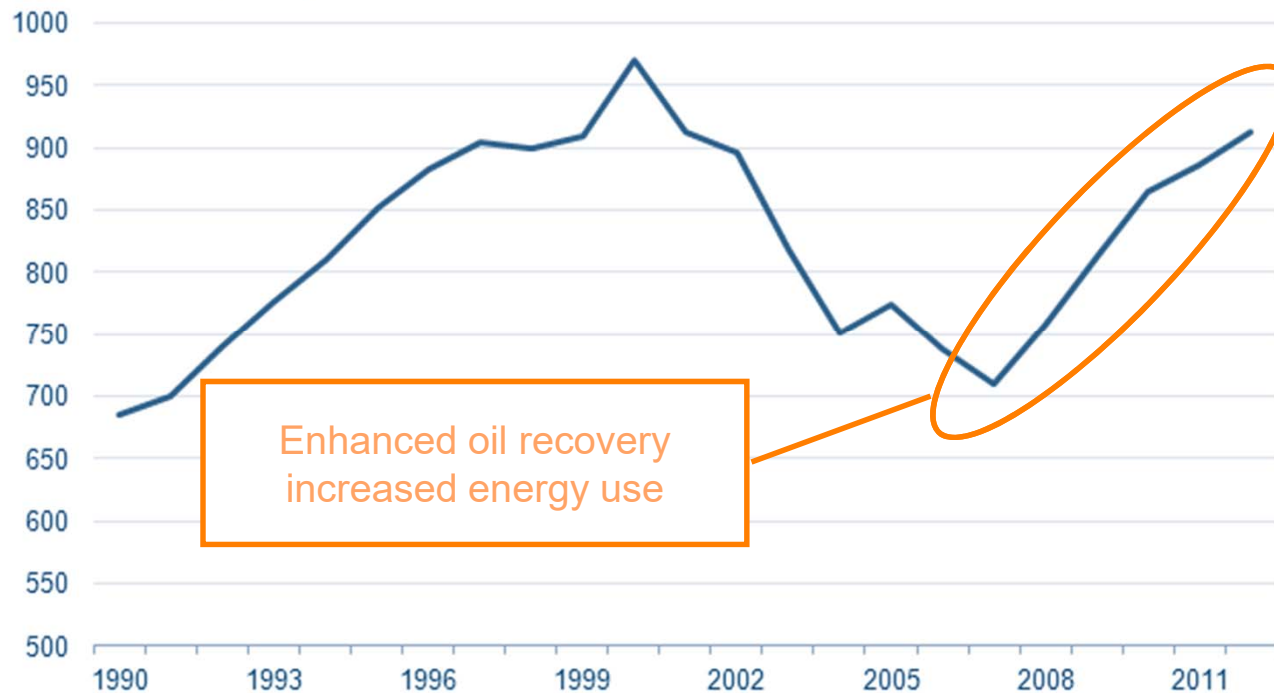


Source: U. S. Energy Information Administration

Revitalized Oman Oil Production

Oman Crude Oil Production, 1990-2012*

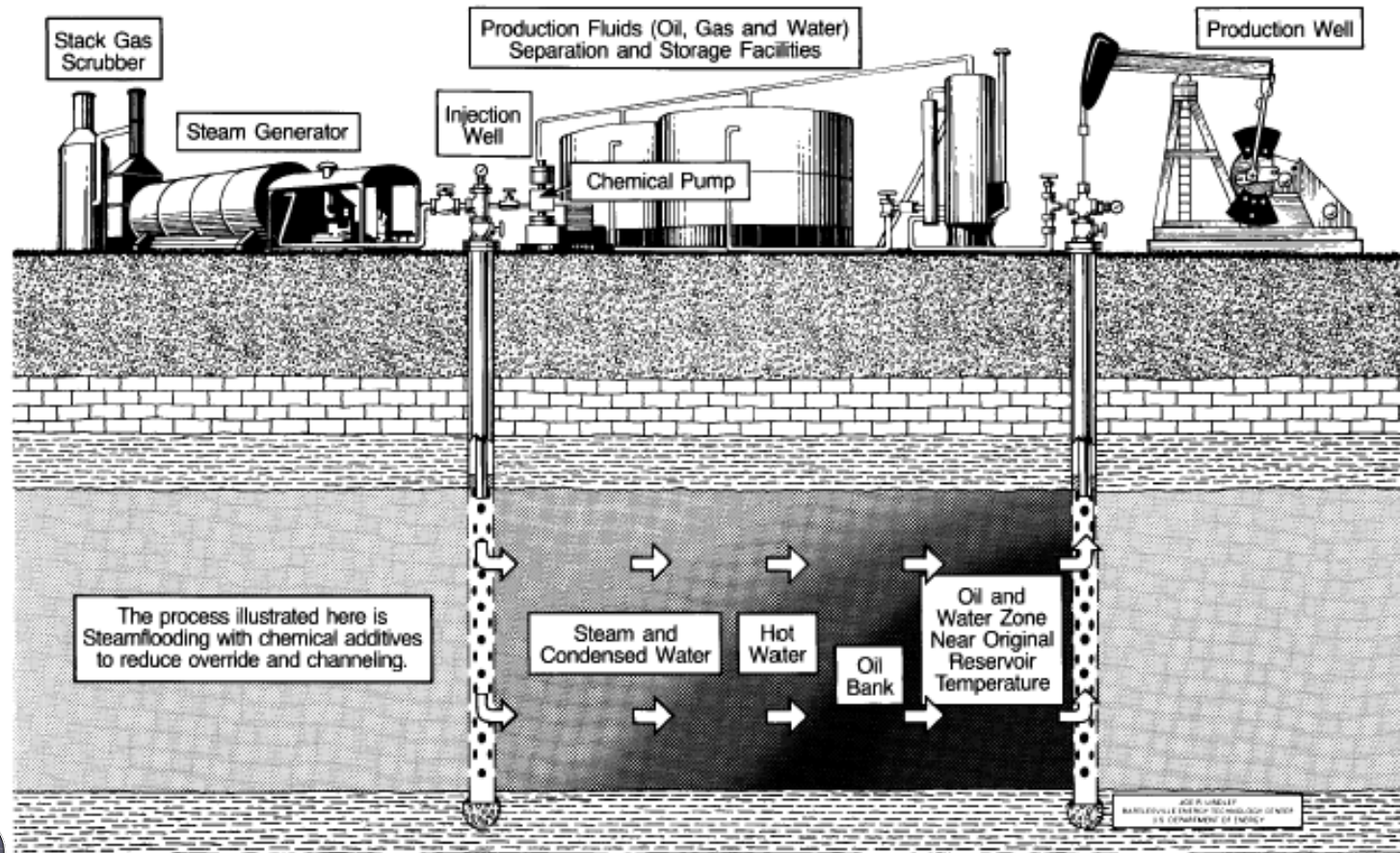
thousand barrels per day



Source: U. S. Energy Information Administration

*2012 is estimated

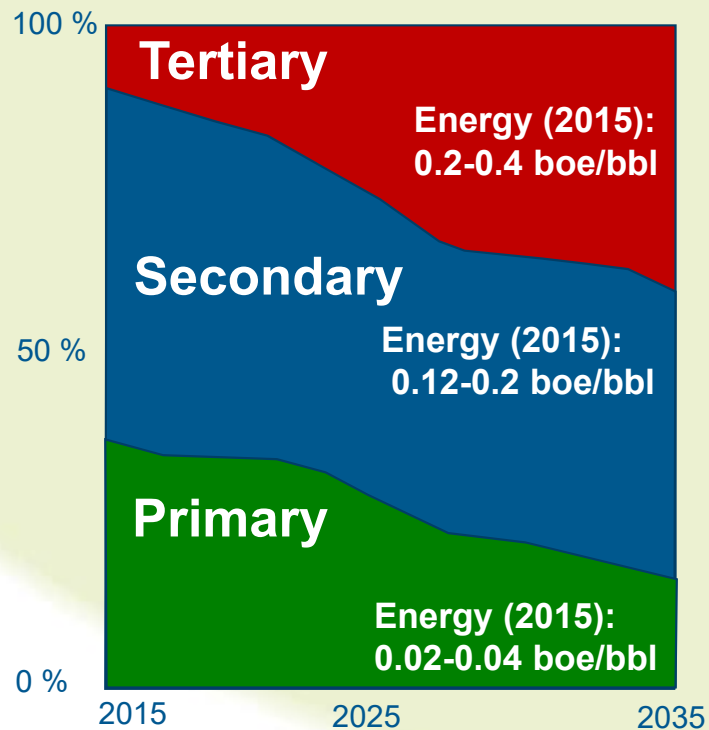
Thermal Enhanced Oil Recovery



PDO's Changing Business Environment

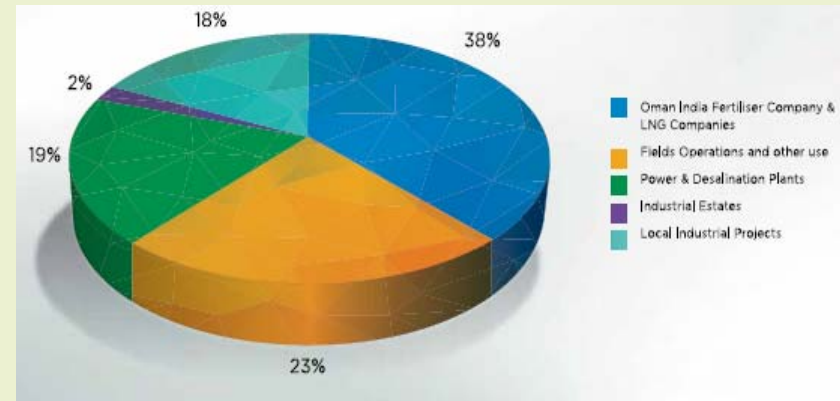
Production energy intensity is rising

(PDO's Oil Recovery methods vs. Time)



Gas is a scarce commodity

2013 Oman Gas Consumption: 39 bcm

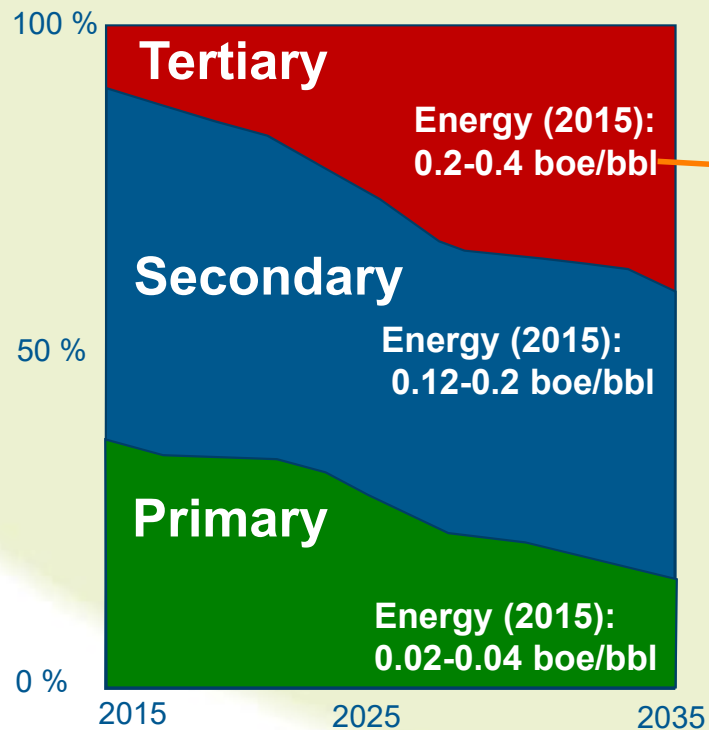


- Domestic gas consumption will continue to increase as a result of economic growth
- Reduced consumption in oil field operations will provide options to monetise gas in-country or through exports

PDO's Changing Business Environment

Production energy intensity is rising

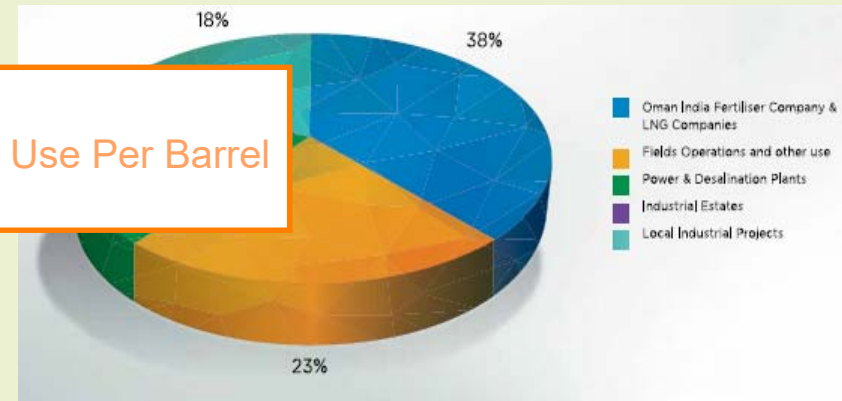
(PDO's Oil Recovery methods vs. Time)



10X Energy Use Per Barrel

Gas is a scarce commodity

2013 Oman Gas Consumption: 39 bcm

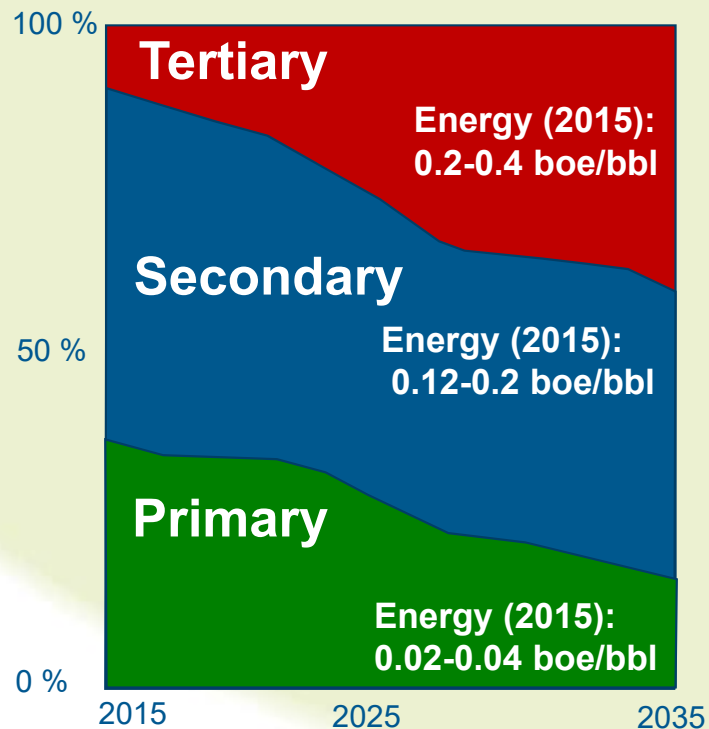


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PDO's Changing Business Environment

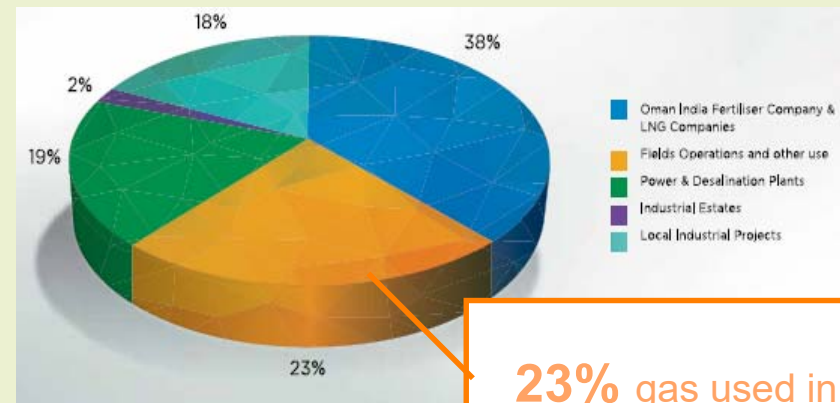
Production energy intensity is rising

(PDO's Oil Recovery methods vs. Time)



Gas is a scarce commodity

2013 Oman Gas Consumption: 39 bcm



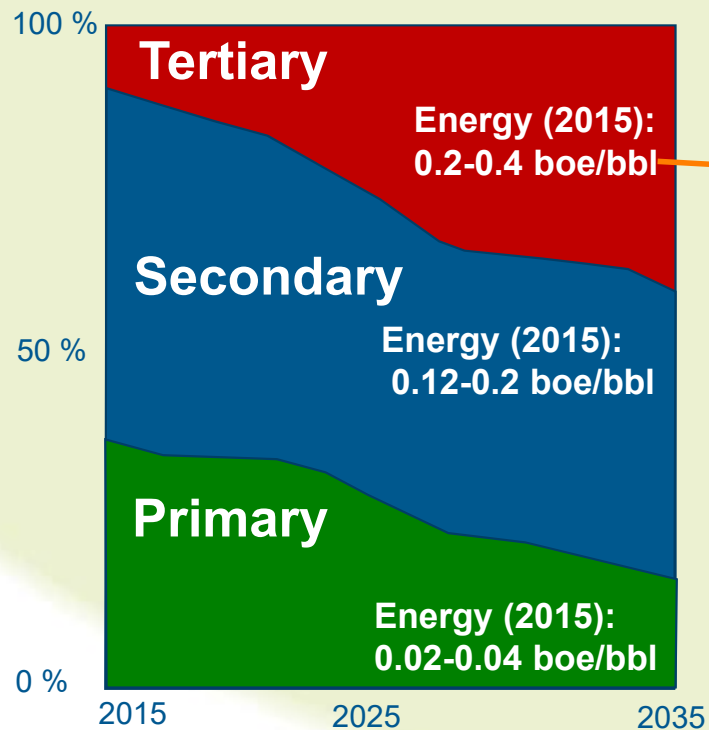
23% gas used in oilfield

- Domestic gas consumption will continue to increase as a result of economic growth
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PDO's Changing Business Environment

Production energy intensity is rising

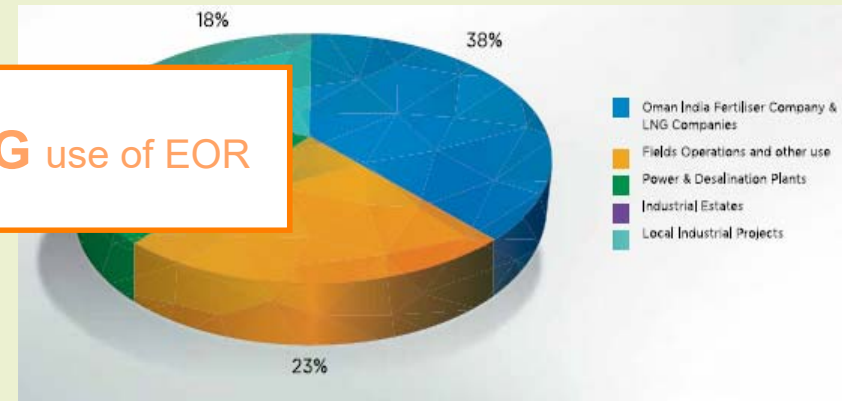
(PDO's Oil Recovery methods vs. Time)



TRIPLING use of EOR

Gas is a scarce commodity

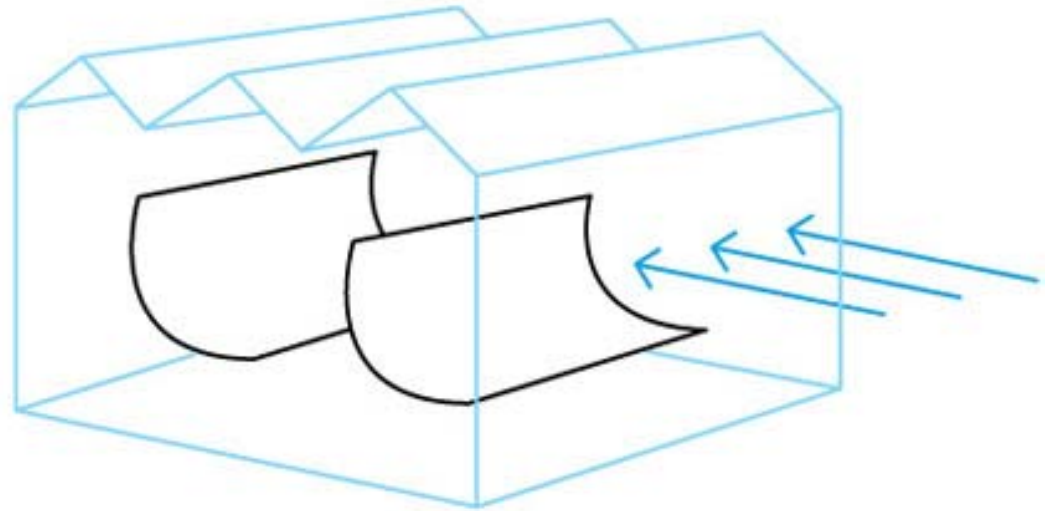
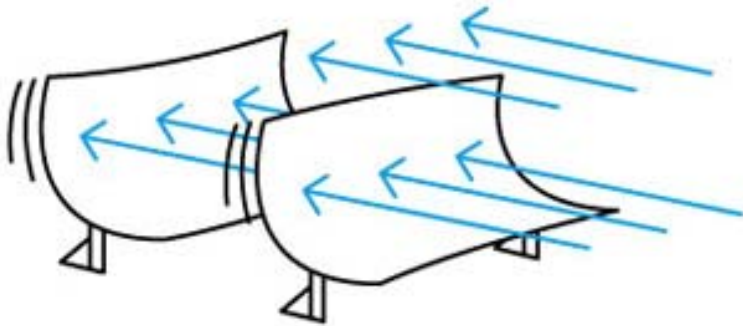
2013 Oman Gas Consumption: 39 bcm



- Domestic gas consumption will continue to increase as a result of economic growth
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Meet Miraah

Enclosed Trough Concept



Enclosed Trough Concept

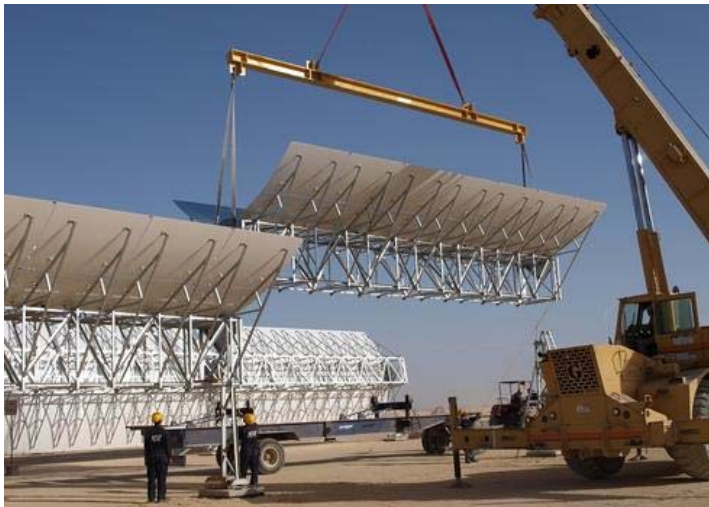


Fundamental Advances

- 90% weight reduction in reflector
- Direct steam without moving joints
- Direct oilfield water
- Environmental protection
- Automatic washing

Result

More than 50% reduction in total metal per unit of steam
90% reduction in reflector system weight



30 kg/m²



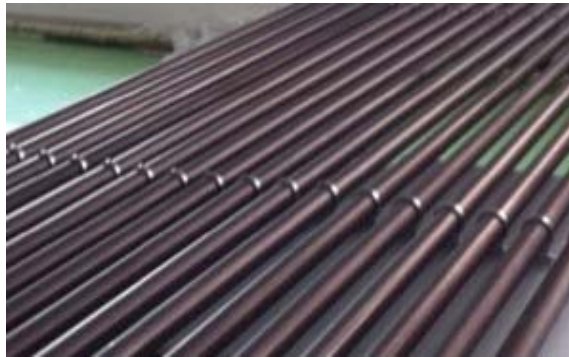
3 kg/m²



Key Technology Innovations



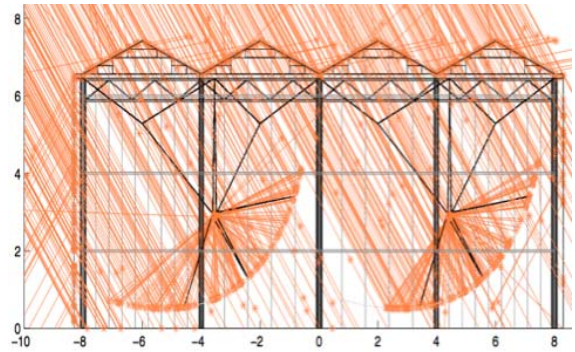
High performance reflector



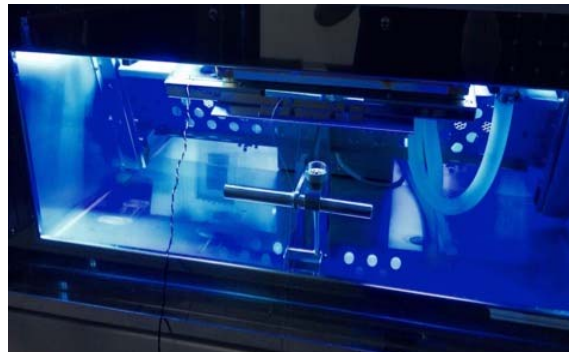
Advanced coatings



Mass produced mirrors



Performance simulation



Accelerated life testing



Installation equipment

Scale

1,021MW 6,000 tons steam per day



Scale



300,000

TONS OF CO₂ EMISSIONS
SAVED EACH YEAR

Scale



300,000

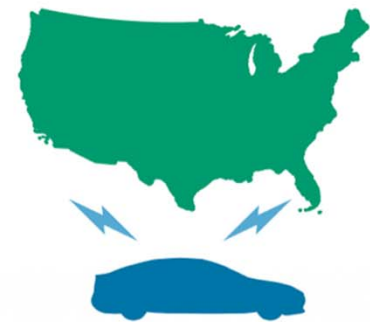
TONS OF CO₂ EMISSIONS
SAVED EACH YEAR



63,000

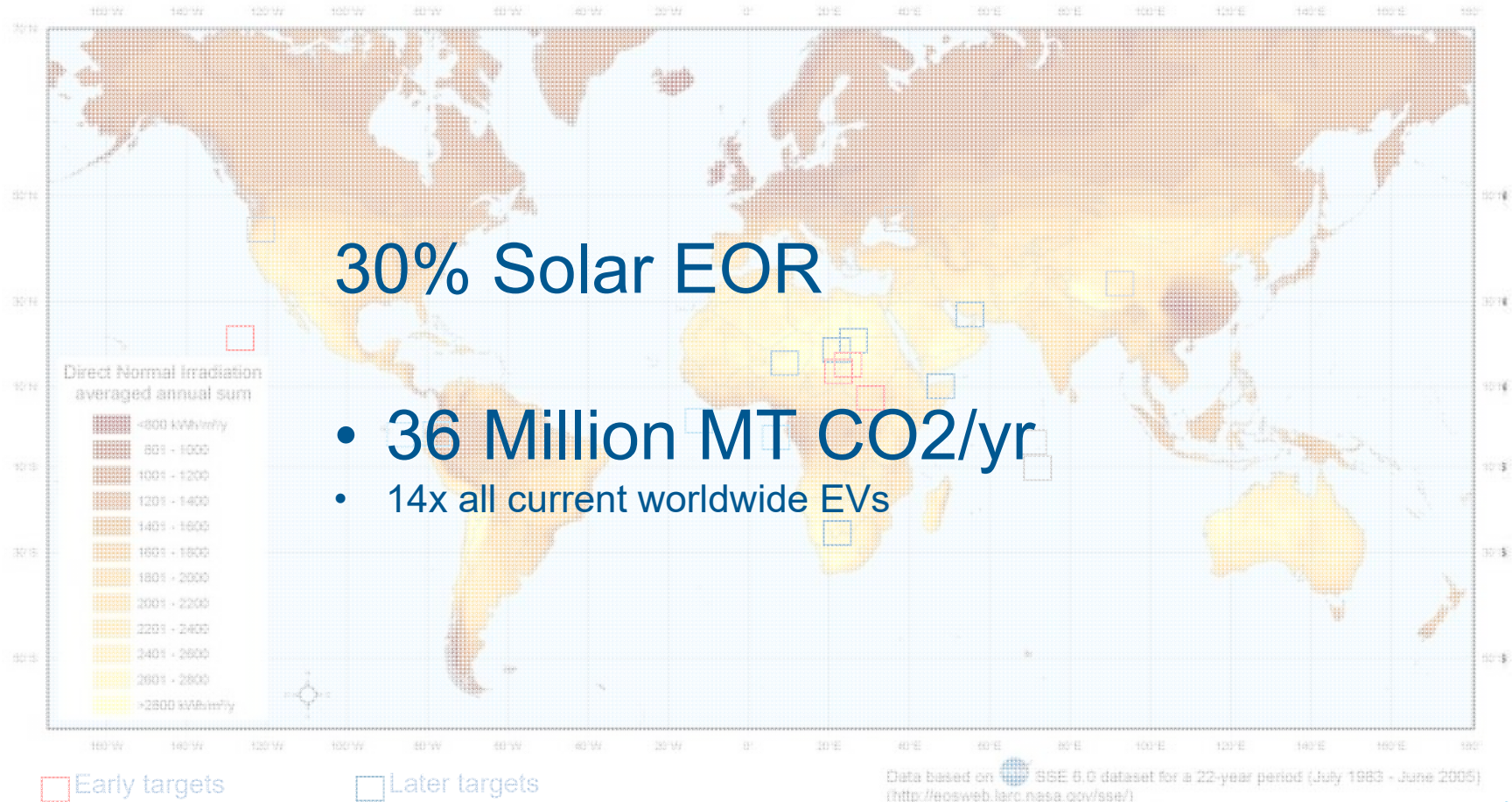
EQUIVALENT OF REMOVING
63,000 CARS OFF THE ROAD

OR



MORE CARBON SAVINGS THAN
ALL THE ELECTRIC CARS IN
THE UNITED STATES TODAY

Scale



Many Other Industrial Uses

