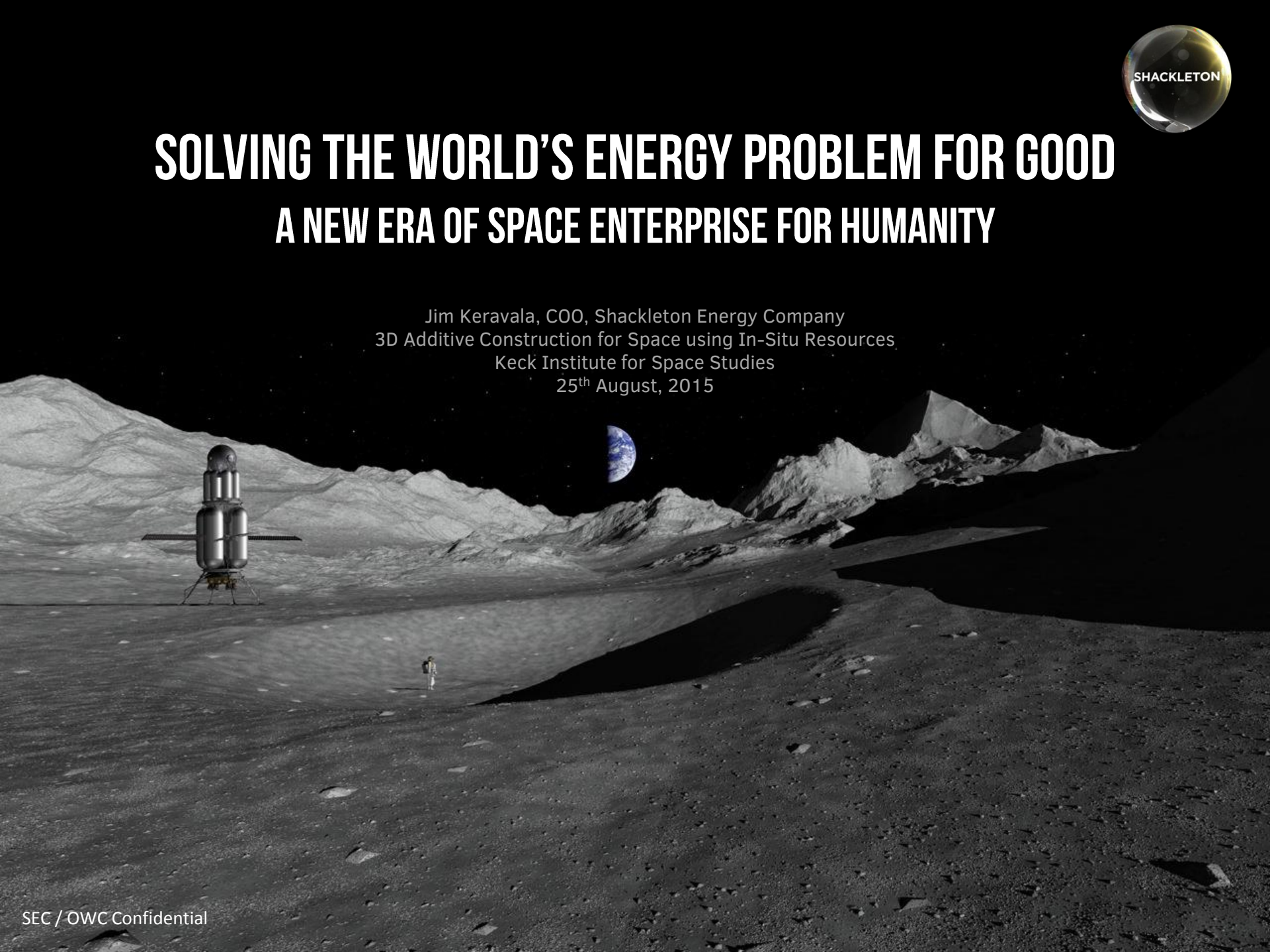
SOLVING THE WORLD'S ENERGY PROBLEM FOR GOOD

A NEW ERA OF SPACE ENTERPRISE FOR HUMANITY

Jim Keravala, COO, Shackleton Energy Company
3D Additive Construction for Space using In-Situ Resources
Keck Institute for Space Studies
25th August, 2015



EARTH'S POWER CONSUMPTION WILL INCREASE SUBSTANTIALLY THIS CENTURY

2015

WORLD POWER CONSUMPTION

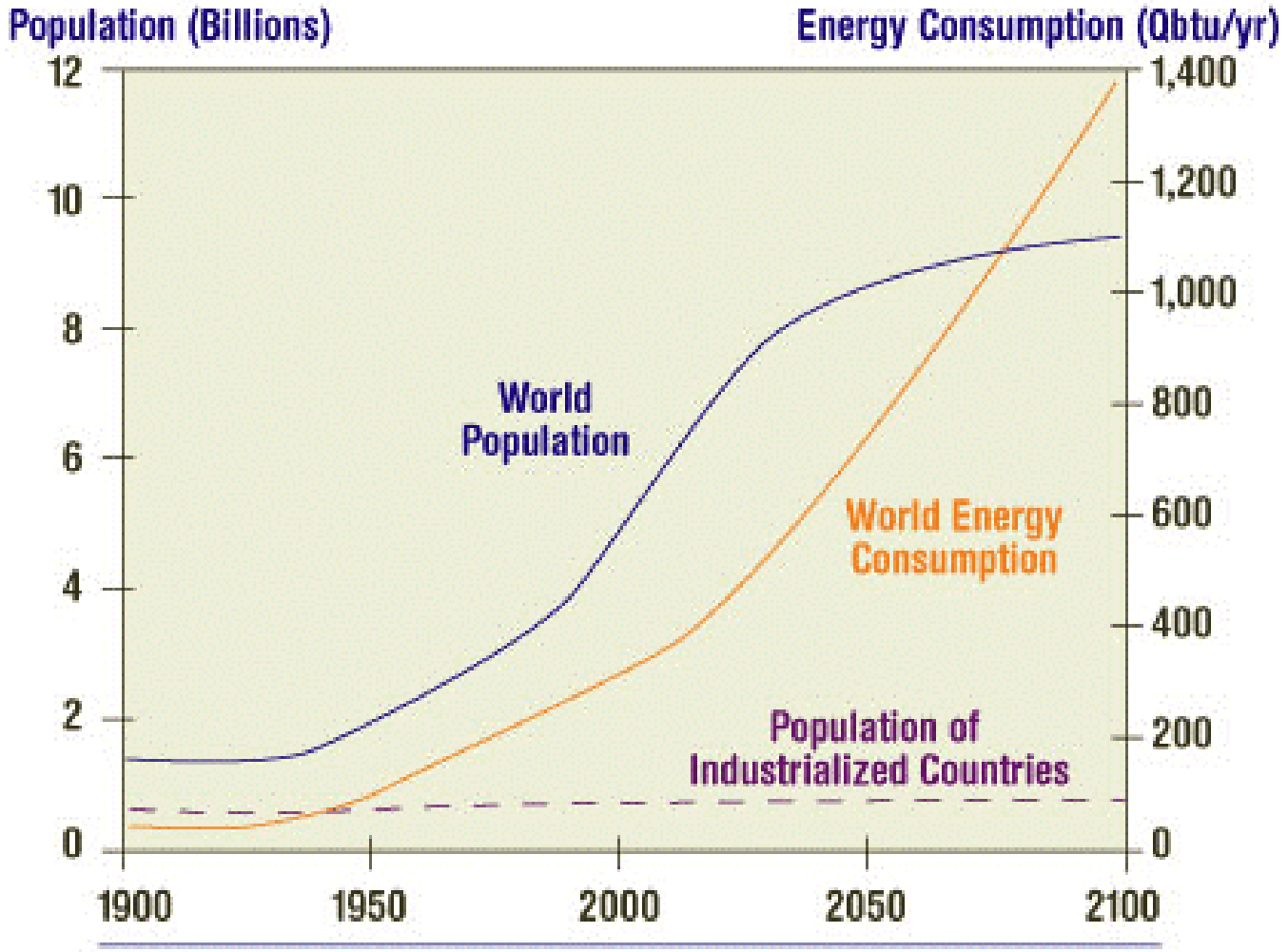
17 TERAWATTS

2100

WORLD POWER CONSUMPTION

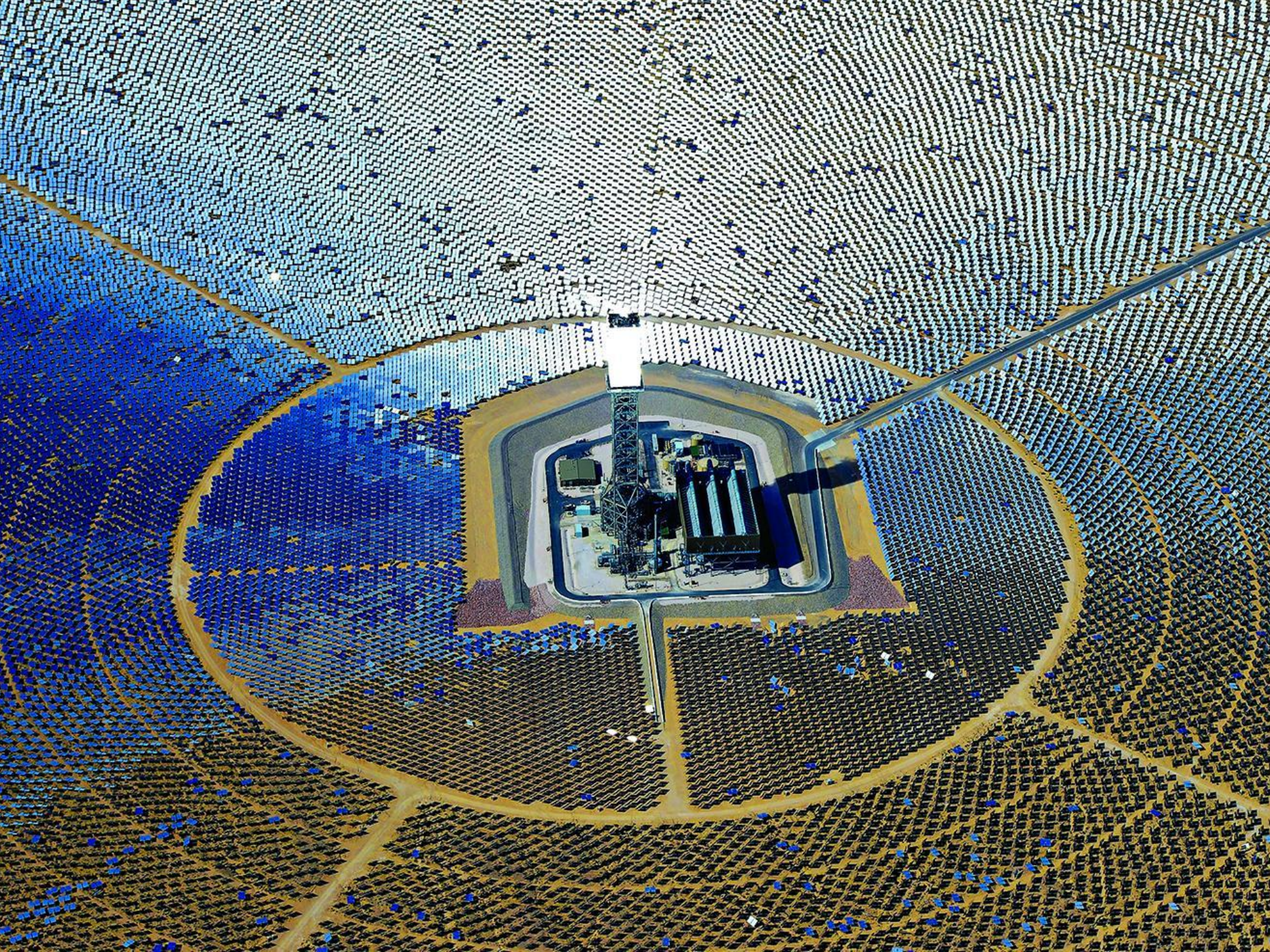
100 TERAWATTS

EARTH'S POWER CONSUMPTION WILL INCREASE SUBSTANTIALLY THIS CENTURY



Population Projections: United Nations "Long-Range World Population Projections: Based on the 1998 Revision"
Energy Projections: "Global Energy Perspectives" ITASA / WEC

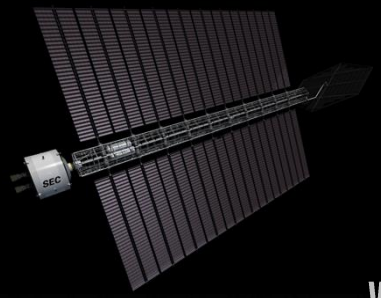
G7 COUNTRIES AGREE TO PHASE OUT FOSSIL FUELS BY 2100



EXCEPT NOW IMAGINE THESE SOLAR FARMS IN SPACE.

CAPTURING SOLAR ENERGY IN SPACE IS 10-40 TIMES MORE EFFICIENT.

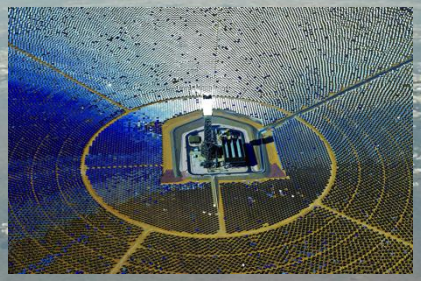
GEOSTATIONARY ORBIT
36,000 km



1,440

WATTS PER M^2

-DAY-NIGHT CYCLE
-ATMOSPHERIC LOSSES
-SUNLIGHT ANGLE



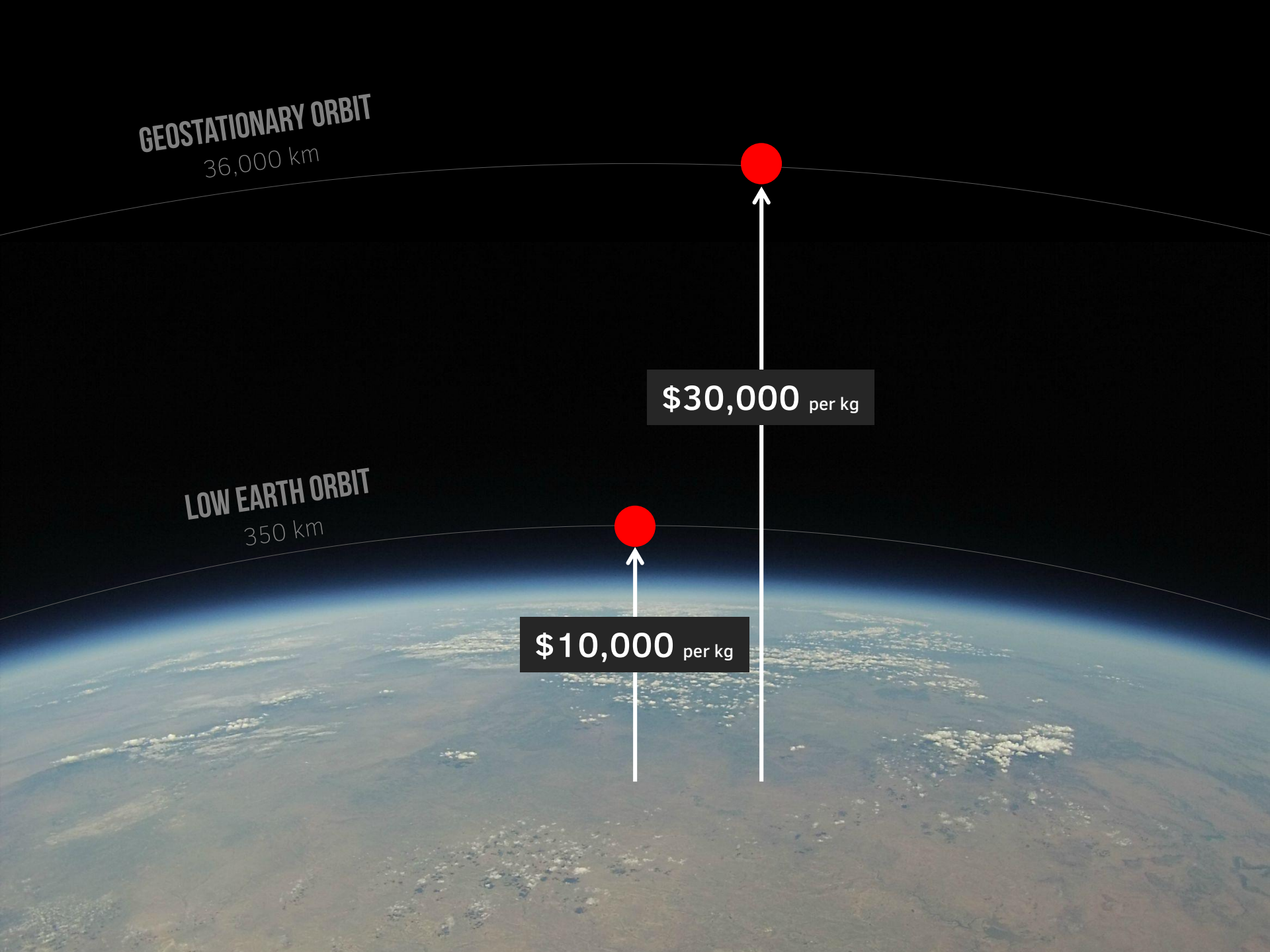
36-144

WATTS PER M^2


WE'LL NEED 10-40X LESS
INFRASTRUCTURE

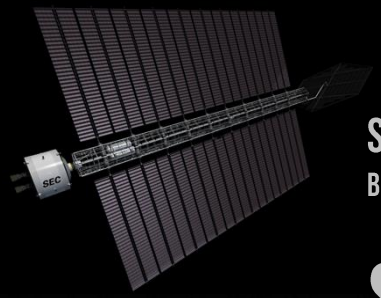
#1: ELECTRICITY FOR 10 BILLION PEOPLE
#2: EXCESS POWER FOR WATER DESALINATION
#3: 100X INFORMATION BANDWIDTH

“GREAT. EXCEPT...
IT WILL NEVER HAPPEN.”


GEOSTATIONARY ORBIT
36,000 km
$30,000 per kg
LOW EARTH ORBIT
350 km
$10,000 per kg

TRANSPORTING INFRASTRUCTURE UP FROM EARTH IS PROHIBITIVELY EXPENSIVE.

GEOSTATIONARY ORBIT
36,000 km



SOLAR FARMS IN GEO
BUILT ON & LAUNCHED FROM EARTH

$30 TRILLION CAPEX

$30,000 per kg

“WELL, MAYBE ONE DAY,
WHEN LAUNCH COSTS DROP BY 95%...”

OR...

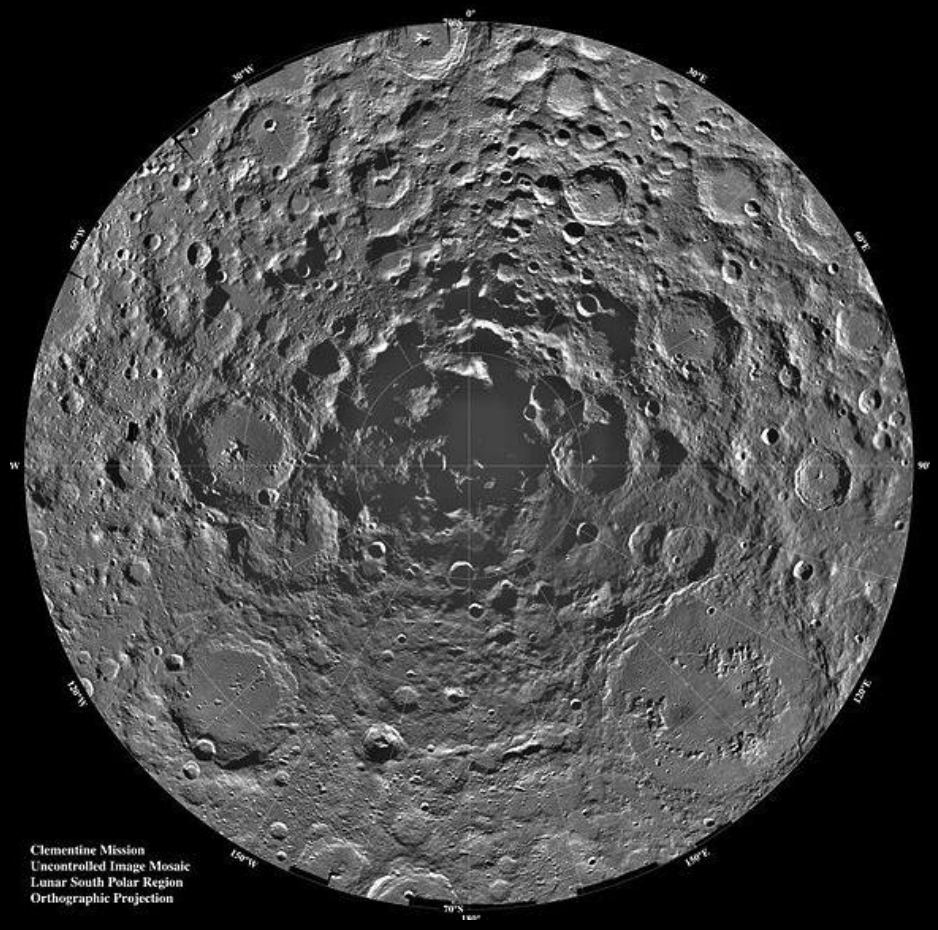
WE THINK BIGGER,
IN SYSTEMS AND
DOWN, NOT UP.

WE HAVE THE RIGHT RESOURCES ON THE MOON.

1.6 BILLION TONS OF WATER ICE
FOR FUEL

+

99% OF MASS MATERIALS FOR
SOLAR POWER SATELLITES



USING LUNAR RESOURCES TO BUILD SOLAR POWER STATIONS MAKES THE IDEA ECONOMICALLY VIABLE.

GEOSTATIONARY ORBIT
36,00 km

MOON
385,000 km

$30,000 per kg → ← $250 per kg

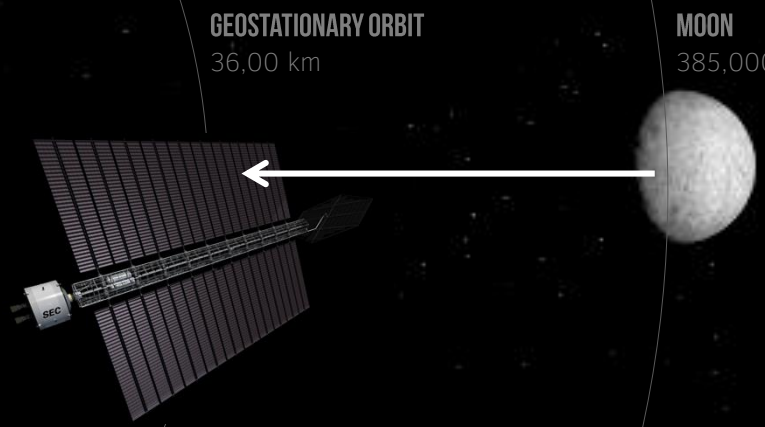
SOLAR STATIONS
BUILT ON & LAUNCHED FROM EARTH

$30 TRILLION CAPEX

SOLAR STATIONS
BUILT ON & LAUNCHED FROM THE MOON

$0.17 TRILLION CAPEX

WE CAN SOLVE WORLD'S ENERGY, WATER AND INTERNET CHALLENGES IN ONE GO.



Solar stations, doubling as communications platforms in geostationary orbit (36,000 km above Earth's surface) are the cleanest, most efficient and most elegant way to supply 30 terawatts of power to 10 billion people by 2100. Excess power can be used to desalinate water. Gigabit internet trunk communications can be modulated on to the transmission beam. The addressable market for this combined infrastructure by 2050 will be almost $3 trillion for wholesale electricity alone.

ECONOMIC VALUE OF THE MOON:

$250 PER KG TRANSPORTATION COST TO GEO

WE WILL PROCEED IN THREE PROGRAMS.

2015-2023

PROGRAM 1

Fuel Station & Lunar Supply Chain

Estimated cost $18 billion

2024-2030

PROGRAM 2

Manufacturing on the Moon

Estimated cost $40 billion

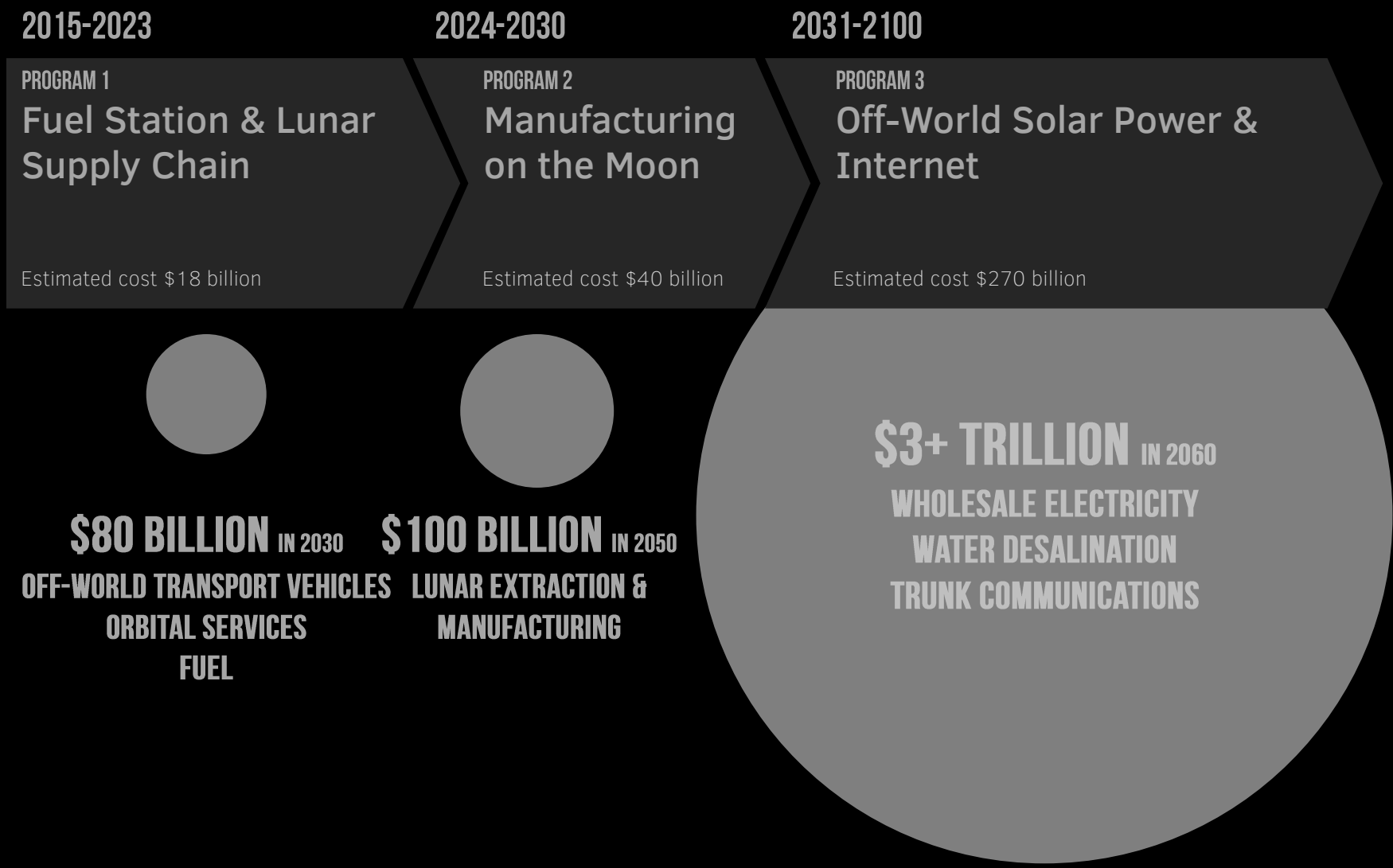
2031-2100

PROGRAM 3

Off-World Solar Power & Internet

Estimated cost $270 billion

EACH PROGRAM WILL CREATE NEW MARKETS.



WE'LL USE LUNAR RESOURCES
FOR THE COMMON BENEFIT OF ALL HUMANKIND.

WE WILL USE THE INCOME STREAM OF PROGRAM 1 TO FUND THE REST.

2015-2023

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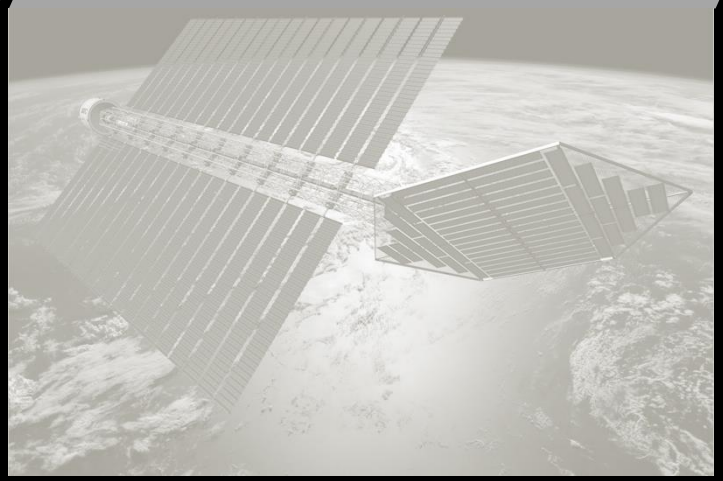


IT HAS BEEN LONG TIME IN THE MAKING.

2015-2023

PROGRAM 1

Fuel Station & Lunar Supply Chain

Estimated cost $18 billion

20 YEARS IN THE MAKING

The SEC team have been working on the concept of Program 1 beginning in 1995 when the Clementine mission reported detection of water ice on the South Pole of the Moon. Water ice in the deep, cold trap craters represented an opportunity to generate large quantities of rocket propellant by splitting water into hydrogen and oxygen and use it to re-fuel spacecraft in the space between the Moon and low Earth orbit (LEO).

4,000 MAN-YEARS OF EXPERIENCE

Since 2007, Program 1 has been carefully planned—technically and commercially—drawing on contributions from hundreds of experts with the combined aerospace and mining experience of ~4,000 man-years.

THE GOAL IS TO CREATE FUEL STATIONS WITH A LUNAR SUPPLY CHAIN.

FUEL STATION

EXTRACT WATER TO MAKE FUEL

LOW EARTH ORBIT
350 km

GEOSTATIONARY ORBIT
36,000 km

MOON
385,000 km

PROGRAM 1 WILL CREATE TWO REVENUE-GENERATING ASSETS.

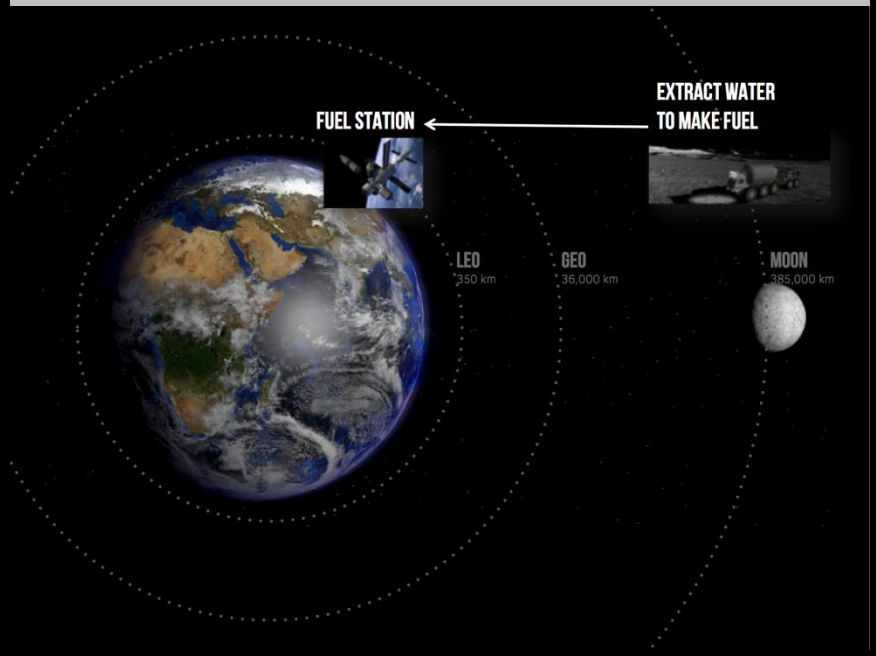
Asset #1:

Fuel station in LEO with a lunar supply chain of fuel

1,040

METRIC TONNES OF FUEL

Total annual production capacity of SEC's lunar supply chain, consisting of 71 spacecraft and lunar modules.



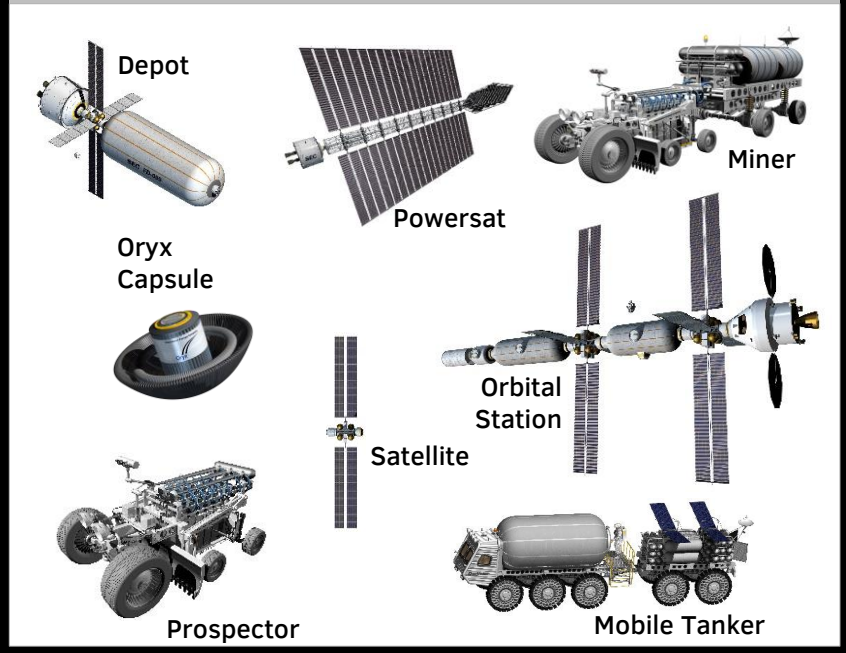
Asset #2:

Production line for a new generation of reusable spacecraft

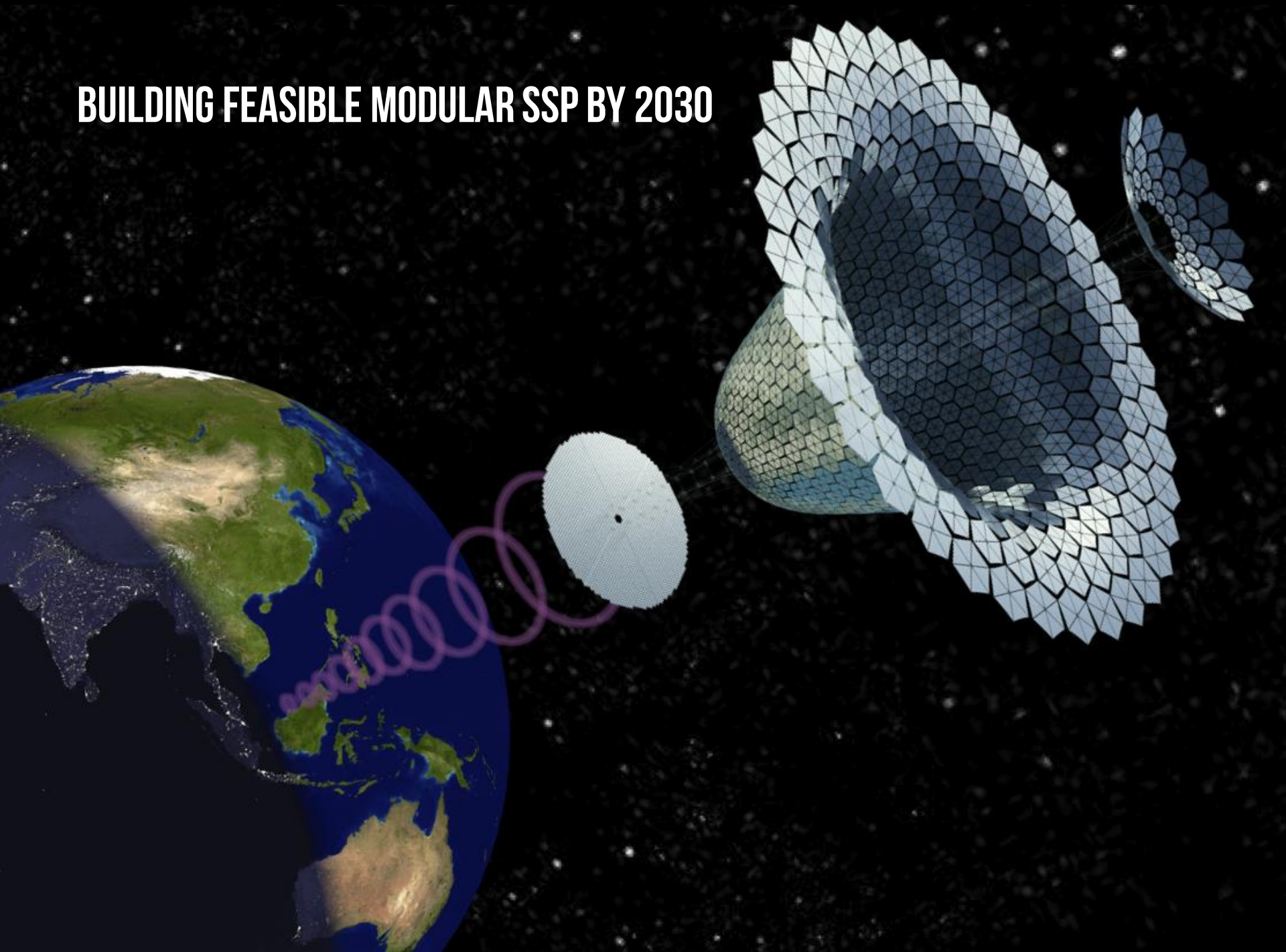
30

SPACECRAFT

Total annual production capacity of facilities used to produce SEC's new generation of modular, reusable and refuelable spacecraft and modules.

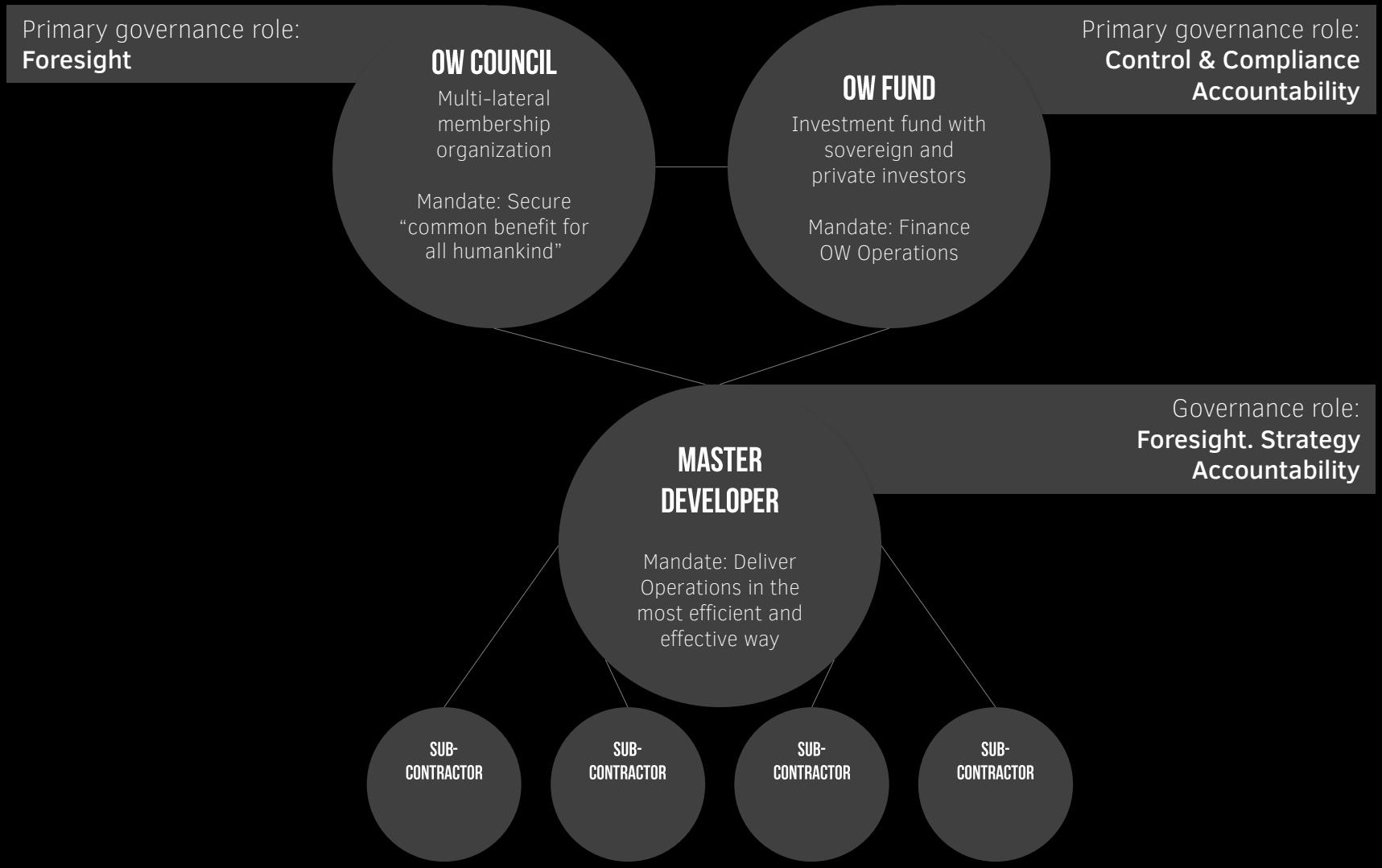


BUILDING FEASIBLE MODULAR SSP BY 2030



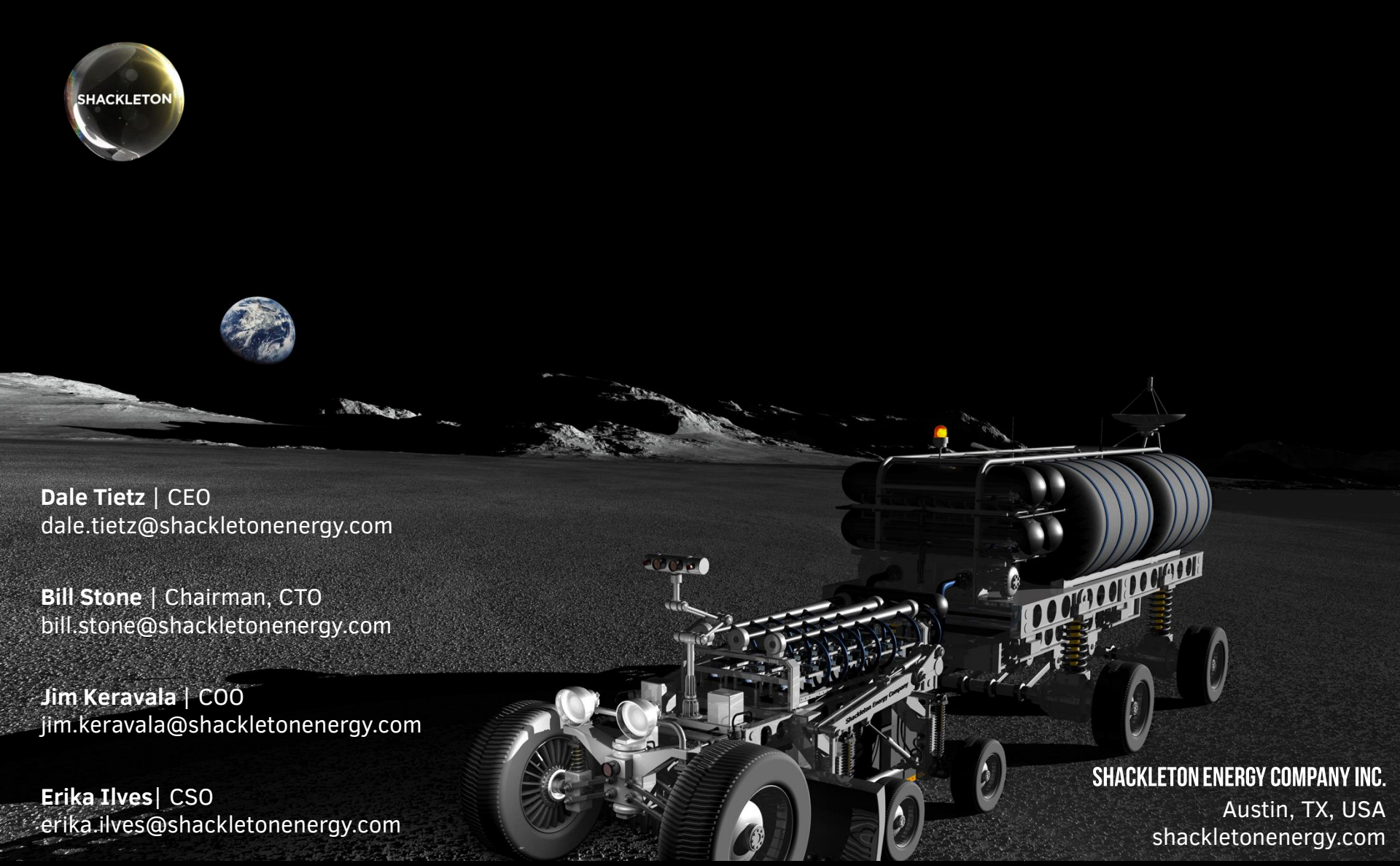
THREE GUIDING OPERATING SYSTEMS

GOVERNANCE FRAMEWORK FOR OFF-WORLD CONSORTIUM



USING LUNAR RESOURCES
TO SCALE SPACE BASED SOLAR POWER THIS CENTURY

OFF-WORLD CONSORTIUM
LAUNCHING 2016



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