

Yearbook on Space Policy

Cenan Al-Ekabi
Blandina Baranes
Peter Hulsroj
Arne Lahcen *Editors*

Yearbook on Space Policy 2015

Access to Space and the Evolution of
Space Activities

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European Space Policy Institute

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Yearbook on Space Policy

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Yearbook on Space Policy

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Preface

The market for launchers and launch services has developed rapidly over the last decade. More competitive markets, sectoral reforms, changing policies, and institutional changes are all affecting the playing field that determines our access to space. What is more, recent innovation dynamics, increasing private involvement, and a continuing trend of globalization will be impacting the launch sector and what we launch even more in the future. In the mid-term, it is expected that these changes will lead to significant cost reductions in bringing payloads to the different Earth orbits and even beyond. In order to clarify and shed additional light on these expected impacts of these trends, ESPI has decided to focus on the topic of access to space and the evolution of space activities from a wide variety of angles in its Yearbook on Space Policy 2015.

Traditionally, the first part of the Yearbook sets out a comprehensive overview of the economic, political, technological, and institutional trends that affected space activities in 2015. It is prepared in-house in ESPI and while its perspective is European, it also provides a comparative analysis of space developments around the world.

The second part of the ESPI Yearbook approaches the overall theme from an analytical perspective. This year it includes ten external contributions that bring together the views of eminent professionals and experts coming from different branches of the space sector. The first contributions in this part of the Yearbook offer a panoramic perspective on the elements that ultimately define how other space activities are affected in the long run. This starts with a contribution by CNES Director of Launchers Jean-Marc Astorg, who presents an overview of the state-of-the-art capabilities of the European launching sector and their outlook. Following this, Cristina Chaplain, Director in the U.S. Government Accountability Office, explains how the commercial space sector in the United States is currently affecting governmental space programs. Subsequently, the future potential of new space activities is explored in a contribution by Richard DalBello, Vice President Business Development and Government Affairs at Virgin Galactic. Subsequent contributions take the assumption of declining launch cost in the future

a step further, as they assess the impact of falling launch costs on various aspects of space utilization. In this respect, Eurisy Secretary General Stefaan de Mey explores the future potential of space applications. This is followed by a contribution written by Professor Shuang-Nan Zhang of the Chinese Academy of Sciences on the potential impacts of what he coined “efficient access to space” on space astronomy and scientific progress. Leopold Summerer, Head of the ESA Advanced Concepts Team, offers an outlook on the evolution of other enabling and game-changing space technologies that might fundamentally impact the status quo of human activities in outer space. The final contributions in Part II of the Yearbook address the evolving needs in terms of governance, strategies, and approaches that will arise in the playing field of space anno 2030. Young researchers Nina Witjes (Scientific Researcher at the Munich Center for Technology in Society), Philipp Olbrich (PhD Student at the Rijksuniversiteit Groningen), and Isabella Rebasso (Trainee at the Austrian Institute for International Affairs) write about how future remote sensing capabilities might impact transparency building and create a new landscape for various societal activities. Professors James Schwartz (Department of Philosophy, Wichita State University, USA) and Tony Milligan (Department of Theology and Religious Studies, King’s College London, UK) then present their views on the main ethical constraints on near-Earth resource exploitation in a wide sense. The European options to deal with the prospect of falling cost of utilizing space are explored by Jesse Phaler, Head of the Industrial Return Management Office at ESA. Finally, Staffordshire University professor and Head of Research at the British Royal Aeronautical Society Keith Hayward sheds light on the transition to a new business model in the launcher markets and its economic implications.

The third part of the Yearbook continues the character of the Yearbook as an archive of space activities. Again prepared in-house by ESPI, a bibliography, chronology, and data about institutions are provided where readers of the now nine volumes of the Yearbook can identify statistical developments and evolutions.

In closing, we would like to thank the contributors of the articles in Part Two for their engagement in this publication. Moreover, we are very grateful to Frances Brown, former editor-in-chief of Space Policy and current member of the ESPI Advisory Council, for her support and inspiration as we prepared the ESPI Autumn Conference 2015. The contributions in Part II of the Yearbook reflect the presentations made by the authors at the Autumn Conference.

Vienna, Austria

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List of Acronyms: Acronym Explanation

#

21AT Twenty-First Century Aerospace Technology Co.

A

A3R Arkyd 3 Reflight
AAD Advanced Air Defence
ABS Asia Broadcast Satellite
ACS Alcântara Cyclone Space
ADF Aerospace Defence Forces
ADM Atmospheric Dynamics Mission
AG Aktiengesellschaft
AI Artificial intelligence
AIA Atmospheric Imaging Assembly
Airbus D&S Airbus Defence and Space
AIS Automatic Identification Satellites
AMS Alpha Magnetic Spectrometer
ARM Asteroid Redirect Mission
ASAT Anti-Satellite
ASI Agenzia Spaziale Italiana (Italian Space Agency)
ASL Airbus Safran Launchers
ASNARO Advanced Satellite with New System Architecture for Observation
AST Office of Commercial Space Transportation
ATK Alliant Techsystems Inc.
ATV Automated Transfer Vehicle
AU Astronomical unit

B

BAES BAE SYSTEMS
BMD Ballistic Missile Defence

C

CAA	Civil Aviation Authority
CAGR	Compound Annual Growth Rate
CALET	CALorimetric Electron Telescope
CALT	China Academy of Launch Vehicle Technology
CASC	China Aerospace Science and Technology Corp.
CAST	China Academy of Space Technology
CATS	Cheap Access To Space
CBERS	China-Brazil Earth Resources Satellite
CCME	Central Command for Maritime Emergencies
CD	Conference on Disarmament
CERN	Conseil Européen pour la Recherche Nucléaire (European Organization for Nuclear Research)
CGWIC	China Great Wall Industry Corporation
CHF	Swiss franc
CIRS	Composite Infrared Spectrometer
CLA	Centro de Lançamento de Alcântara (Alcântara Launch Center)
CME	Coronal Mass Ejections
CMSA	China Manned Space Agency
CNES	Centre National d'Études Spatiales (French Space Agency)
COP	Conference of the Parties
COPUOS	Committee on the Peaceful Uses of Outer Space
CPM	Conference Preparatory Meeting
CRS	Commercial Resupply Services
CSA	Canadian Space Agency
CSLCA	Commercial Space Launch Competitiveness Act

D

DAMPE	Dark Matter Particle Explorer
DARPA	Defense Advanced Research Projects Agency
DARS	Digital Audio Radio Service
DBS	Direct Broadcast Services
DG	DigitalGlobe
DHN	Digital Humanitarian Network
DLR	Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Center)
DoD	Department of Defence
DPAC	Data Processing and Analysis Consortium
DRDO	Defence Research and Development Organisation
DSI	Deep Space Industries
DTH	Direct To Home

E

EARSC	European Association of Remote Sensing Companies
EATS	Efficient Access to Space
EBITDA	Earnings Before Interest, Taxes, Depreciation and Amortization
EC	European Commission
ECA	Evolution Cryotechnique type A
ECB	European Central Bank
ECMWF	European Centre for Medium-Range Weather Forecasts
EDA	European Defence Agency
EDC	Export Development Canada
EDM	Entry, Descent and Landing Demonstrator Module
EDRS	European Data Relay Satellite System
EELV	Evolved Expendable Launch Vehicle
EFS	Equator-Facing Slopes
EGNOS	European Geostationary Navigation Overlay Service
EIP	European Innovation Partnership
ELIRG	Extremely luminous infrared galaxies
EMG	Environment Management Group
EMSA	European Maritime Safety Agency
EO	Earth Observation
EPS-SG	European Polar System Second Generation
ESA	European Space Agency
ESA DG	ESA Director General
ESOA	European Satellite Operators Association
EU	European Union
EUMETSAT	The European Organisation for the Exploitation of Meteorological Satellites
EUSC	European Union Satellite Centre
EUTELSAT	European Telecommunications Satellite Organisation
EVE	EUV Variability Experiment
Ex-Im Bank	U.S. Export-Import Bank

F

FAA	Federal Aviation Administration
FSS	Fixed Satellite Services
FWF	Austrian Science Fund
FY	Fiscal Year

G

GAO	Government Accountability Office
GCR	Galactic Cosmic Rays
GDP	Gross Domestic Product
GEO	Geostationary Earth Orbit

GEOSS	Group on Earth Observation System-of-Systems
GERD	Gross Domestic Expenditure on Research and Development
GLONASS	Globalnaya Navigatsionnaya Sputnikovaya Sistemya (Russian GNSS Constellation)
GmbH	Gesellschaft mit beschränkter Haftung
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
GSLV	Geosynchronous Satellite Launch Vehicle
GSSAP	Geosynchronous Space Situational Awareness Program
GTO	Geosynchronous Transfer Orbit

H

He3	Helium-3
HMI	Helioseismic and Magnetic Imager
HST	Hubble Space Telescope
HTV	H-2 Transfer Vehicle

I

IAC	International Astronautical Congress
IAEA	International Atomic Energy Agency
IAP	Integrated Applications Promotion
ICC	International Criminal Court
ICG	International Committee on Global Navigation Satellite Systems
ICoC	International Space Code of Conduct for Outer Space Activities
ICS	Information and Communication Systems
ICT	Information and Communications technology
IGS	International GNSS Service
ILS	International Launch Services
IMF	International Monetary Fund
IMT	International Mobile Telecommunication
IMU	Inertial Measurement Unit
INDC	Intended Nationally Determined Contribution
IOV	In-Orbit Validation
IRIS	Interface Region Imaging Spectrograph
IRNSS	India Regional Navigation Satellite System
ISA	International Seabed Authority
ISIS	Islamic State of Iraq and Syria
ISL	International Launch Services
ISRO	Indian Space Research Organization
ISS	International Space Station
IT	Information Technology
ITAR	International Traffic in Arms Regulations
ITU	International Telecommunication Union

IUVS Imaging Ultraviolet Spectrograph
 IXV Intermediate Experimental Vehicle

J

JAXA Japan Aerospace Exploration Agency
 JCPOA Joint Comprehensive Plan of Action
 JPS Joint Polar System
 JUICE Jupiter ICy moon Explorer

K

K2 Kepler 2
 KSA Kazakh Space Agency

L

L2 Earth-Moon Lagrange point on the opposite side of the Moon
 LEND Lunar Exploration Neutron Detector
 LEO Low Earth Orbit
 LHC Large Hadron Collider
 LOLA Lunar Orbiter Laser Altimeter
 LPW Langmuir Probe and Waves
 LRO Lunar Reconnaissance Orbiter
 LTS Large Technical Systems

M

MATS Mesospheric Airglow/Aerosol Tomography and Spectroscopy
 MAVEN Mars Atmosphere and Volatile Evolution (NASA)
 MDA MacDonald, Dettwiler and Associates Ltd.
 Melco Mitsubishi Electric Co.
 MENCA Mars Exospheric Neutral Composition Analyser
 MEO Medium Earth Orbit
 MESSENGER MErcury Surface, Space ENvironment, GEochemistry and Ranging
 Metop Meteorological Operational Satellite
 Metop-SG Metop Second Generation
 MFF Multiannual Financial Framework
 MFG Meteosat First Generation
 MMO Mercury Magnetospheric Orbiter
 MOD Ministry of National Defense
 MOKV Multi-object kill vehicle
 MOM Mars Orbiter Mission
 MPCV Multi-Purpose Crew Vehicle
 MPO Mercury Planetary Orbiter
 MRO Mars Reconnaissance Orbiter

MSG	Meteosat Second Generation
MSL	Mars Science Laboratory
MSM	Methane Sensor for Mars
MSS	Mobile Satellite Services
MTG	Meteosat Third Generation

N

NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organisation
NDAA	National Defense Authorization Act
NEA	Near-Earth Asteroids
NEC	Nippon Electric Company
NEO	Near-Earth Object
NEOWISE	Reboot of the Wide-field Infrared Survey Explorer mission to find NEOs
NER	Near-Earth Resources
NGA	National Geospatial-Intelligence Agency
NOAA	National Oceanic and Atmospheric Administration
NRO	National Reconnaissance Office
NTER	Thermal and Electric Nuclear Power

O

OCX	GPS Next Generation Operational Control System
OECD	Organisation for Economic Co-operation and Development
OGLE	Optical Gravitational Lensing Experiment
OHB	Orbitale Hochtechnologie Bremen
OSM	OpenStreetMap
OSTP	Office of Science and Technology Policy
OPEC	Organization of the Petroleum Exporting Countries

P

PAD	Prithvi Air Defense
PCP	Pre-Commercial Procurement
PFS	Pole-Facing Slopes
PGM	Platinum-Group Metals
PHA	Potentially hazardous asteroids
PLA	People's Liberation Army
PND	Portable Navigation Devices
PPI	Public Procurement of Innovative solutions
PPP	Public-Private Partnership
PPWT	Treaty on Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force Against Outer Space Objects
PROBA	PRoject for OnBoard Autonomy

PRS Public Regulated Service
 PSLV Polar Satellite Launch Vehicle

Q

QZSS Quasi-Zenith Satellite System

R

R&D Research and Development
 REID Risk of Exposure Induced Death
 RHESSI Ramaty High Energy Solar Spectroscopic Imager
 RKV Redesigned kill vehicle
 RLV Reusable Launch Vehicle
 Roscosmos Russian Federal Space Agency
 ROSINA Rosetta's Orbiter Spectrometer for Ion and Neutral Analysis
 RP15 Resource Protector
 RRS Regional Radiocommunication Seminar
 rSLV reusable Suborbital Launch Vehicles

S

SAFER Simplified Aid For EVA Rescue
 SAM Sample Analysis at Mars instrument
 SAR Synthetic Aperture Radar
 SBTF Standby Volunteer Task Force
 SDO Solar Dynamics Observatory
 SES Société Européenne des Satellites
 SIA Satellite Industry Association
 SLA Service Level Agreement
 SLI Sustainable Land Imaging
 SLS Space Launch System
 SM Standard Missile
 SME Small and Medium-sized Enterprises
 SNSB Swedish National Space Board
 SOHO SOLar and Heliospheric Observatory
 SPACE Act Spurring Private Aerospace Competitiveness and
 Entrepreneurship Act
 SpaceX Space Exploration Technologies
 SPE Solar Particle Events
 SS2 SpaceShipTwo
 SS/L Space Systems/Loral
 SSO Sun-synchronous orbit
 SSTL Surrey Satellite Technology Ltd.

STEM	Science, Technology, Engineering and Mathematics
STEREO	Solar TERrestrial RELations Observatory
SWF	Secure World Foundation
T	
TCBM	Transparency and Confidence Building Measures
TGO	Trace Gas Orbiter
THEMIS	Thermal Emission Imaging System
TPP	Trans-Pacific Partnership
TRL	Technology Readiness Level
U	
UAV	Unmanned Aerial Vehicle
UCAR	University Corporation for Atmospheric Research
UK	United Kingdom
ULA	United Launch Alliance
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDSS	United Nations Department of Safety and Security
UNFCCC	United Nations Framework Convention on Climate Change
UNGA	United Nations General Assembly
UNGIWG	United Nations Graphic Information Working Group
UNIDIR	United Nations Institute for Disarmament Research
UNOOSA	United Nations Office for Outer Space Affairs
UNPSA	United Nations Programme on Space Applications
UNSC	United Nations Security Council
UNSDI	United Nations Spatial Data Infrastructure
UN-SPIDER	United Nations Platform for Space-based Information for Disaster Management and Emergency Response
URSC	United Rocket and Space Corporation
US	United States of America
USAT	Ultra Small Aperture Terminals
USMDA	Missile Defense Agency
V	
VKO	Russian Aerospace Defence Forces
VMC	Venus Monitoring Camera
VSAT	Very Small Aperture Terminals
W	
WGP	World Gross Product
WISE	Wide-field Infrared Survey Explorer
WRC	World Radiocommunication Conference

Part I
The Year in Space 2015

Chapter 1

European Space Activities in the Global Context

Cenan Al-Ekabi

1.1 Global Political and Economic Trends

1.1.1 Global Economic Outlook

The United Nations Annual Report “World Economic Situation and Prospects” reported a slight stumble in global growth by the end of 2015, as the persistent effects of the financial crisis in 2007 continued to discourage investment and global growth. In mid-2015, the growth of World Gross Product (WGP) was estimated to be 2.8 %, yet weak aggregate demand, falling commodity prices and increasing financial market volatility in major economies resulted in a year-end revision of WGP growth to 2.4 %.¹

Developed economies contributed more to WGP growth, reaching a 1.9 % increase in global output in 2015; they will likely continue to pick up momentum in 2016, surpassing 2 %, which has not been seen since 2010. In the eurozone, new EU Members showed the most growth at 3.2 %, while Western European economies continued to be the main drivers of growth in the region with 1.8 % for 2015; and the European Union as a whole reached 1.9 % for 2015. U.S. growth in global output reached 2.4 % in 2015, in line with the 2.4 % in 2014, and is expected to contribute more in 2016. Japan’s global output also increased by 0.5 % in 2015, a notable change from the 0.1 % decrease in 2014; Japan’s GDP growth should reach 1.3 % in 2016.²

¹“World Economic Situation and Prospects 2016.” 30 Nov. 2015. United Nations 20 June 2016 <http://www.un.org/en/development/desa/policy/wesp/wesp_current/2016wesp_full_en.pdf>.

²Ibid. at 2.

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Growth slowed in developing and transition economies to 3.8 % and –2.8 % respectively in 2015, due to the earlier-mentioned headwinds (i.e. sharply lower commodity prices, large capital outflows, and increased financial market volatility). While China may have contributed to a reduction of growth in East and South Asia, the region will likely remain the fastest growing as many of the region’s economies will benefit from importing low-cost oil, metals, and food commodities. In contrast, Russia and Brazil were mired in severe economic downturns, accompanied by elevated inflation, reaching –3.8 % and –2.8 % in 2015 respectively.³

Generally less restrictive fiscal and still accommodative monetary stances worldwide are likely to support WGP growth by 2.9 % in 2016 and 3.2 % in 2017. That increased growth is also predicated on the easing of downward pressures on commodity prices and on the anticipated pace of normalization of the United States monetary policy stance that should help to reduce policy uncertainties. Yet, amid the moderate pace of global growth and in an environment of weak investment, employment figures continue to fall short of closing the gap in the employment rate that had opened up during the global financial crisis. In developed economies, particularly in the euro area, the pattern of work has been shifting towards more part-time employment, which raises concerns about job security, working poverty, and low long-term earnings. Moreover, given the sharp economic slowdown and declining labour force participation in several economies in the developing world, masked by large informal sectors in these regions, employment opportunities in the developing world for 2015 are likely to have deteriorated. The persistence of these factors may undermine the United Nations 2030 Agenda for Sustainable Development, which focuses on promoting “inclusive and sustainable economic growth, employment and decent work for all”.⁴

1.1.2 Political Developments

1.1.2.1 Geopolitics

A number of significant world events in 2015 remained unresolved by year’s end.

While the United States sought to unseat Islamic State (ISIS) terrorists from occupied territory in Syria throughout 2015, Russia’s surprise airstrike intervention starting in September 2015 worked to muddle the operation, as the U.S. targeted ISIS forces while Russian counterparts aimed at Syrian rebel groups seeking to oust Syria’s President and long-time Russian ally, Bashar al-Assad. Russia’s military operations were not coordinated with the U.S. and its allies which raised concerns of unintended confrontations, such as on 24 November when Turkish F-16s shot

³Ibid.

⁴“World Economic Situation and Prospects 2016.” 30 Nov. 2015. United Nations 20 June 2016: 1–8 <http://www.un.org/en/development/desa/policy/wesp/wesp_current/2016wesp_full_en.pdf>.

down a Russian Su-24 fighter jet following repeated warnings not to fly over Turkish airspace.⁵ As the campaign went on throughout the year, ISIS terrorists also managed to carry out attacks in France, Turkey, and in the United States.⁶ France experienced its first shock at the beginning of 2015, when gunmen attacked its satirical magazine Charlie Hebdo offices and a Jewish supermarket in Paris on 7 January 2015.⁷ On 13 November 2015, three suicide bombings took place outside the Stade de France stadium during a football match while other ISIS fighters attacked young concertgoers, resulting in a death toll of 130 people, with another 351 injured.⁸ In Turkey, a suicide-bomber with reported links to ISIS killed a group of 32 youth activists on 22 July 2015,⁹ while in the United States, a self-radicalized couple killed 14 people and wounded another 21 in California on 4 December 2015.¹⁰

In Europe, Greece's debt crisis came back into the spotlight at the beginning of 2015 with the election of Syriza party leader Alexis Tsipras, who pledged to renegotiate the terms of the 240 billion euros (\$268 billion) bailout Greece received in 2010 in the wake of the financial crisis.¹¹ His anti-austerity position worried investors and euro-zone supporters, and following a series of negotiations with Europe's so-called 'Troika' (EU, IMF, and ECB) and a 4-month extension of the bailout to 30 June 2015, it became apparent that Greece might default on its June payment if it did not receive an infusion of cash from the final bailout instalment. The deadline was not met, and with Greek banks closed along with the threat of financial collapse and complete exit from the euro zone looming, Tsipras agreed to the Troika's conditions on measures, including taxes and pensions, along with intensive international oversight in order to qualify for the aid.¹² Yet even with its course correction, Greece's struggles with its bailout looked to be headed toward

⁵"Turkey's downing of Russian warplane – what we know." 1 Dec. 2015. BBC News 23 June 2016 <<http://www.bbc.com/news/world-middle-east-34912581>>.

⁶Lindsay, James M. "Top Ten Most Significant World Events in 2015." 15 Dec. 2015. Council on Foreign Relations 22 June 2016 <<http://blogs.cfr.org/lindsay/2015/12/15/ten-most-significant-world-events-in-2015/>>.

⁷"Charlie Hebdo attack: Three days of terror." 14 Jan. 2015. BBC News 23 June 2016 <<http://www.bbc.com/news/world-europe-30708237>>.

⁸Fuller, Jaime. "Paris Attacks Death Toll Rises to 130." 20 Nov. 2015. New York Magazine 23 June 2016 <<http://nymag.com/daily/intelligencer/2015/11/paris-attacks-death-toll-rises-to-130.html>>.

⁹"Suruc massacre: 'Turkish student' was suicide bomber." 22 July 2015. BBC News 23 June 2016 <<http://www.bbc.com/news/world-europe-33619043>>.

¹⁰Schmidt, Michael S., and Richard Pérez-Peña. "F.B.I. Treating San Bernardino Attack as Terrorism Case." 4 Dec. 2015. The New York Times 23 July 2016 <<http://www.nytimes.com/2015/12/05/us/tashfeen-malik-islamic-state.html>>.

¹¹"Greece election: Syriza leader Tsipras vows to end austerity 'pain'." 26 Jan. 2015. BBC 22 June 2016 <<http://www.bbc.com/news/world-europe-30978052>>.

¹²Daley, Suzanne and Liz Alderman. "Premier of Greece, Alexis Tsipras, Accepts Creditors' Austerity Deal." 13 July 2015. The New York Times 22 June 2016 <<http://www.nytimes.com/2015/07/14/world/europe/greece-debt-plan.html>>.

another ‘Grexit’ scenario from the eurozone near the end of the year,¹³ just as Europe was faced with a wave of refugees escaping the calamity in Syria and nearby regions.¹⁴

Early in 2015, an unprecedented influx of migrants began crossing the Mediterranean and travelling through the Balkans to enter Europe—sometimes at their peril.¹⁵ In addition to violence in Iraq and Afghanistan, and abuses in Eritrea, the ongoing conflict in Syria became the biggest driver of migration in the year, amounting to a total of more than one million migrants coming by sea and land; by comparison, 280,000 migrants had entered Europe by sea and land in 2014.¹⁶ More than 800,000 people crossed by sea from Turkey to Bulgaria and Greece—half of whom were Syrian asylum seekers—other migrants travelled by water to Spain and Italy from Morocco, Tunisia, Libya, and Egypt, while just 34,000 migrants crossed by land to Bulgaria or Greece travelling from Turkey.¹⁷ European countries struggled with the influx, sparking divisions in the EU on how best to deal with resettling people; Germany alone received more than 476,000 asylum applications in 2015. As tensions rose in the EU due to the disproportionate burden placed on some of its member states, ministers had to find a way to relocate and integrate refugees throughout Europe; of the 292,540 asylum applications approved in 2015, 48.2 % were granted by Germany, 11.0 % Sweden, 10.1 % Italy, 7.1 % France, 5.6 % Netherlands, 4.8 % UK, with the remaining 13.3 % granted by other EU member states.¹⁸

Iran and the five permanent members of the United Nations Security Council¹⁹ (UNSC) plus Germany (P5+1) reached a long awaited agreement on scaling back Iran’s Nuclear Programme on 14 July 2015. In development since 2003, the agreement, known as the Joint Comprehensive Plan of Action (JCPOA), was endorsed by the UNSC by 20 July 2015.²⁰ Yet, concerns over the JCPOA’s viability existed while the agreement underwent a 60-day Congressional Review Period in

¹³Khan, Robert. “Greece’s Bailout Dead End.” 9 Nov. 2015. Council on Foreign Relations 23 June 2016 <<http://blogs.cfr.org/kahn/2015/11/09/greeces-bailout-dead-end/>>.

¹⁴Lindsay, James M. “Top Ten Most Significant World Events in 2015.” 15 Dec. 2015. Council on Foreign Relations 22 June 2016 <<http://blogs.cfr.org/lindsay/2015/12/15/ten-most-significant-world-events-in-2015/>>.

¹⁵“European leaders fret over porous borders.” 12 Mar. 2015. CBS News 23 June 2016 <<http://www.cbsnews.com/news/eu-borders-isis-migrants-refugees-smuggling-human-trafficking-libya/>>.

¹⁶“Migrant crisis: Migration to Europe explained in seven charts.” 4 Mar. 2016. BBC News 23 June 2016 <<http://www.bbc.com/news/world-europe-34131911>>.

¹⁷“Migrant crisis: One million enter Europe in 2015.” 22 Dec. 2015. BBC News 23 June 2016 <<http://www.bbc.com/news/world-europe-35158769>>.

¹⁸“Migrant crisis: Migration to Europe explained in seven charts.” 4 Mar. 2016. BBC News 23 June 2016 <<http://www.bbc.com/news/world-europe-34131911>>.

¹⁹Namely China, France, Russia, the United Kingdom, and the United States.

²⁰Williams, Jennifer R. “A comprehensive timeline of the Iran nuclear deal.” 21 July 2015. The Brookings Institution 22 June 2016 <<http://www.brookings.edu/blogs/markaz/posts/2015/07/21-comprehensive-timeline-iran-nuclear-deal>>.

the U.S., during which Republicans in both the House and Senate sought unsuccessfully to block the agreement through various motions.²¹ In return for sanctions relief, Iran has agreed to give up 97 % of its stockpile of enriched uranium, cut its number of centrifuges by two-thirds, shut down a heavy water reactor, and allow onsite inspections by the International Atomic Energy Agency (IAEA), with some provisions lasting into 2040.²²

China continued to rapidly form seven new islands, piling sand dredged from the ocean floor on what were previously coral reef beds in the Spratly Island region of the South China Sea. Those new islands are among a number of other nearby islands claimed by the Philippines, Malaysia, Vietnam, Brunei and Taiwan, and appear to be meant more for asserting China's territorial claims in the region, as demonstrated by sustained Chinese air and sea patrols of the area, than to support large military units.²³ China also claimed the 12 nautical miles surrounding each island as its exclusive territorial waters; a position China's neighbours contested, and the U.S. considers has no basis in international law.²⁴ At the heart of their concern is whether China will try to use the islands to choke off freedom of navigation in that strategic area where more than \$5 trillion in trade passes through each year, while also containing rich fisheries and the potential for vast oil and mineral deposits.²⁵ That prospect seems particularly unsettling for the U.S. which has about \$1.2 trillion in trade travelling through the South China Sea each year, and which also in October finally reached an agreement on the Trans-Pacific Partnership (TPP) trade deal with 11 other Pacific Rim nations (including Canada, Mexico, Peru, Chile, Japan, Vietnam, Malaysia, Brunei, Singapore, Australia, and New Zealand).²⁶ If approved by the U.S. Congress, the TPP would set trade rules that govern roughly 40 % of the global economy.²⁷

²¹Demirjian, Karoun. "Senate rejects attempt to derail Iran deal in victory for Obama." 10 Sept. 2015. The Washington Post 22 June 2016 <<https://www.washingtonpost.com/news/powerpost/wp/2015/09/10/senate-set-to-vote-on-iran-nuclear-deal/>>.

²²Lindsay, James M. "Top Ten Most Significant World Events in 2015." 15 Dec. 2015. Council on Foreign Relations 22 June 2016 <<http://blogs.cfr.org/lindsay/2015/12/15/ten-most-significant-world-events-in-2015/>>.

²³Watkins, Derek. "What China Has Been Building in the South China Sea." 27 Oct. 2015. The New York Times 23 June 2016 <<http://www.nytimes.com/interactive/2015/07/30/world/asia/what-china-has-been-building-in-the-south-china-sea.html>>.

²⁴Lindsay, James M. "Top Ten Most Significant World Events in 2015." 15 Dec. 2015. Council on Foreign Relations 22 June 2016 <<http://blogs.cfr.org/lindsay/2015/12/15/ten-most-significant-world-events-in-2015/>>.

²⁵Glaser, Bonnie S. "Conflict in the South China Sea." 7 Apr. 2015. Council on Foreign Relations 23 June 2016 <<http://www.cfr.org/asia-and-pacific/conflict-south-china-sea/p36377>>.

²⁶Calmes, Jackie. "Trans-Pacific Partnership Is Reached, but Faces Scrutiny in Congress." 5 Oct. 2015. The New York Times 23 June 2016 <<http://www.nytimes.com/2015/10/06/business/trans-pacific-partnership-trade-deal-is-reached.html>>.

²⁷Lindsay, James M. "Top Ten Most Significant World Events in 2015." 15 Dec. 2015. Council on Foreign Relations 22 June 2016 <<http://blogs.cfr.org/lindsay/2015/12/15/ten-most-significant-world-events-in-2015/>>.

1.1.2.2 Environment

The 21st UN Framework Convention on Climate Change Conference of Parties (UN FCCC/COP), which took place in Paris, France from 30 November to 12 December 2015, reached a landmark agreement among 195 Parties on 12 December 2015.²⁸ The Paris Agreement aims to keep global average temperature increases to below 2 °C above pre-industrial levels, and to make more ambitious efforts to limit the temperature increases even further to 1.5 °C and eliminate the increase of greenhouse gas emissions in the second half of the century.²⁹ Around 188 countries contributed intended nationally determined contributions (INDCs), essentially national climate action plans that that will be updated and enhanced every 5 years—the next occurring in 2020. The members will also continue to address mitigation and adaptation opportunities, in addition to developing a clear roadmap for obtaining \$100 billion in climate funding by 2020, while also setting another \$100 billion floor before 2025.³⁰ Yet for now, the requirements of the Paris Agreement are non-binding until 30 days after the date on which at least 55 Parties accounting in total for at least an estimated 55 % of total global greenhouse gas emissions have deposited their instruments of ratification, acceptance, approval or accession³¹; reaching that goal will be challenging without having China, the U.S. or the EU on board, which together account for 45 % of the world's greenhouse emissions.³² And while the regular review and submission of emission reduction targets and the \$100 billion fund from developed economies to help emerging and developing nations decarbonise their energy mix will be binding, each country's INDC targets will not be binding.³³

²⁸“OUTCOMES OF THE U.N. CLIMATE CHANGE CONFERENCE IN PARIS | 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 21) November 30-December 12, 2015.” 12 Dec. 2015. Centre for Climate and Energy Solutions 24 June 2016 <<http://www.c2es.org/international/negotiations/cop21-paris/summary>>.

²⁹“The Paris agreement marks an unprecedented political recognition of the risks of climate change.” 12 Dec. 2015. The Economist 24 June 2016 <<http://www.economist.com/node/21683990/>>.

³⁰UN Climate Change Newsroom. “Historic Paris Agreement on Climate Change | 195 Nations Set Path to Keep Temperature Rise Well Below 2 Degrees Celsius.” 12 Dec. 2015. UNFCCC 24 June 2016 <<http://newsroom.unfccc.int/unfccc-newsroom/finale-cop21/>>.

³¹United Nations Framework Convention on Climate Change | Conference of the Parties. Adoption of the Paris Agreement, Held in Paris from 30 November to 11 December 2015. UN Doc. FCCC/CP/2015/L.9/Rev.1 of 12 December 2015. United Nations (Annex | Paris Agreement, Article 21.1).

³²Kinver, Mark. “COP21: What does the Paris climate agreement mean for me?” 14 Dec. 2015. BBC News 24 June 2016 <<http://www.bbc.com/news/science-environment-35092127>>.

³³Ibid.

1.1.2.3 Energy

There were increasing signs of change in global energy throughout 2015, following a steep drop in oil prices at the beginning of the year, along with corresponding fluctuations in other fuel prices in many parts of the world. Some signs of stability emerged, as mandatory energy efficiency regulations grew to cover more than 25 % of global consumption, and renewable energy contributed to almost half of the world's new power generation capacity in 2014. Yet energy demand is expected to grow by one-third over the period to 2040, with that increase driven mainly by India, China, and other non-OECD countries in Africa, the Middle East, and Southeast Asia. In contrast, the European Union is expected to decrease its consumption by 15 % over the period to 2040, followed by Japan by 12 %, and the U.S. by 3 %.³⁴

India is entering a period of rapid sustained growth, contributing around one quarter of the growth in global energy demand, including oil demand that was higher than any other country in 2015. Meanwhile, China has started to transition to a less energy-intensive phase in its growth, shifting from heavy industry to the service sector; it will be the largest oil-consuming country by the 2030s, and in 2040 its total energy demand will be nearly twice that of the United States. China and the Middle East were the drivers of natural gas demand growth in 2015, surpassing the European Union whose demand for natural gas peaked in 2010, yet the long-term supply of natural gas remains a concern, constrained by efficiency policies and deferred investment in the current low-price environment, which could bring tighter markets in the 2020s. Yet even with low oil prices, and the return of Iran into the hydrocarbon market, an estimated \$2.8 trillion of investment will be needed to meet projected energy demand in 2040.³⁵

China was both the world's largest producer and consumer of coal in 2015; it has also deployed more renewable power generation capacity than any other country. Moreover, India was the largest source of growth in global coal use in 2015, increasing the demand for coal in power generation and industry to almost half of the global energy mix for the year. India is now the second-largest coal producer in the world, and will overtake Japan, the EU and China as the world's largest coal importer by 2020. Yet renewable energy contributed nearly half of the world's new power generation capacity in 2014, and is projected to have a 50 % share of generation in the EU, around 30 % in China and Japan, and above 25 % in the U.S. and India by 2040. In order to meet the anticipated one-third growth in world energy demand by 2040, more renewable power generation capacity needs to be added.³⁶

³⁴“International Energy Agency. World Energy Outlook 2015 – Executive Summary” 10 Nov. 2015. IAE 3 Dec. 2015 <http://www.iea.org/publications/freepublications/publication/WEB_WorldEnergyOutlook2015ExecutiveSummaryEnglishFinal.pdf>.

³⁵Ibid.

³⁶Ibid.

1.1.2.4 Resources

The growth of international trade remained lacklustre continuing at a rate of 2.3 % in 2014, from 2.2 % in 2013; while initial estimates for 2015 expected the rate of growth of international trade to be close to that of global output (2.5 %), this is still well below the 4.0 % growth posted in the years immediately preceding the financial crisis.³⁷ Developed economies experienced considerable growth in the volume of imports, with the EU and Japan increasing 2.8 %, while the U.S. had an even higher increase of 4.7 % in part due to the increasing value of the dollar. The volume of exports from developed countries also showed signs of acceleration, with the biggest uptick in Japan, whose export growth of 0.6 % seemed to recover from a slump in previous years. Europe's exports to China and the U.S. also showed resiliency at 1.5 % growth, while U.S. exports have been showing signs of deceleration in recent years hovering at 3.1 %. By contrast, import volumes in transition economies dropped by 8.5 % in 2014, and were anticipated to have contracted even further in 2015, due mainly to the economic and financial difficulties involving Russia and Ukraine; and export volumes growth of 0.2 % showed almost no change from 2013. Developing economies also continued to show deceleration, of which only South Asia departed from the downward trend. Overall, developing countries' growth in volume of imports for 2014 slowed to 2.0 % from 6.1 % in 2013; their volume of exports had a similar outcome in 2014 growing by 2.9 % from 4.2 % in 2013.³⁸

By the start of 2015, crude oil prices had dropped to \$48 per barrel, dropping by 56.7 % from a monthly average of \$112 per barrel as at June 2014—lows not seen since 2009. According to the United Nations Conference on Trade and Development (UNCTAD), the plunge in prices was caused by greater global production, particularly by the United States' 15.9 % increase in shale oil production in contrast to 2.3 % increase by the rest of the globe in 2014. The U.S. had increased production by 50.6 % from 2011 until mid-2014, which helped to stabilize global oil prices during production disruptions in other countries, but this led to an oversupply when disruptions became less of a problem. Prices began to fall even quicker following OPEC's decision not to change production quotas in November 2014; that decision was upheld in OPEC's following meeting in June 2015, in effort to undercut higher cost—shale oil, tar sands, and deep-water oil producers. While prices increased to \$65 per barrel between the end of April and June 2015, by the end of 2015 the price of a barrel of oil dropped further to \$37.28 per barrel.³⁹

³⁷According to the latest data available from UNCTAD.

³⁸United Nations Conference on Trade and Development. Trade and Development Report, 2015. Geneva: UNCTAD, 2015. 1–18.

³⁹Friedman, Nicole. "U.S. Oil Prices End 2015 Down 30 % for the Year." 31 Dec. 2015. The Wall Street Journal 27 June 2016 <<http://www.wsj.com/articles/oil-prices-rise-but-supply-glut-caps-gains-1451560147>>.