

World War II in Europe 1939–1941



- ✈ Germany had virtually no petroleum deposits
- ✈ All war waging machinery were exceedingly dependent on gasoline and Diesel for mil ops
- ✈ HOW DID GERMANY SUSTAIN WAR EFFORTS ?



World War II in Europe 1939–1941



- ✈ It had abundant coal reserves
- ✈ By 1930 developed technology to produce synthetic fuel from coal
- ✈ Between 1930-1940 built over 12 chemical plants
- ✈ 15% fuel for war came from non-crude source



BOB PALMER
SPRINGFIELD (MO.) LEADER-PRESS
BOB PALMER
Courtesy Springfield (Mo.)
Leader-Press

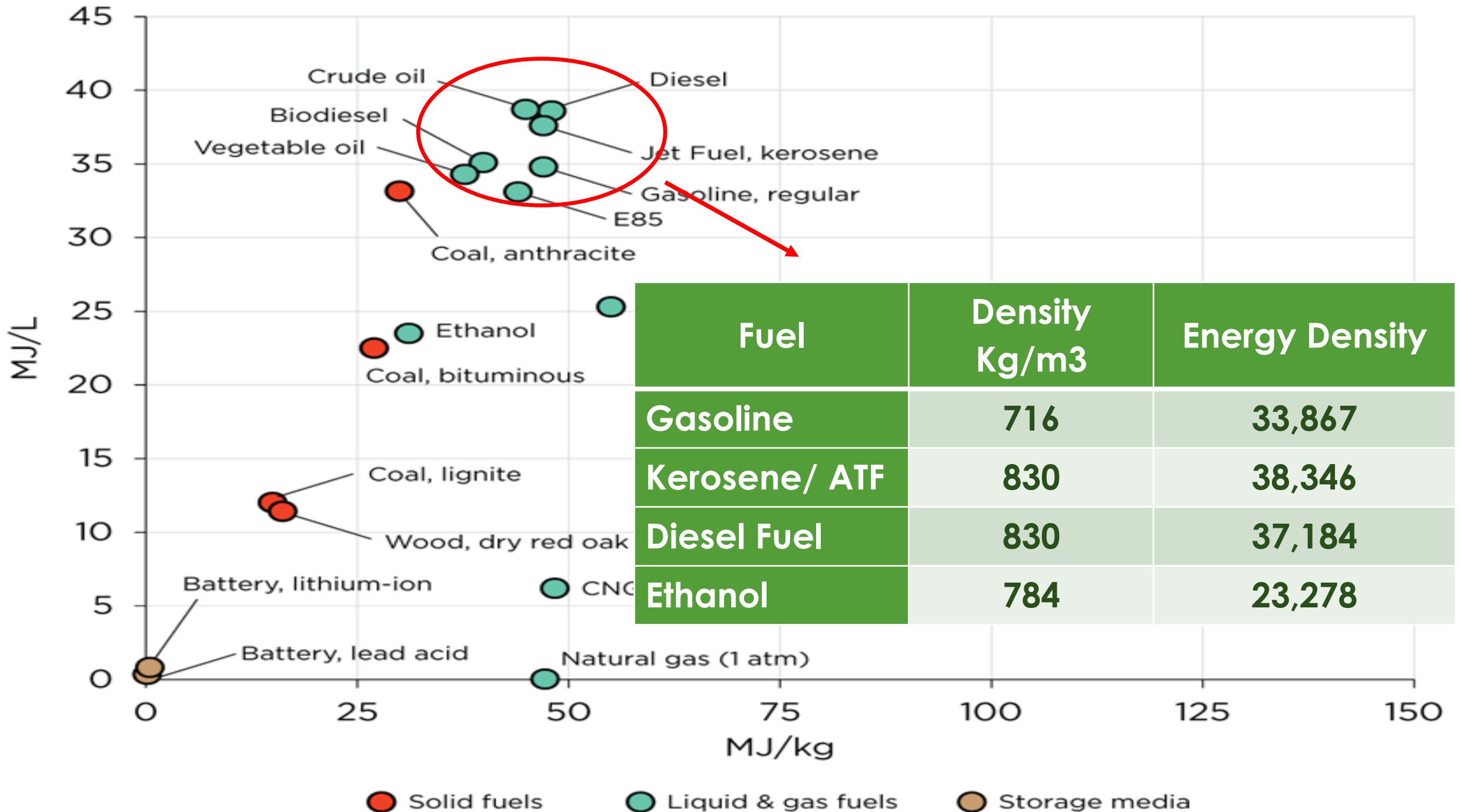
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ENERGY SECURITY

*Developing
Aviation
Biofuel for
Military
Aviation*

Why Bio-jet fuel for IAF ?

- Energy security- reduce import
- Fossil fuel centric to Military operations
- Enrich farmer- Fuel from waste
- Promote indigenisation- foster research & development





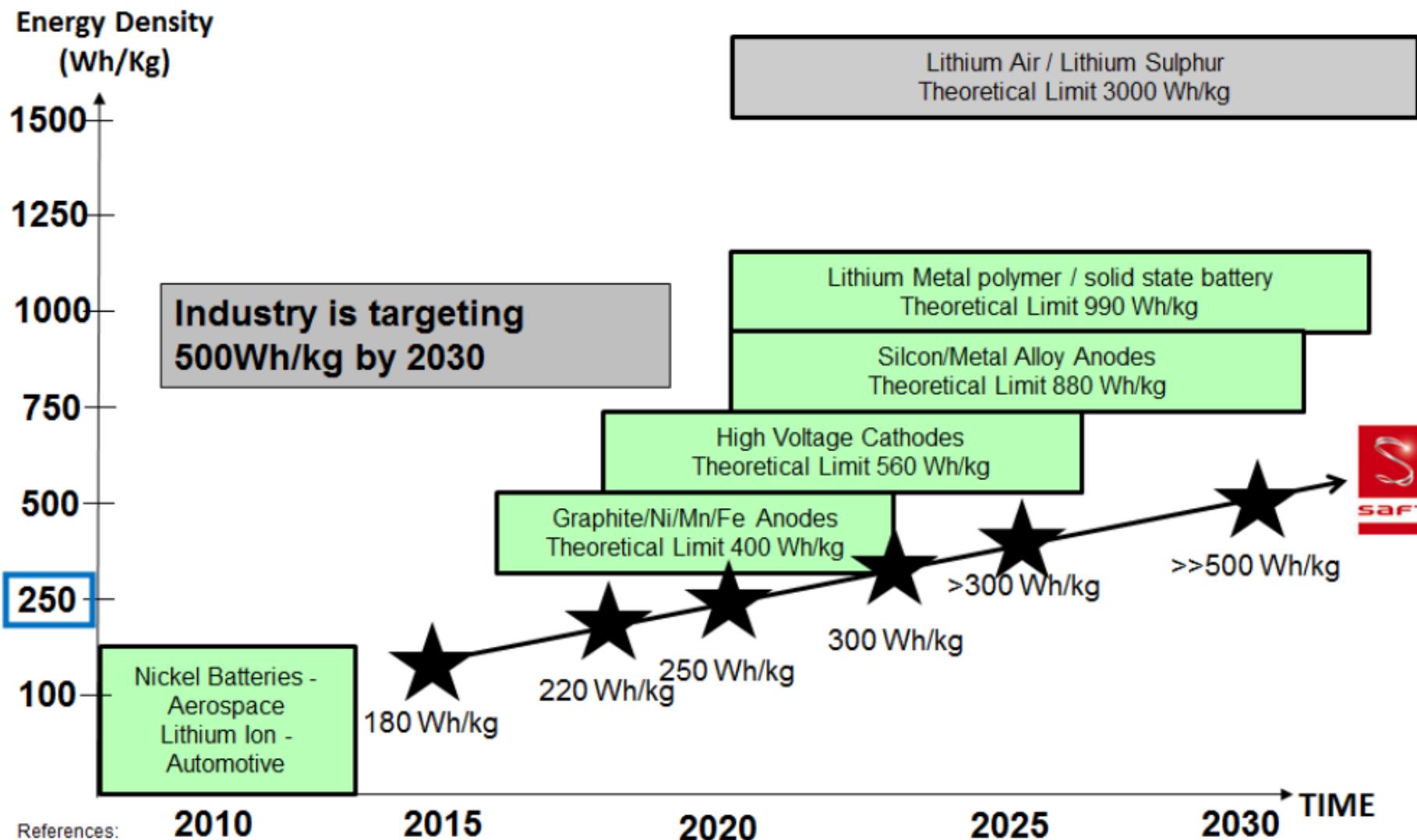
Battery Capability

Where Power Density is Key (Combat) the Gas Turbine will Continue to Dominate

The latest military gas turbines are 20 times more power dense than today's battery solutions

Kerosene: 12,000 Wh/kg

GT Burning Kerosene: 5,500 Wh/kg



References:

1. Argonne National Laboratory – US DoE

2. Batteries: Key Elements to the Success of More Electric Aircraft – Holger Schuh, Saft GmbH - Electric & Hybrid Aerospace Symposium 2015



Military Flights

Airforce/Navy	Aircraft / War machine	Location	Country	Date	Remarks
US Air Force	A10 Thunderbolt II	Eglin AFB, Florida	USA	25-Mar-10	First test flight with both engines fueled by 50/50 biofuel blend
US Navy	F/A-18 Green Hornet	Patuxent River, Maryland	USA	22-Apr-10	First supersonic flight with engines fueled by 50/50 biofuel blend
"Royal Netherland Air Force"					
	Boeing AH-64D Apache Helicopter	Gilze-Rijen AFB	Netherlands	16-Jun-10	First helicopter flight using 50/50 biofuel
US Air Force	C-17 Globemaster III	Edwards AFB, California	USA	27-Aug-10	
US Air Force	F 15 III Strike Eagle	Eglin AFB, Florida	USA	22-Oct-10	
US Navy	MH-60S Sea Hawk Helicopter	Patuxent River, Maryland	USA	Nov 18,2010	First helicopter flight in U.S. using 50/50 blend of camelina-based aviation biofuel
US Air Force	F 22 Raptor	Edwards AFB, California	USA	18-Mar-11	U.S. military's most advanced combat aircraft flown at Mach 1.5 on 50/50 biofuel blend
US Air Force	F 15 E Strike Eagle	Seymour Johnson AFB, North Carolina	USA	1-Apr-11	Formation flight. One of four aircraft fueled with 50/50 biofuel blend
US Navy	MH-60S Sea Hawk Helicopter	Patuxent River, Maryland	USA	May 20,2011	First military aircraft to fly on algal-based jet fuel
US Air Force	F 16 Thunderbirds Demonstration	Joint Base Andrews, Maryland	USA	20-May-11	USAF Thunderbirds became the U.S. military's first aerial performance team to fly on biofuel
US Navy	MV-22 Osprey	Patuxent River, Maryland	USA	10-Aug-11	U.S. Marine Corps tilt rotor aircraft fueled by 50/50 biofuel blend
US Navy	T-45C Goshawk	Patuxent River, Maryland	USA	24-Aug	
US Navy	The Blue Angels F/A-18 Hornets	Patuxent River, Maryland	USA	Sept 3-4, 2011	All six aircraft fueled with 50/50 biofuel blend
US Navy	AV-8B Harrier	China Lake, California	USA	21-Sep-11	
US Navy	MQ-8B Fire Scout	Webster Field, Maryland	USA	30-Sep-11	First unmanned biofuel flight using a MQ-8B Navy Fire Scout

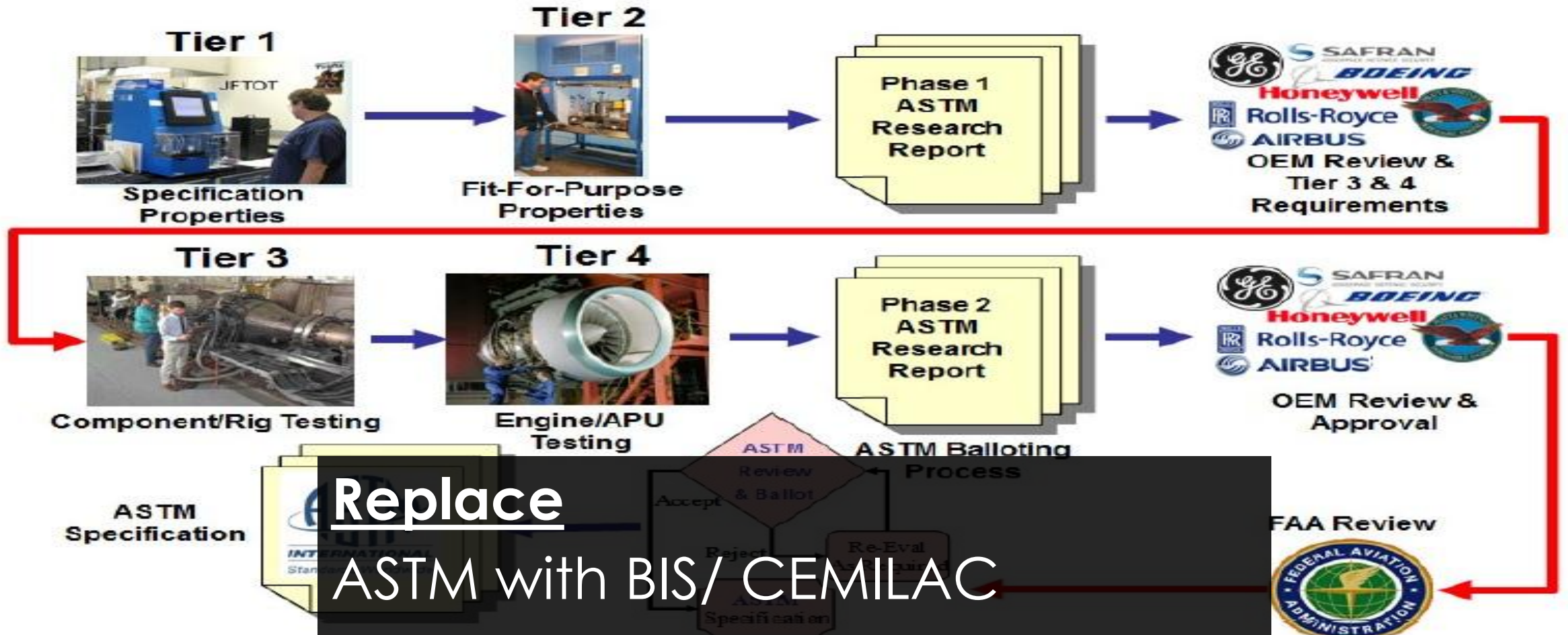
IAF's STRATEGY

- ✈ IAF has over 1800 aircraft including fighter, transport, helicopter and trainer
- ✈ Consumes over 80 Cr Itrs of ATF annually
- ✈ Offered use of military infrastructure to develop, test and certify the use of indigenous bio-jet fuel
- ✈ At 10% bio-jet blend, IAF would require Eight Crs Its
- ✈ Immediate monthly demand 10 KL
- ✈ Increasing gradually to 30,000KL/ month
- ✈ **Assist civil aviation to achieve global emission targets**

ROADMAP TO INDIGENISATION

- ✈ Funded a program to test bio-jet fuel on military aircraft
- ✈ Developed the Indian Standard for Synthetic Fuel IS:17081 in-line with ASTM D7566
- ✈ Designed testing methodology similar to ASTM D4054 for evaluation & approving aviation fuel
- ✈ Tested and certified indigenous technology for military and civil use

FAA RECOMMENDED TESTING PROCEDURE



Replace

ASTM with BIS/ CEMILAC

FAA with DGAQA/ DGCA

OEM with ASTE/ BRD

D4054 Qualification Process



STAGES IN TESTING AND CERTIFICATION OF INDIAN BIO-JET

RECENT DEVELOPMENTS

- ✈ Lands an AN-32 aircraft at Leh in extreme cold weather conditions
- ✈ Both engines powered with 10% Indian Bio-jet mix
- ✈ Aircraft takes-off after remaining parked in -40°C and snowy condition
- ✈ Performance at par with conventional jet A1
- ✈ Pioneering demonstration, not yet replicated by any aviator
- ✈ **Proves confidence of IAF in home grown technology**



GLIMPSES OF TRIAL AT LEH



HIGHLIGHTS

- ✈ Flown over 30 hrs on bio-jet fuel mix
- ✈ Consumed over 450 KL of indigenous fuel
- ✈ Tested for compliance - entire flight envelop for military operations
- ✈ **Feedstock sourced from tribal areas of Chhattisgarh and waste from edible oil industry of Andhra Pradesh**

WAY FORWARD

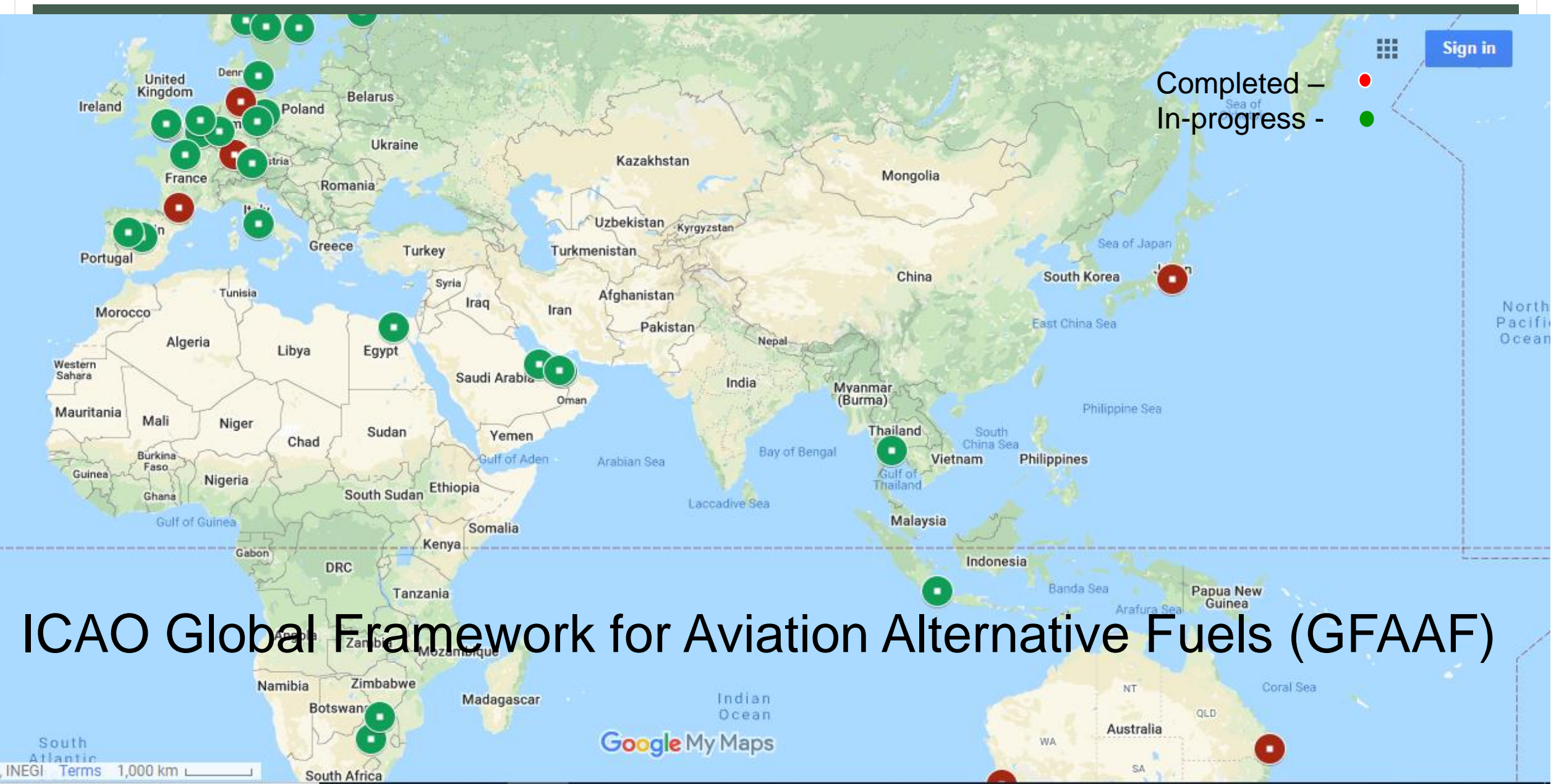
- ✈️ Test and certify bio-jet produced using homegrown technology partnered with MSME/ agri-based industries
- ✈️ Performance evaluation on Russian aircraft
- ✈️ Commercial production with Praj Industries.
- ✈️ Technology CORSIA compliant for Indian civil aviation
- ✈️ **IAF ready to nurture aviation technologies for Indian industry**

STATUS CHECK- INDIAN AVIATION

- ✈ Fastest growing domestic market
- ✈ Projected passenger growth rate - 6.1%
- ✈ Target to hit 350 Million Air Px Journey
- ✈ Poised to become 3rd largest Air Px market
- ✈ Consumed 8.3 MMT of ATF (2018-19)
- ✈ Produced from imported crude
- ✈ Contributes 2% net Greenhouse Gas emission

STATUS CHECK- INDIAN AVIATION

- ✈️ OMC's sold 8.3MMT of ATF
- ✈️ Conventional Jet A1 more expensive in India than Middle East, South Asia & Africa
- ✈️ OMC's not producing CORSIA eligible fuel
- ✈️ International route operators will demand CORSIA eligible fuel from Jan 2021
- ✈️ SAF supply base developing in Thailand, Indonesia, UAE, Botswana, etc



Completed – ●
In-progress - ●

ICAO Global Framework for Aviation Alternative Fuels (GFAAF)

Google My Maps

Recommendations

- Indigenous technologies for bio-jet could foster growth
- India blessed with abundant sunshine, wide variety of vegetation and ample farm waste
- Oil refineries develop/ co-produce bio-jet fuel
- Indian Jet Fuel not listed as CORSIA eligible fuel
- May recede fuel sales on International routes
 - **Need to reduce Research to Commercialization gestation period**
 - **IAF ready to manage this change**



**AN-32 formation over Rajpath
26 Jan 19**



**AN-32 Taking-Off from Leh on
31 Jan 20**

THANK YOU