Webinar Training:
Risk Assessment of Power Projects

Antonio Della Pelle
Enerdata Energy Consulting

19 April 2017

Outline

1. Introductions
2. Primary Energy & Electricity Forecasts
3. LCOE Trends
4. Renewables and Feed-In-Tariffs
5. Case Studies:
   a. Impact of nuclear restart on gas in Japan
   b. Small scale LNG in Indonesia
   c. Malaysia's future energy mix
6. ERI Intro
7. Benchmarking (Japan, Indonesia and Malaysia)
8. Conclusions

Enerdata

Enerdata Power & Gas Market Review

19 April 2017

8:00 a.m. Central European Time | 2:00 p.m. Singapore Standard Time

With the cost of renewables dropping each year, and with the need for additional energy capacity in regions such as Africa and Asia, having a rigorous methodology to identify areas of opportunities and risk is paramount. Enerdata's in-house Energy Risk Index (ERI) methodology can execute risk analysis for power related projects. The ERI methodology is capable of qualifying and quantifying market risks, allowing companies to efficiently take actions to prevent loss of capital.

Enerdata will discuss the outlook of global and regional energy trends, levelized cost of electricity trends, feed-in-tariff systems, benchmarking results between countries, and real case studies of power related projects including Malaysia, Indonesia and Japan.

During the webinar we will touch on the main elements that a feasibility study for a power project needs to cover, such as policy and regulatory assessment, market assessment and sizing, technology selection, economic analysis, and risk assessment. In the case studies we will assess how the energy trade balances and energy policies are designing the future fuel mix for power generation. In the Japan case study, we assess the nuclear restart, which of impacts liquefied natural gas (LNG) consumption in Japan and LNG prices globally (because Japan is a major global LNG importer). In the Indonesia case, the 1,000+ islands are a key factor in determining what power options are and are not feasible. In Malaysia, the absence of renewables presents a key dilemma for the future energy mix of the country, which is already experiencing a domestic oil and gas production shortage.

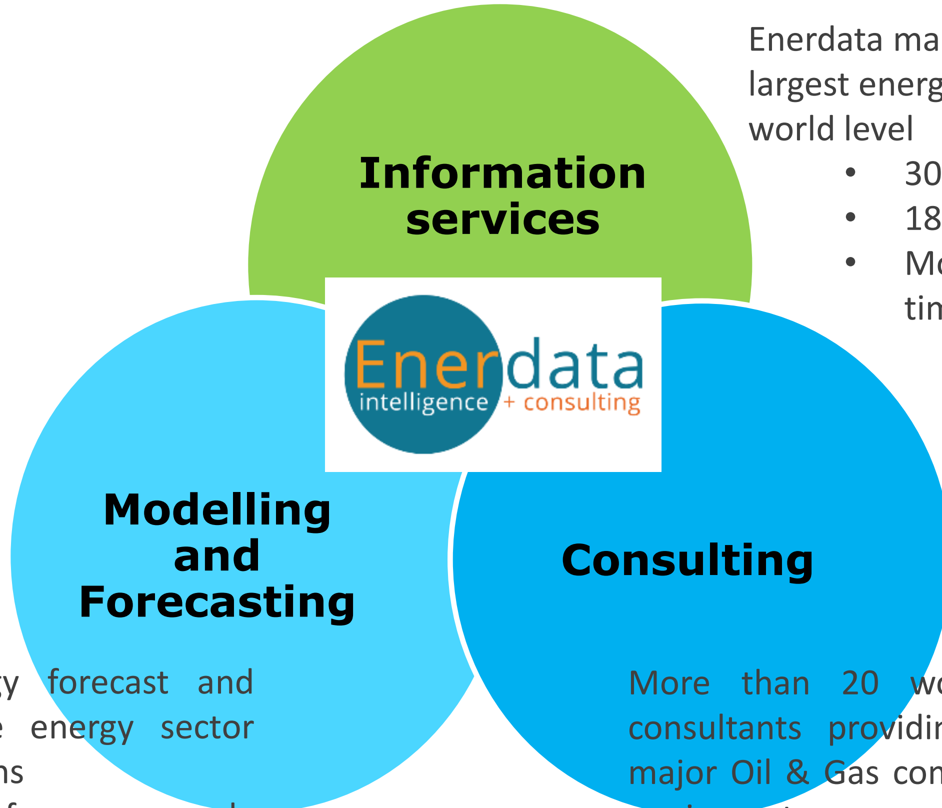
A 25 Years old global energy intelligence company

- **Independent** energy research & consulting company since 1991
- **Expert** in analysis and forecasting of global energy & climate issues
- **In-house** and globally recognized databases and forecasting models
- Headquartered in the Grenoble (French Alps) research cluster
- Offices in Paris, London and Singapore + network of partners World Wide
- **Global reach**: clients in Europe, Asia, Americas, Africa

A 25 Years old global energy intelligence company

Enerdata manages and updates the largest energy database existing at world level

- 300 different sources
- 186 countries
- More than 1000 annual time series



POLES is a global energy forecast and simulation model for the energy sector covering all countries/regions

- Complete accounting of energy supply and demand of all energy sources, associated technologies and greenhouse gases emissions
- Developed for over 20 years

More than 20 world recognized energy consultants providing advisory services to major Oil & Gas companies, electric utilities, equipment companies, banks and public organizations on

- Business Strategy
- Feasibility Study
- Market Study

A sample of our clients

Oil & Gas/Power Utilities/Equipment/Government/Research Institutions/Financial

Eni
REPSOL
enel
EDF
AREVA
AnsaldoEnergia
A Finmeccanica Company
CA
CREDIT SUISSE
Qatar Petroleum
e·on
ABB
Power and productivity
for a better world™
ALSTOM
WORLD BANK
PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY
TOTAL
PETRONAS
SIEMENS
JRC
EUROPEAN COMMISSION
GDF SUEZ
endesa
WÄRTSILÄ
vallourec
ADB
STATOIL
GAZPROM
KOGAS
RWE
DOOSAN
WORLD ENERGY COUNCIL

Antonio Della Pelle – Enerdata Managing Director

- Antonio is a chartered chemical engineer with 20 years of experience working in the Energy Industry. Antonio was the Project Director of the **Singapore Government** project related to **Energy Markets Review**, **Global Energy Outlook** and **Energy Policies Analysis**. In 2014, Antonio the **Bioenergy Advisor** for a SE Asia Government on a retainer basis. In addition, Antonio is part of the **expert panel on energy policies** to the **United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)**. He is also an advisor to **Asia Development Bank (ADB)** on **Energy Policies and Energy Markets**. Antonio is an expert in Industrial energy efficiency; energy policies, geopolitics and presented several papers in international forums. He created **business plan** for two **clean energy** start-ups company based in Singapore.
- He has experience in Energy Management implementation, management of change and is a qualified coach. He has a wide technical and managerial knowledge on energy market and energy policies implications.
- He has been living in Asia since 2003. He is graduated from L'Aquila University in Italy CMEng (1st class) Chemical Engineering and INSEAD BUSINESS SCHOOL Singapore, Supply Chain Management programme. Antonio is currently a member of the board of the IChemE Energy Centre (UK).

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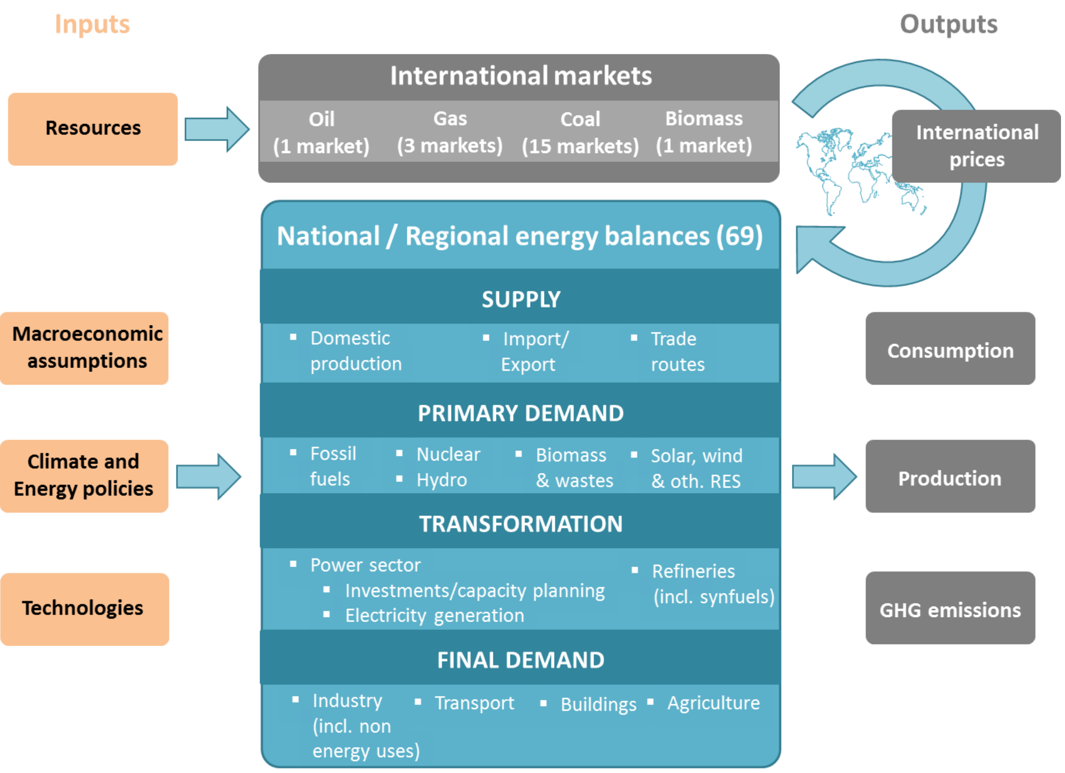
POLES – An integrated tool to assess the evolution of future energy systems

Main features

- Long-term energy demand & supply forecasts by country/region and commodity up to 2050 (-2100)
- Outlook for international oil, gas, and coal prices + end user prices (incl. power)
- Simulation of GHG emissions, analysis of abatement strategies
- Simulation of future technology developments in the energy sector

Structure and functions

- Yearly dynamic recursive, includes anticipation behaviours
- Energy balances for 66 countries/regions
- Disaggregation into 15 energy demand sectors, 50 energy-related technologies & technological learning
- Simulation of oil and gas : 88 countries
- Full power generation system
- Uranium & renewables resources



Issues and topics covered by POLES

Energy Demand

- 66 countries
- 15 detailed sub-sectors industry, buildings & transportation, incl. detailed description of large Energy Intensive Industries : steel, aluminium…
- All key energies: oil, gas, coal, power, biomass, solar, wind
- End consumer prices
- Detailed demand technology description (buildings, transport)
- Demand function based on activity levels, prices effects, autonomous technological change

Energy supply

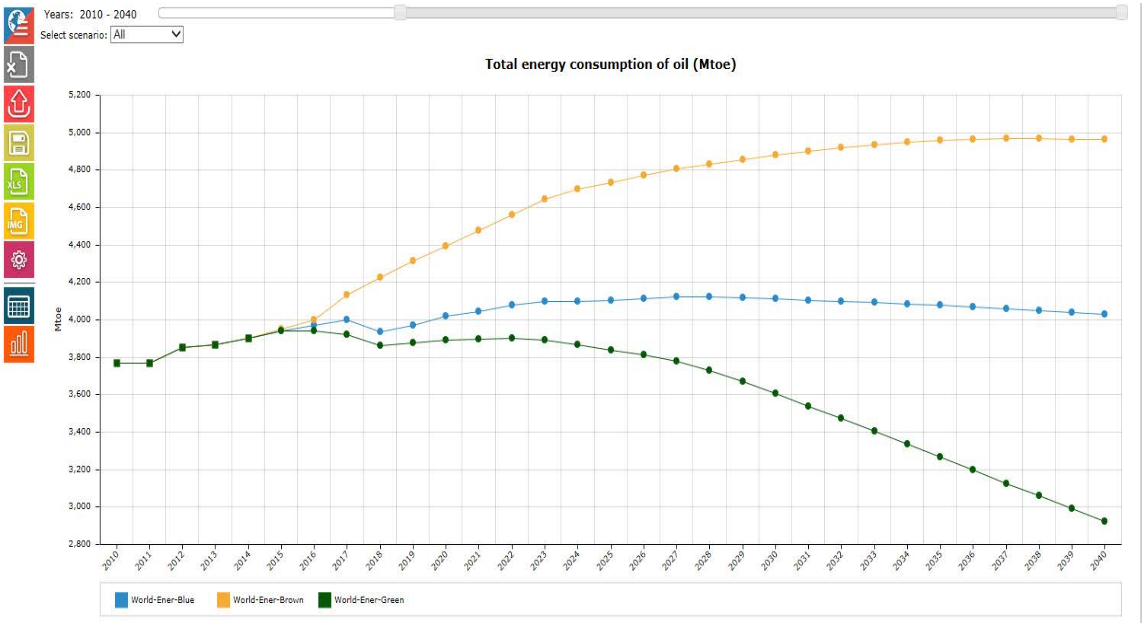
- Oil, gas, coal, and renewables
- Resources, discoveries and reserves for 88 producing countries
- Production strategies (countries)
- Unconventional oil and gas
- International and regional prices: oil, gas, coal, biomass
- Development potential for renewables
- Oil, gas, coal, and biofuels, imports & exports

Transformation

- 30 different power generation technologies
- Simulation of future power generation mix by country
- Power capacity planning
- Electricity load forecasting
- Power price analysis
- Technology availability scenarios: Nuclear revival or phase-out, CCS, wind & intermittency…
- Impact of support schemes for renewables (feed-in tariffs…)
- Hydrogen

EnerFuture online database

- Easy access to the complex, comprehensive and insightful POLES model !
- 24/7 online access
- Projections based on 3 Enerdata's contrasted scenarios
- Annual forecasts to 2040 of demand and prices by sector for all energies and CO_2 emissions
- Power mix forecasts to 2040 (capacities + production)
- 66 countries/regions
- Energy indicators
- Unlimited Excel exports
- Regular updates
- Enerdata assistance



Description of the EnerFuture scenarios

Ener-Blue	Ener-Green	Ener-Brown
CLIMATE & ENERGY POLICIES		
▪ **2030 NDCs targets achieved** ▪ **CO_2 emissions growth slow-down** ▪ **+3-4°C** temperature increase	▪ **Reinforcement** trend ▪ **NDCs** targets regularly **reviewed upwards** ▪ **+1.5-2°C** temperature increase	▪ **NDCs targets not reached** ▪ Soaring **CO_2 emissions** ▪ **+5-6°C** temperature increase
ENERGY DEMAND		
▪ **Increase** in developing countries ▪ Slightly decreasing in OECD ▪ **Controlled** through NDCs	▪ **Global stabilization** ▪ Ambitious **energy efficiency policies** ▪ **Regular updates** of efficiency targets	▪ **Gradual improvement** on energy intensity ▪ High growth in developing countries ▪ Upward trend in OECD too
ENERGY SUPPLY & PRICES		
▪ **Tensions** on available resources ▪ **Increasing energy prices** ▪ **Diversification** towards renewables	▪ Fossil fuel subsidies phase-out ▪ **Strong development** of **renewables** ▪ **Price increase** reflect policies and CO_2 constraints	▪ **Fossil fuels** renaissance ▪ Lower **energy prices** ▪ **Diffusion of unconventional** US "success story" ▪ Continued efforts on renewables

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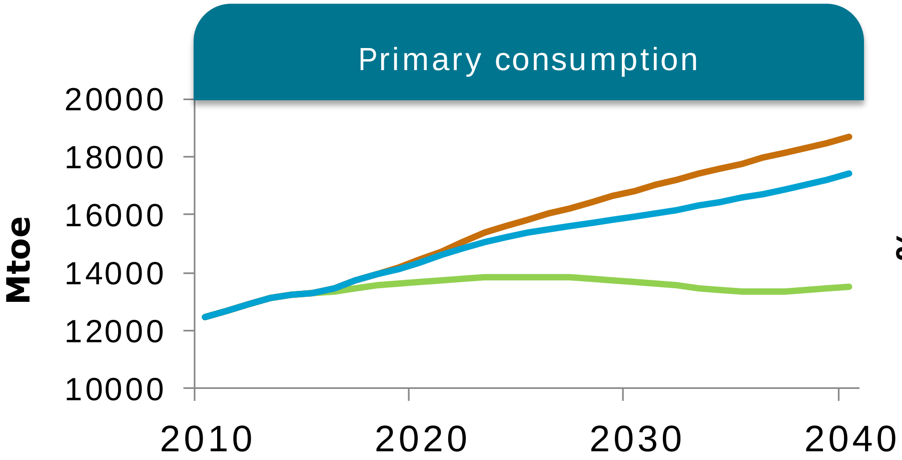
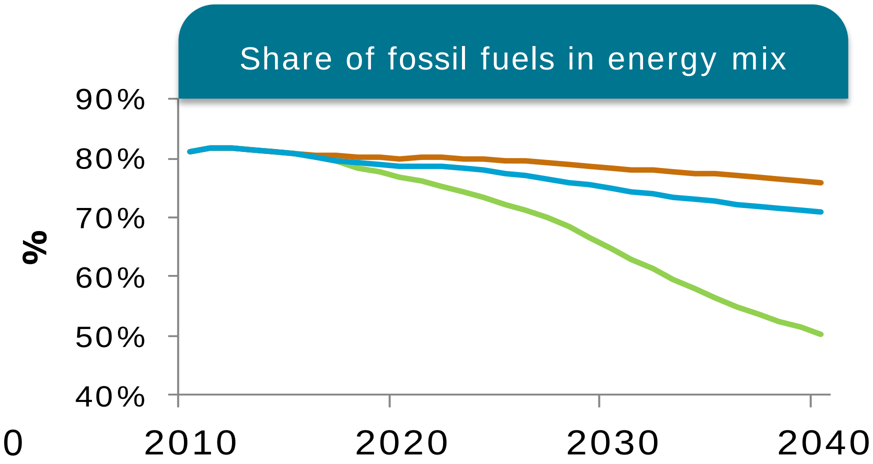
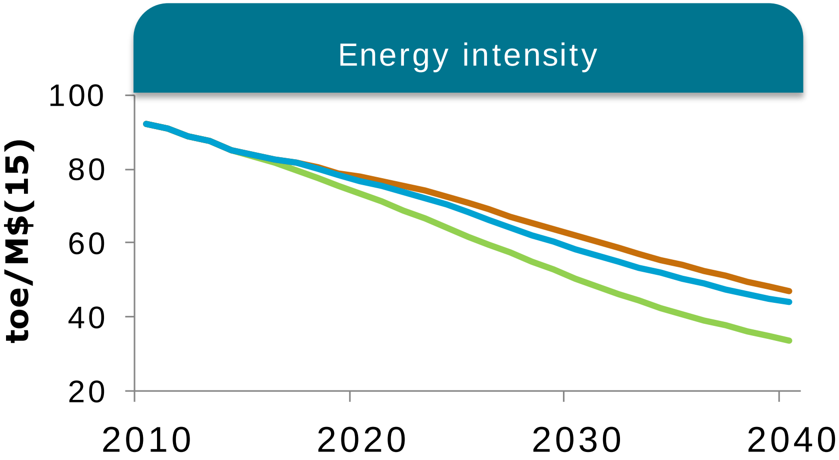
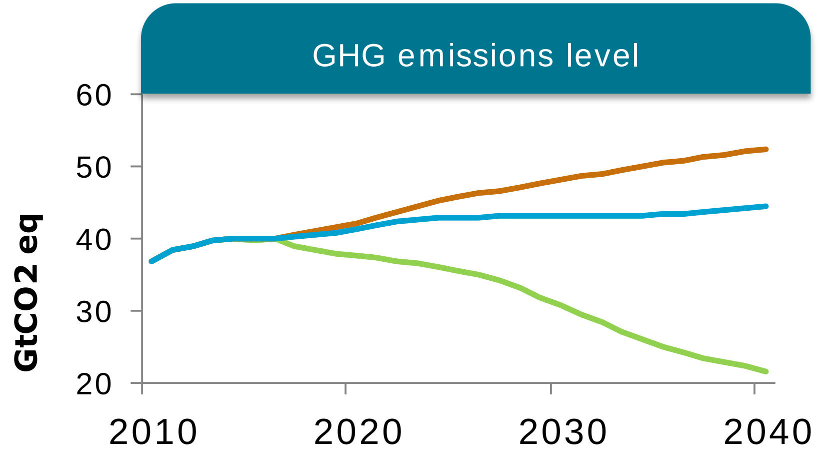
Key energy indicators by scenario



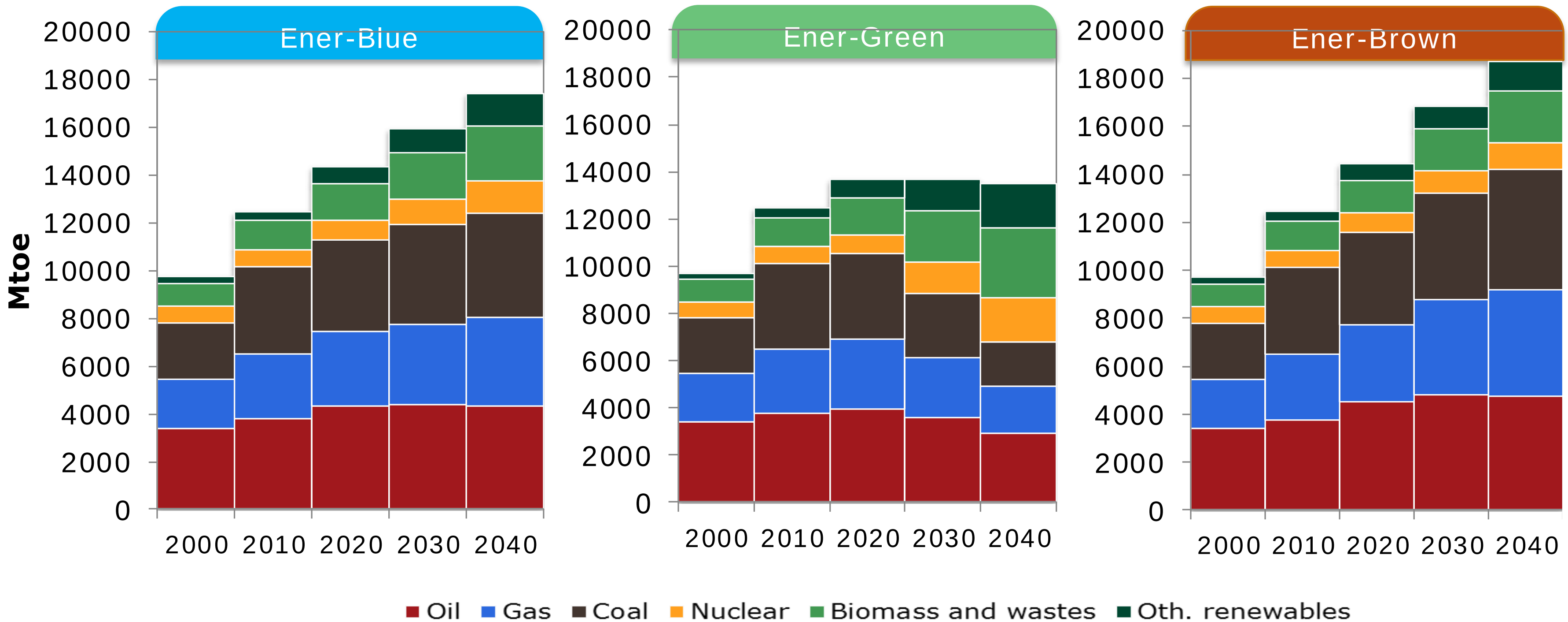






Source: EnerFuture

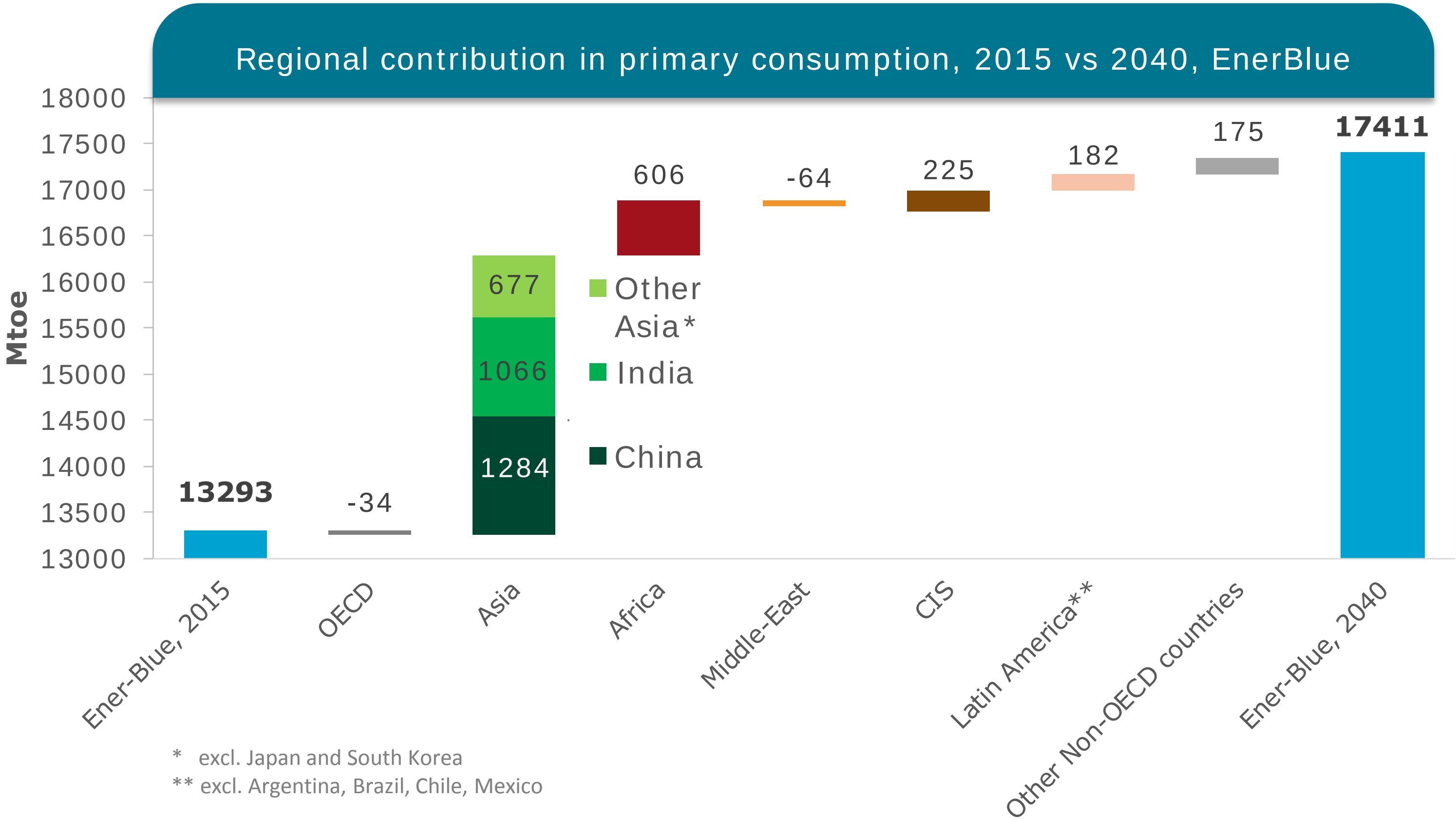
Primary Energy Demand (World)



Source: Enerdata POLES Model

- Fossil fuels share in 2040 reduced to 76% in Ener-Brown and 71% in Ener-Blue, and even further to 50% in Ener-Green.
- Renewable energy share varies between 18% (Ener-Brown), 21% (Ener-Blue) and 36% (Ener-Green).

Global demand is driven by Asia, followed by Africa

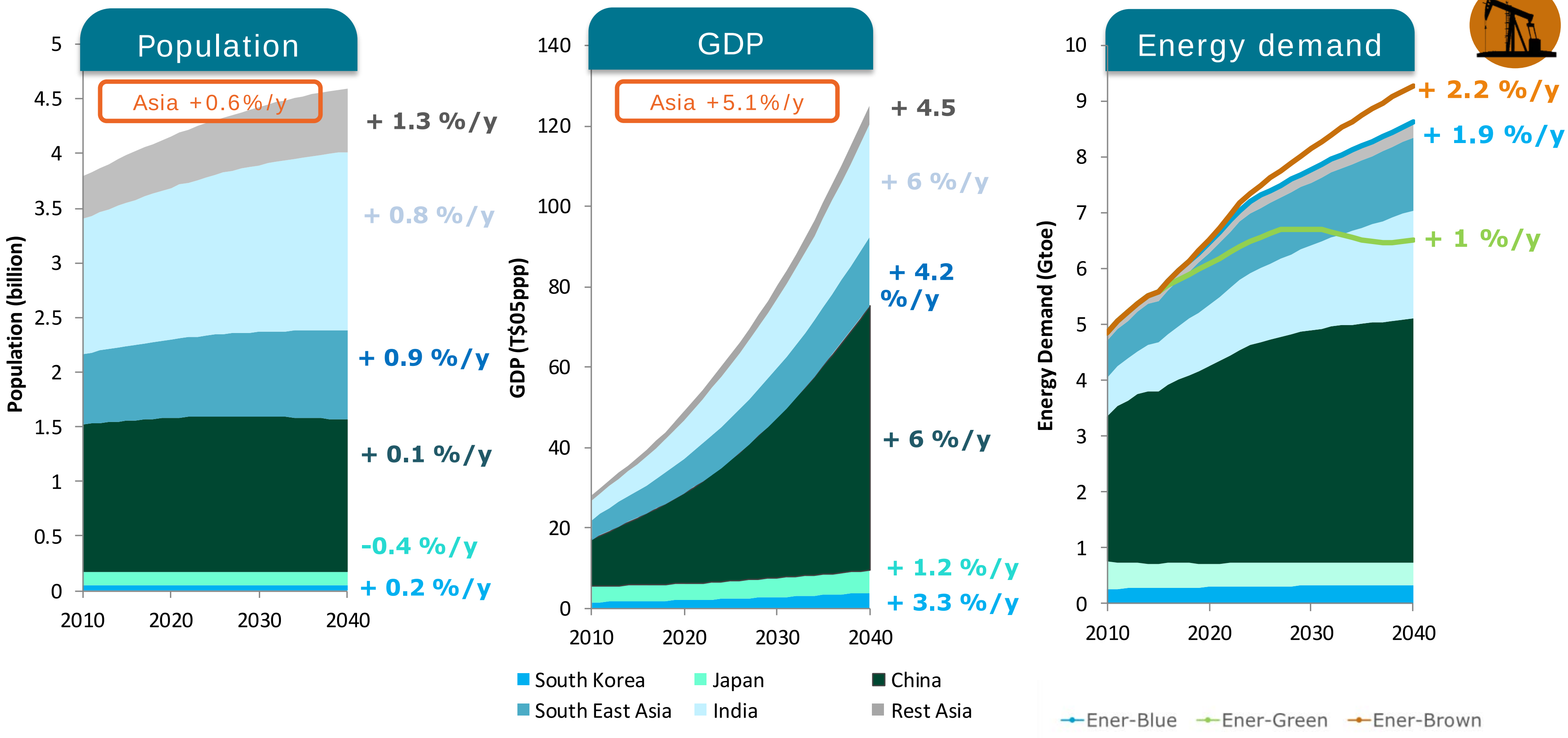


* excl. Japan and South Korea
** excl. Argentina, Brazil, Chile, Mexico

74% of the demand growth over 2015-2040 will come from Asia, and 15% from Africa.

Source: EnerFuture, Ener-Blue scenario

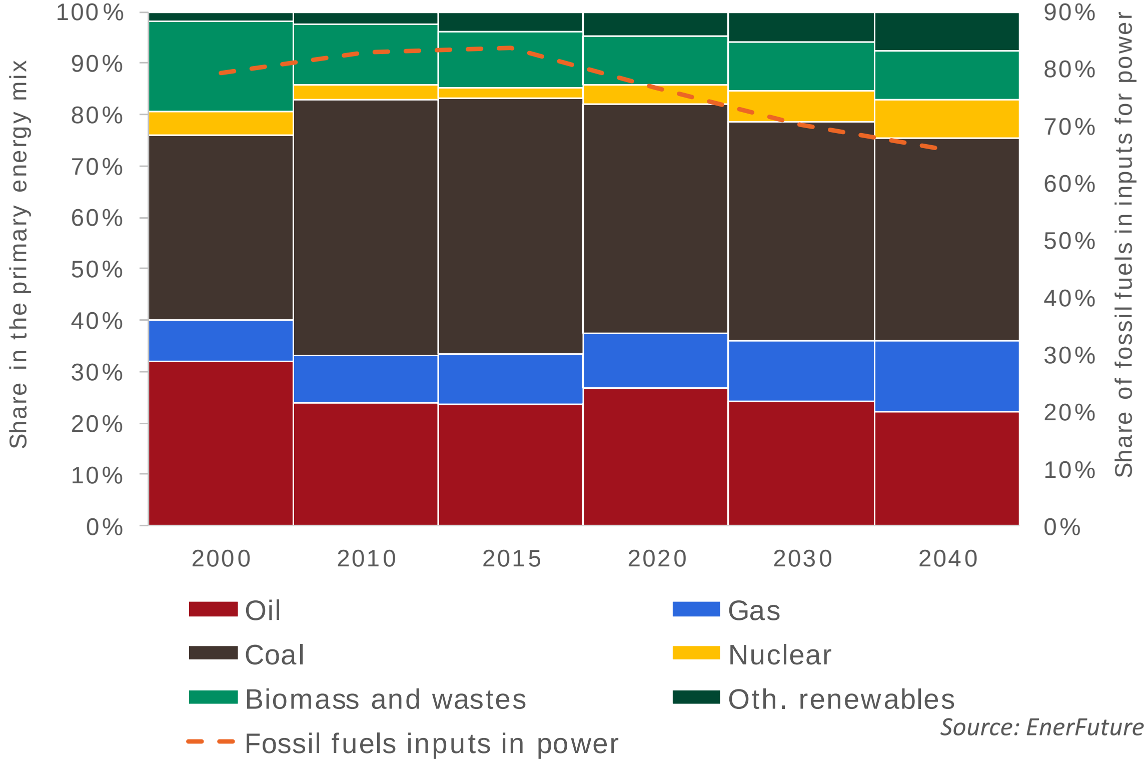
Strong economic growth leads to a doubling of Asian energy consumption…



… which drives the global demand (~50% of the worldwide demand in all scenarios).

The Asian energy mix remains dominated by fossil fuels, especially coal

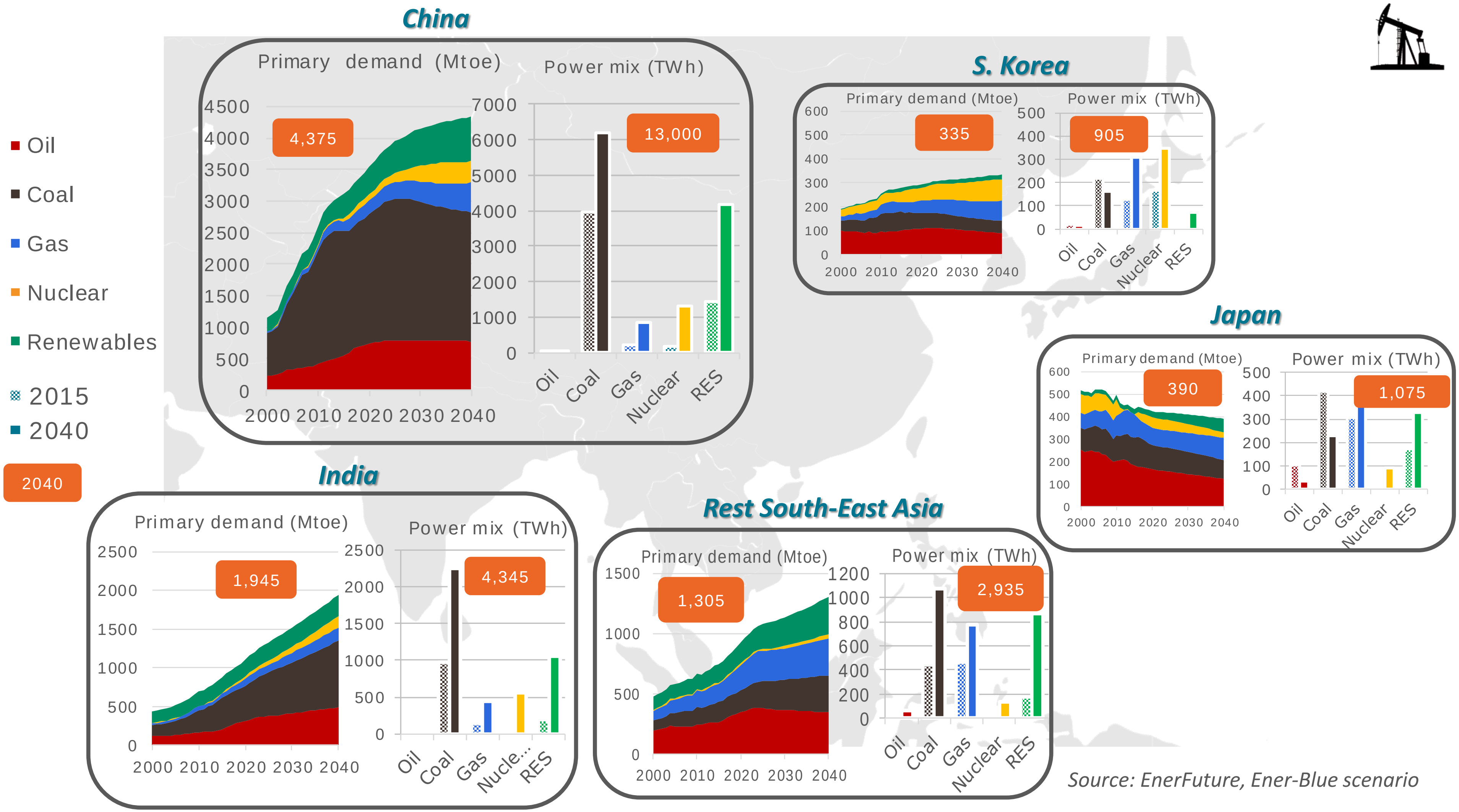
Primary energy mix, Ener-Blue



Source: EnerFuture

In the power sector, the share of fossil fuels inputs decreases from 84% to 66% between 2015 and 2040.

Primary energy mix and power mix in different Asian countries and regions, Ener-Blue



Source: EnerFuture, Ener-Blue scenario

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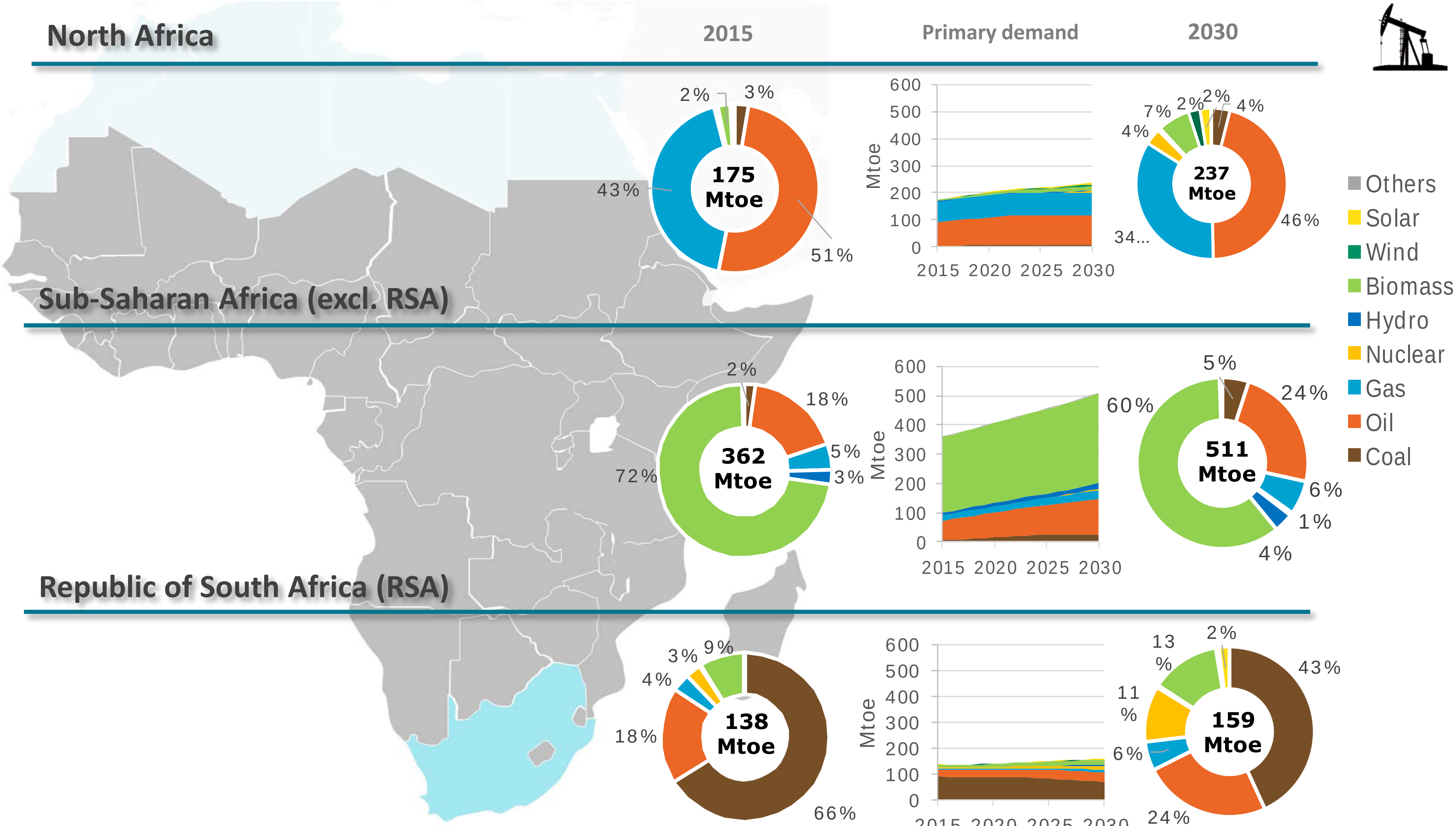
Energy demand on the African continent at horizon 2030: a market in expansion



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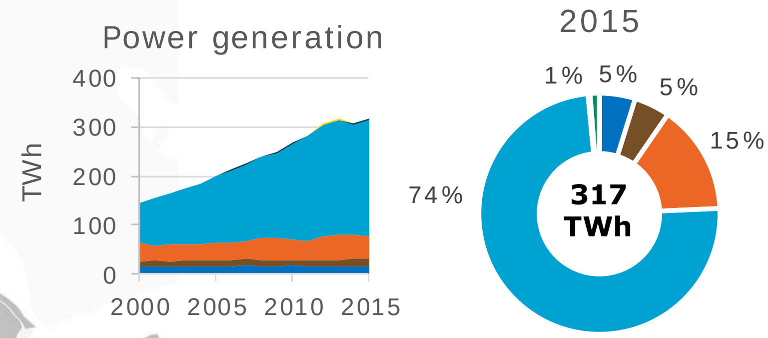
Evolution of the power mix: historical development

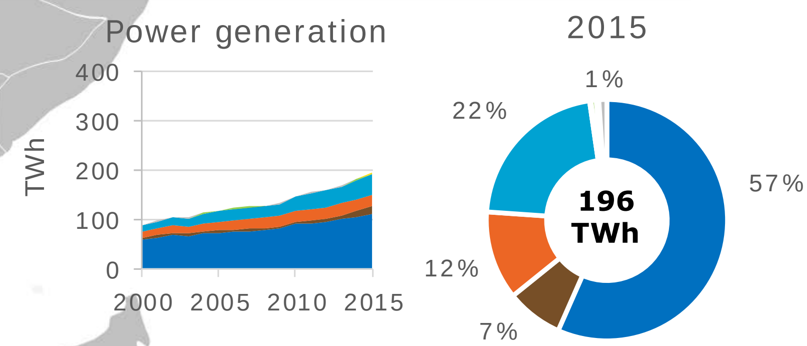
North Africa

Electrification rate (%) **99**
Power cons./cap. (kWh/cap.) **1,791**



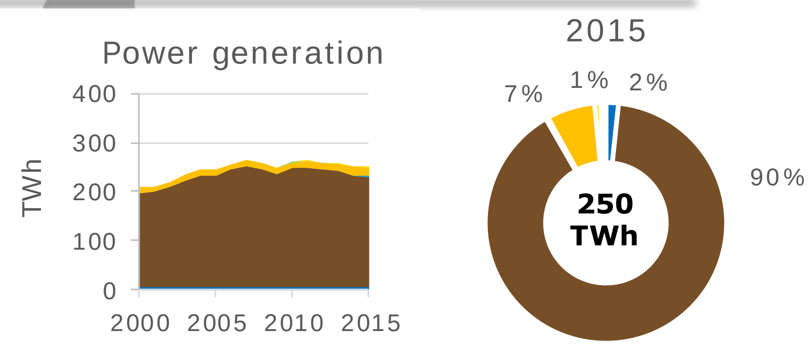
Sub-Saharan Africa (excl. RSA)

Electrification rate (%) **27**
Power cons./cap. (kWh/cap.) **52**



Republic of South Africa (RSA)

Electrification rate (%) **86**
Power cons./cap. (kWh/cap.) **4,595**



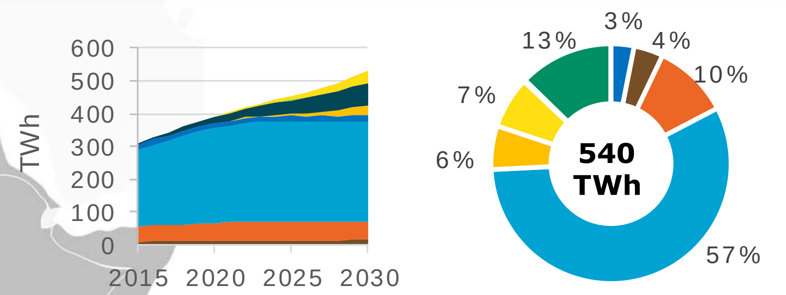
- Others
- Solar
- Wind
- Biomass
- Hydro
- Nuclear
- Gas
- Oil
- Coal

Evolution of the power mix: future trends

North Africa

Power generation — 2030

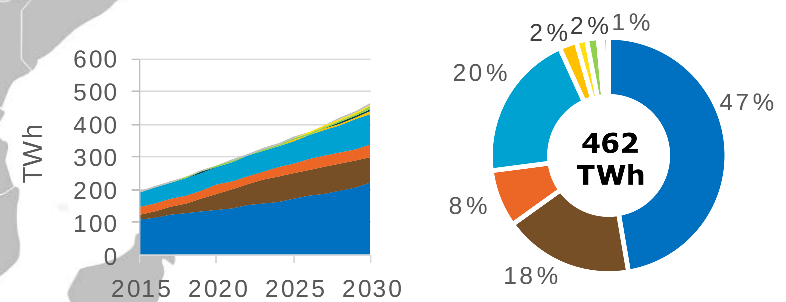
Power cons./cap. (kWh/cap.) 2030	**2,480**
Power cons./cap. (kWh/cap.) 2015	1,791



Sub-Saharan Africa (excl. RSA)

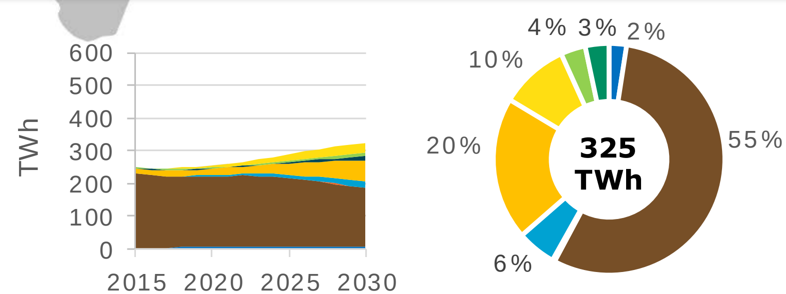
Power cons./cap. (kWh/cap.) 2030	**551**
Power cons./cap. (kWh/cap.) 2015	452

Electrification rate 2030	**45%**
Electrification rate 2015	**27%**



Republic of South Africa (RSA)

Power cons./cap. (kWh/cap.) 2030	**5,409**
Power cons./cap. (kWh/cap.) 2015	4,595



Source: EnerFuture, EnerGreen Scenario

EnerFuture scenarios – wrap up

Ener-Blue	Ener-Green	Ener-Brown
POLICIES & OBJECTIVES		
▪ 2030 INDCs targets achieved ▪ CO_2 emissions growth slow-down +3-4°C temperature increase	▪ Reinforcement trend ▪ INDCs targets regularly reviewed upwards +1.5-2°C temperature increase	▪ INDCs objectives not reached ▪ Soaring CO_2 emissions +5-6°C temperature increase
KEY OUTPUTS		
▪ Demand: +25% over 2015-40, up to +30% in Non-OECD ▪ Energy mix transformation : less fossil (70% in 2040), RES share >20% by 2040 ▪ Energy intensity nearly divided by 2 over 2015-2040 ▪ GHG emissions stabilization around 44 GtCO2eq, thanks to RES and Energy Efficiency ▪ CO_2 shadow price ~35€/tCO_2 in 2040 (~80€/tCO_2 in the EU)	▪ Global demand stabilization below 14 Gtoe ▪ Fossil fuels share around 50% by 2040, coal share halved ▪ RES + nuclear development: ~70% of power capacities (2040) ▪ GHG emissions reach ~22 GtCO_2eq; >70% of reduction efforts in Non-OECD countries ▪ Add. costs + investments (CO_2 shadow price >600€/tCO_2) balanced partially by lower fuel expenses	▪ Demand continuous growth: +40% over 2015-2040 ▪ Fossil fuels stay at nearly 75% and grow in volume, with gas gaining market share ▪ RES power production also grows: x2.5 over 2015-2040 ▪ GHG emissions growth: +31% over 2015-2040, reaching 52 GtCO2eq

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How to compare between power generation technologies

$$Levelized\ cost\ of\ electricity\ (LCOE) = \frac{Total\ Life\ Cycle\ Cost}{Total\ Lifetime\ Energy\ Production}$$

LCOE is the minimum price at which energy must be sold for project to breakeven, expressed in cents/kWh or $/MWh

Total Life Cycle Cost = ***Initial Investment*** *(includes Cost of Capital) +* ***Fuel Costs***
+ ***Operations & Maintenance Costs – Residual Asset Value***

Total Lifetime Energy Production = Total number of hours in a year (8760)
x Capacity Factor (0<x<1)
x Electricity production per hour

Significance:

- *Enables comparison of projects using different generation technologies of unequal lifetimes and differing capacities*
- *Enables grid competitiveness comparisons for projects in different locations*

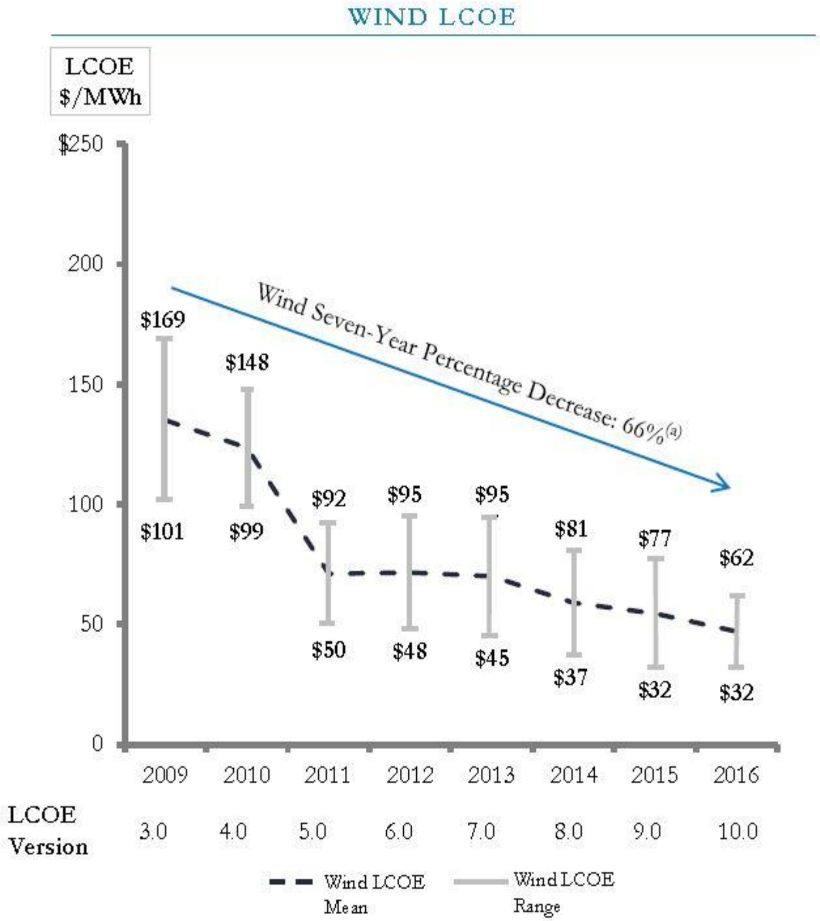
Solar PV (utility-scale) and wind unsubsidized LCOEs have become cost competitive and have minimal sensitivity to fuel prices compared with conventional technologies

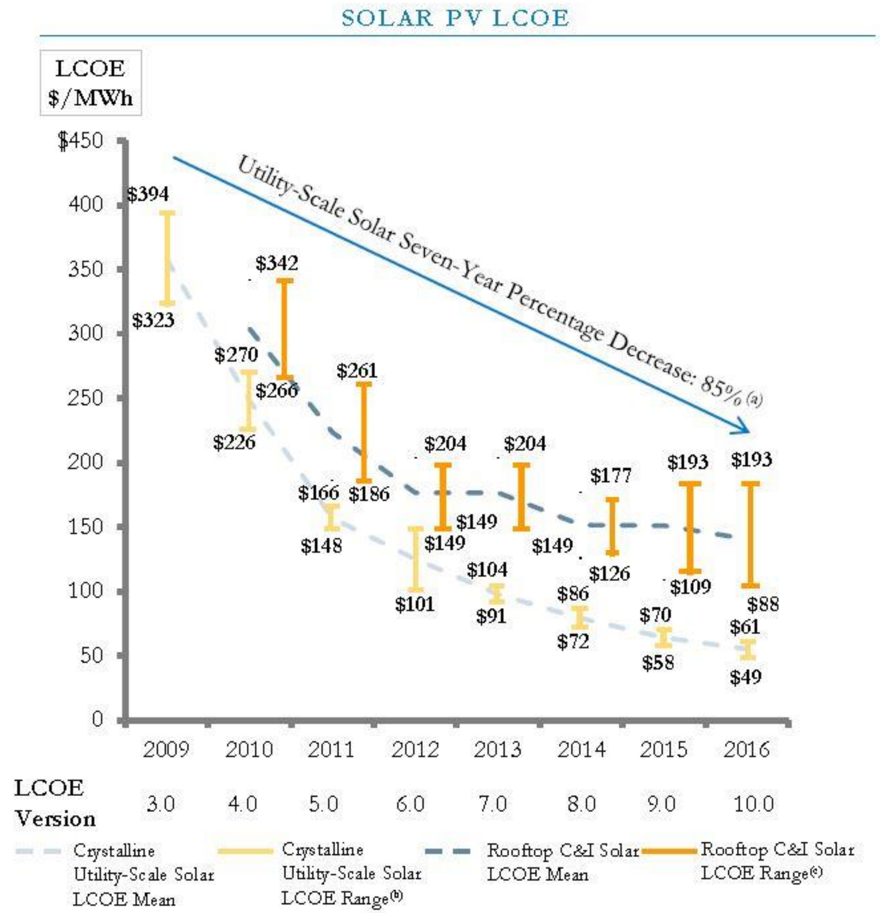
Source: Lazard LCOE 2016 Estimates, US Market

Analysis assumes:

- global costs of capital structure: 60% debt at 8% interest rate, 40% equity at 12% interest rate for conventional and alternative energy generation technologies (which may be significantly higher than OECD country costs of capital)
- Exclusion of integration costs (grid & conventional generation investment to overcome system intermittency) for intermittent technologies
- Does not account for differences in heat coefficients within technologies / balance-of-system costs / other factors which may differ across solar technologies or due to geographical circumstances

Potential for solar PV and wind LCOEs to decrease further if trend in component cost reductions and efficiency improvements continue





*Source: Lazard LCOE 2016 Report (*LCOE trends primarily focused on US market)*

Latest Developments on Renewable Projects

Renewables to account for over 60 percent of India's power capacity – Piyush Goyal

25 March, 2017

India's Power Minister has suggested that India could achieve a generation capacity mix that comprises 60-65 percent renewable energy. India's solar generation capacity is expected to reach 20 GW within the next 15 months (from the current level of 10 GW). Reduced capital expenditure and financing costs have helped drive tariffs down. New lows were set in recent auctions for solar and wind power, the former falling to Rs 2.97 per unit (US 4.55 cents per kWh) in a 750 MW capacity auction, and the latter to Rs 3.46 per unit (US cents 5.30 per kWh) in a 1,000 MW capacity auction.

Hanwha-Kalyon consortium wins contract to build 1 GW solar park in Turkey

21 March, 2017

Turkey is reported to have awarded a tender for the construction of a 1 GW solar park to a 50-50 joint venture formed by Hanwha Q CELLS and Kalyon Enerji. The project was awarded by offering a price of US 6.99 cents per kWh (€0.065 per kWh) and it is expected to be supported by the award of a 15-year power purchase agreement ("PPA"). The project is expected to commence operations within 36 months and will include a 500 MW factory which would be commissioned within 24 months.

Japan prepares for biomass power plant surge and increases imports of wood chips

27 February, 2017

Japan's government is revising the fixed price power purchase scheme meaning that biomass generated power will see the price fall to 21 Yen per kWh from 24 Yen per kWh, effective October, 2017. Consequently, there is expected to be an increase in demand for biomass plants that will come online around 2020. Although many power plants run on construction waste, imported wood chips are likely to meet future plant's feedstock need.

Jordan will award 300 MW renewable projects

17 January, 2017

The assistant secretary general of Jordan's Ministry of Energy Ziad Jibril Sabra has announced that the government plans to approve up to six renewable energy projects, comprising four solar and two wind farms of 50 MW each, in order to help Jordan achieve 1.6 GW of renewable energy capacity and have a 20 percent renewable share in power generation by 2020. The government has recently awarded a 61.3 MW solar project to Saudi Arabia's ACWA Power International, which bid a record low (for Jordan) of 5.88 US cents per kWh.

Source : Enerdata Energy Business Intelligence, Key Energy News

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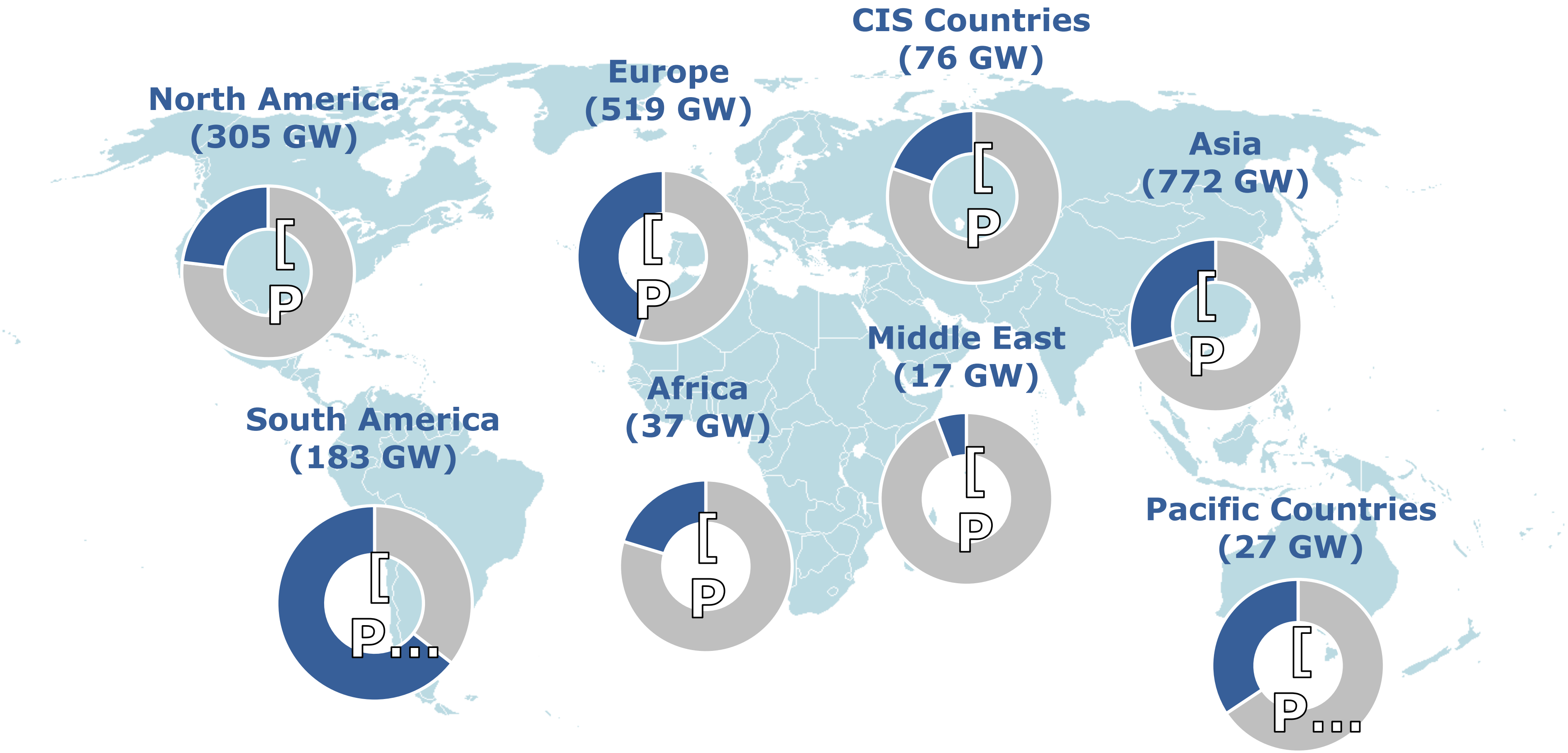
In 2015, the share of renewable energy in the global installed generation capacity reached 31%



Source: Enerdata Global Energy & CO_2 Data

Development of non-fossil energies capacities

Installed capacities of solar, wind, hydro and nuclear in main regions, Ener-Blue

GW

USA

28% (2015) | 53% (2040)

Source	2015	2040
Solar	21	233
Wind	75	168
Hydro	102	113
Nuclear	98	100

EU-28

53% (2015) | 69% (2040)

Source	2015	2040
Solar	98	220
Wind	144	317
Hydro	154	178
Nuclear	121	97

China

33% (2015) | 51% (2040)

Source	2015	2040
Solar	51	512
Wind	106	591
Hydro	324	534
Nuclear	28	170

India

24% (2015) | 48% (2040)

Source	2015	2040
Solar	6	156
Wind	25	157
Hydro	43	94
Nuclear	5	68

South America

55% (2015) | 69% (2040)

Source	2015	2040
Solar	2	71
Wind	14	91
Hydro	180	287
Nuclear	5	23

Africa & Middle-East

12% (2015) | 39% (2040)

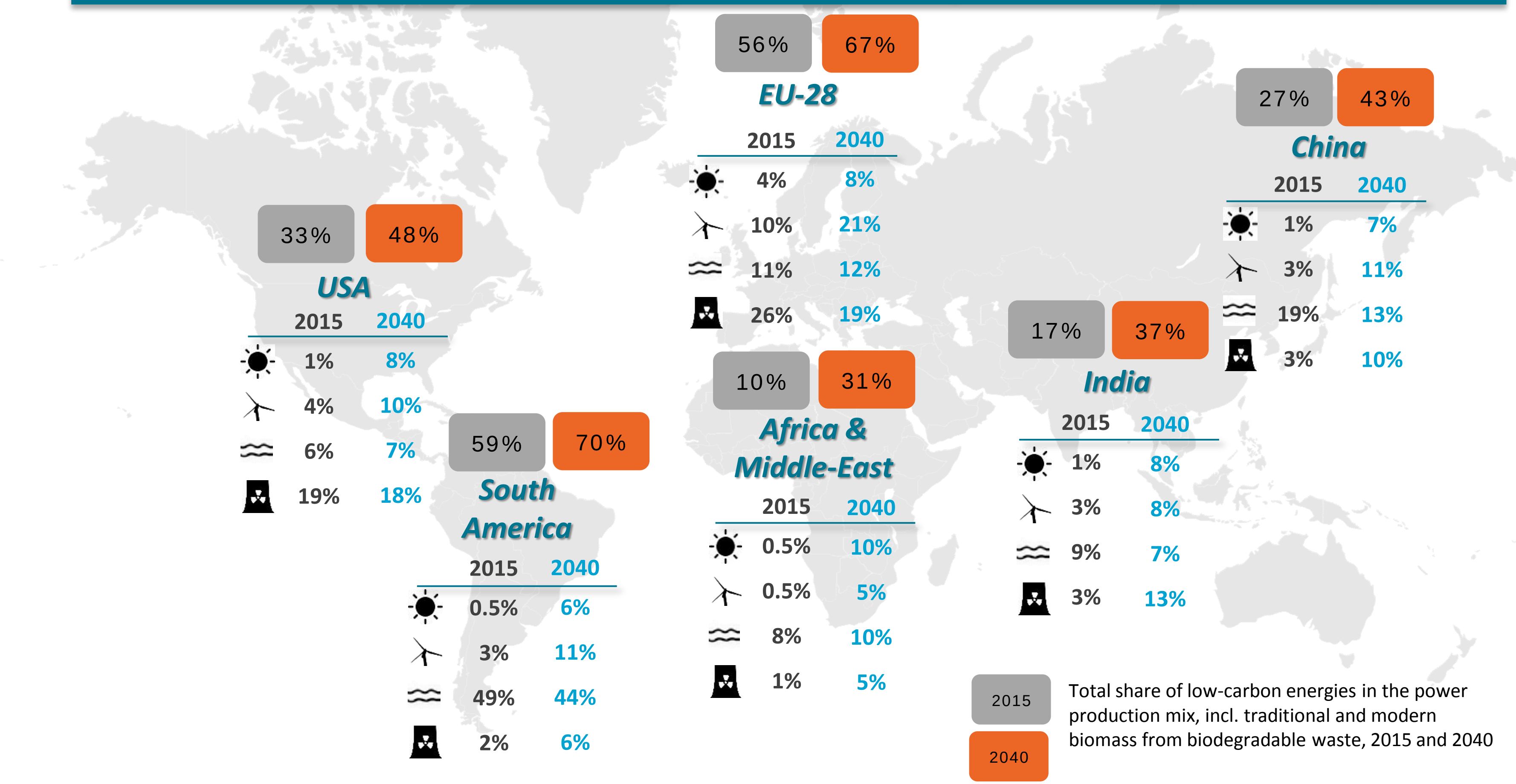
Source	2015	2040
Solar	4	157
Wind	4	79
Hydro	48	116
Nuclear	3	31

2015 / 2040: Total share of low-carbon energies in installed capacities, incl. traditional and modern biomass from biodegradable waste 2015 and 2040

Source: EnerFuture, Ener-Blue scenario

In 2040, depending on the regions, non-fossil energies will cover 30% to 70% of the power mix

Shares of main low-carbon energies in the power production mix, Ener-Blue, %



Source: EnerFuture, Ener-Blue scenario

Renewable Energy (RE) developments in Asia

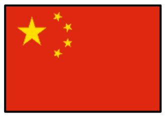
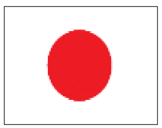
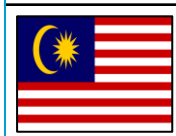
**Renewable capacity includes hydropower, biomass, solar, wind, geothermal*

	Total RE Capacity in 2015	RE annual capacity growth (2010-15)	RE share of electricity production in 2015	Key Renewable Energy Targets
	504.4 GW	14.6%	24.7%	China's 13th Five Year for Power Sector Development (November, 2016), sets 2020 installed targets of 340 GW (hydropower), wind (210 GW), solar (110 GW), and biofuels (15 GW).
	94.2 GW	8.7%	17.4%	Japan's 2015 Long Term Energy Supply and Demand Outlook set a 2030 RE target of 22-24% of generation (hydro 8.8-9.2%; solar PV 7%, biomass 3.7-4.6%, wind 1.7%, geothermal 1.0-1.1%).
	81.4 GW	8.5%	14.6%	India increased its RE in January 2015 to 175 GW by 2022, which would comprise 100 GW solar, 60 GW wind, 10 GW biomass and 5 GW small hydropower.
	12.1 GW	12.5%	2.4%	The Renewable Portfolio Standard (RPS) introduced in 2012, requires power generators to source an increasing percentage of RE with the initial target for 2022 pushed back to 2024.
	7.3 GW	8.0%	11.7%	Indonesia targets a RE share in its primary energy mix of 10-15% by 2019, 23% by 2025 and 31% by 2050.
	7.0 GW	20.2%	10.4%	Malaysia's Eleventh Plan (2016-2020) targets 2.08 GW of RE capacity (excluding large-scale hydropower), a 3% RE share and a 15% hydropower share in its primary energy mix

Source: Enerdata Global Energy & CO_2 Data, Countries' Energy Policies

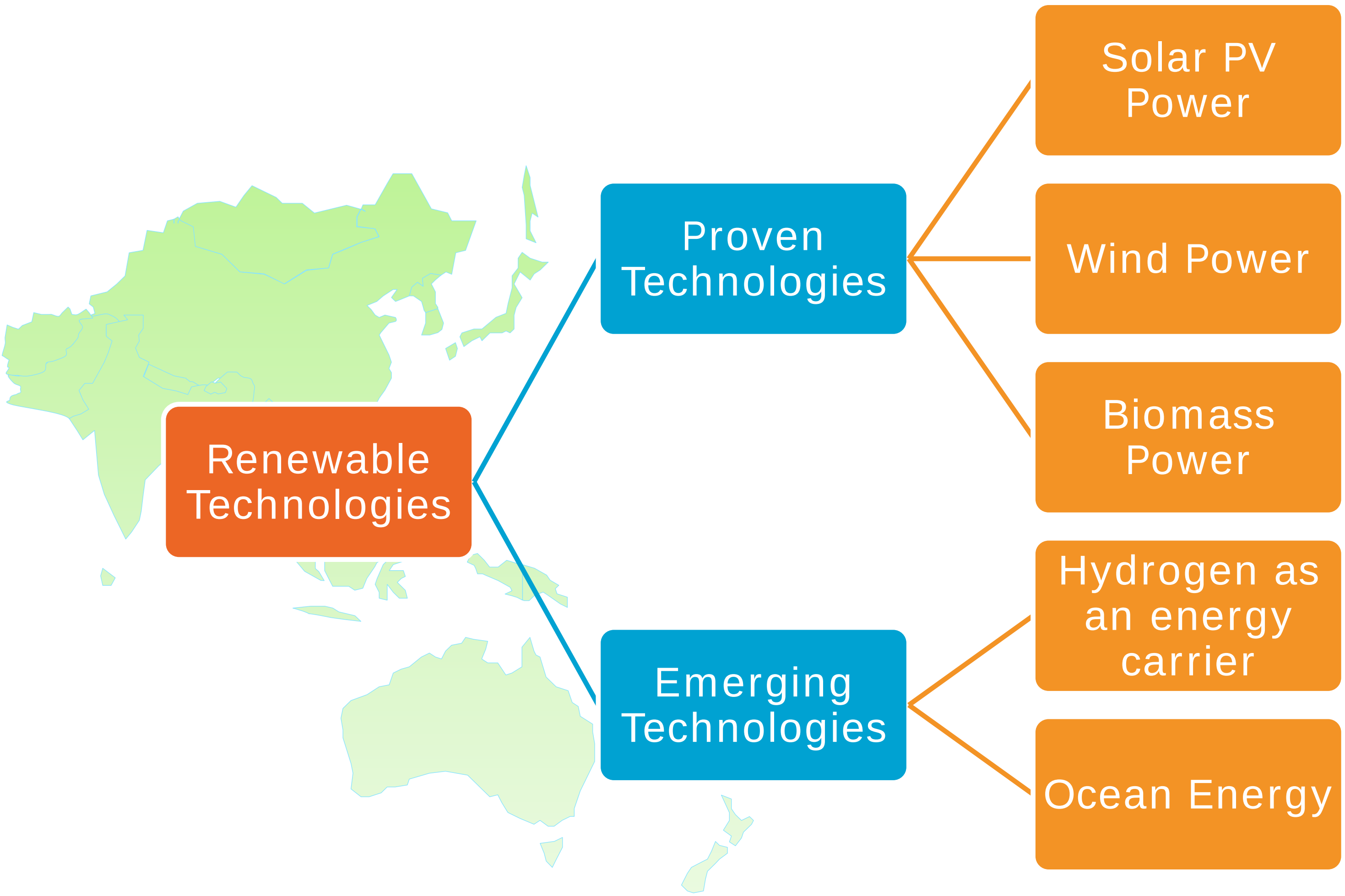
INDC commitments in Asia

**LULUCF – Land Use, Land-use Change and Forestry*

	Total CO_2 Emissions (excl. LULUCF) in 2015	**Total emissions growth since 2010**	**Key INDC Commitments** (in accordance with Paris Agreement entering into force on 4 November, 2016 and the countries nationally determined contribution commitments thereof)
	10,793.1 $MtCO_2$	18.5%	The peaking of CO2 emissions earlier than 2030 if possible; CO2 emissions per unit of GDP to fall from 65% to 60%; non fossil fuels to rise to around 20% of primary energy.
	1,202.7 $MtCO_2$	2.2%	Japan has committed to reduce GHG emissions by 26% in Fiscal Year 2030, as compared to Fiscal Year 2013, i.e. a 25.4% reduction as compared to Fiscal Year 2005.
	2,335.3 $MtCO_2$	33.6%	To reduce the emissions intensity of GDP by 33-35% from 2005 levels by 2030; to achieve about 40% non fossil fuel based energy with help from the Green Climate Fund (GCF).
	655.4 $MtCO_2$	5.7%	Korea has an economy wide target to reduce GHG emissions by 37% below the business as usual (BAU) level (850.6 $MtCO_2e$) by 2030.
	536.6 $MtCO_2$	22.4%	Indonesia has committed to unconditionally reduce GHG emissions to 26% below the BAU scenario by 2020 and to 41% below BAU level of 2.88 $MtCO_2e$ by 2030 (incl. 12% dependent on international support).
	237.3 $MtCO_2$	14.5%	To reduce the emissions intensity of GDP by 45% from 2005 levels (0.531 tons CO_2eq per thousand RM) by 2030 (35% unconditional, 10% contingent on climate finance, technology transfer and capacity building).

Source: Enerdata Global Energy & CO_2 Data, Countries' INDCs

Proven and Emerging Renewable Energy Technologies



FiT in Asia – Most of the countries in Asia have FiT

	Feed-in tariffs	Net metering	Renewable obligations	Fiscal incentives	Public financing	Biofuels targets	Renewable target
Australia	√		√		√		√
Bangladesh				√	√		√
China	√						√
India	√	√	√	√	√	√	√
Indonesia	√		√	√	√	√	√
Japan	√	√	√	√	√	√	√
Malaysia	√		√	√	√	√	√
Mongolia	√						√
Nepal					√		√
New Zealand				√	√		√
Pakistan	√	√			√	√	√
Philippines	√		√	√			√
Singapore		√			√		
South Korea			√	√	√	√	√
Sri Lanka	√						√
Taïwan	√				√	√	√
Thailand	√			√	√	√	√
Vietnam	√			√			√

Source: Enerdata Global Energy & CO_2 Data, Countries' INDCs

FiT in Asia – Example of complex FiT Schemes

Technology	Sub-techonology	Region	2009	July 2014	2015	2016	2017	2018
Onshore		Region 1	8.21		7.89	7.57		7.09
		Region 2	8.70		8.37	8.05		7.57
		Region 3	9.34		9.02	8.70		8.21
		Region 4	9.82		9.82	9.66		9.34
Duration			20 years					
Offshore	Near shore		n.a.	13.7				
	Intertidal			12.1				

Source: Enerdata, China Wind FiT

Sub-energy	Network	Region	Capacity	2010-2012	2013	2014	2015 onwards
Biomass	Medium Voltage	Jawa Bali	≤ 10 MW	7.29	7.29	8.59	8.59
		Sumatera				9.88	9.88
		Sulawesi NTB and NTT			8.74	10.7	10.7
		Kalimantan				11.2	11.2
		Bali, Bangka Belitungn, Lombok			9.47	12.9	12.9
		Riau archipelago, Papua and others				13.7	13.7
	Low Voltage	Jawa Bali		9.90	9.90	11.2	11.2
		Sumatera				12.9	12.9
		Sulawesi NTB and NTT			11.88	14.0	14.0
		Kalimantan				14.6	14.6
		Bali, Bangka Belitungn, Lombok			12.87	16.8	16.8
		Riau archipelago, Papua and others				17.9	17.9
Zero Waste	Medium Voltage	All		7.85	10.8	10.8	10.8
	Low Voltage			10.4	13.4	9.34	9.34
MSW Thermal Process Utilisation	High Voltage		20-50MW	n.r.			16.0
							13.1
MSW Methane Gas	High and Medium Voltage		<20MW				16.6
MSW Thermal							18.8
MSW Methane Gas Utilisation	Low voltage						20.2
MSW Thermal Process Utilisation							22.4
Duration	20 years						

Source: Enerdata, Indonesia BioMass FiT

Enerdata intelligence + consulting

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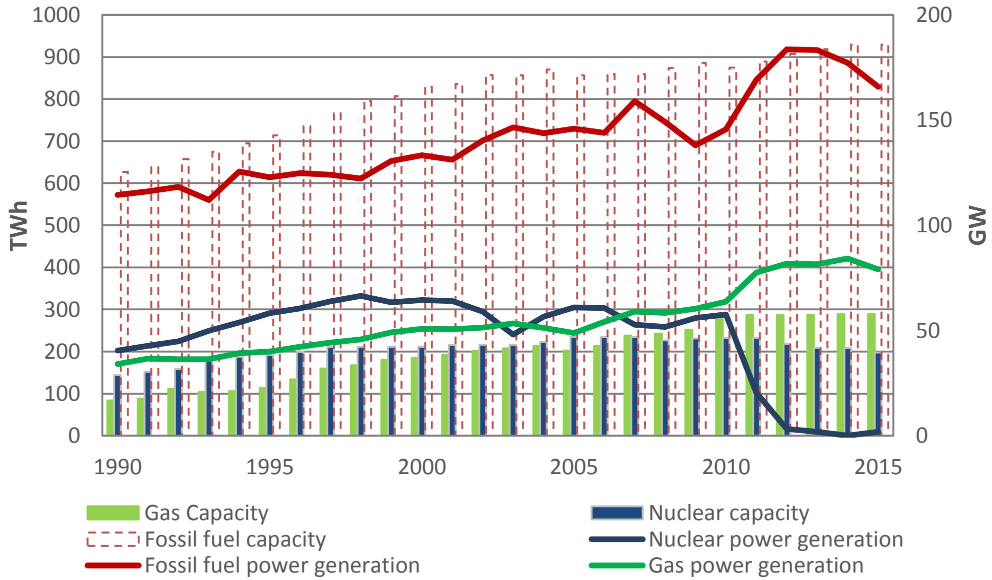
The increased reliance on fossil fuels imports for power generation following the 2011 nuclear shutdown has cost Japan an annual average of $30 billion

Growth in Power Capacity & Generation

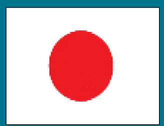


Source: Global Energy & CO2 Database

- Following the Fukushima nuclear accident in 2011, power generation using fossil fuels surpassed 900 TWh in 2012 and 2013 before reducing slightly to 830 TWh in 2015 due to declining oil-fired power generation.
- Between 2010 and 2015, nuclear power generation declined to 0 in 2014 before Kyushu Electric's Sendai 1 and 2 reactors were allowed to restart in 2015. Since then, Shikoku Electric's Ikata 3 reactor restarted in 2016, while a number of reactors (Kansai's Takahama 3 and 4 units, Kyushu's Genkai 3 and 4 units, Chubu's Hamaoka 3 and 4 units) are potential restarts.
- Overall capacity growth for fossil fuels has not changed significantly (1.6% per year between 1990 and 2015) despite gas and coal-fired capacities growing three-fold and two-fold over the same time period.
- The government is expected to start revising its 2015 long-term energy plan this year, and it is likely that fierce public opposition to nuclear will result in a lowering of the current 2030 nuclear share target of 20-22%, rather than a complete removal of nuclear as the government weighs the cost of higher electricity prices and government debt from costly fossil fuel imports.

Japan – Electricity Targets

**Renewable capacity includes hydropower, biomass, solar, wind, geothermal (total capacity is slightly different due to rounding)*

	2015 installed capacity	2020 forecast capacity (EnerBlue)	2015 share of power generation	Electricity Targets
Coal	71.9 GW	81.2 GW	33.8%	26% of power generation in 2030
Oil	56.2 GW	52.9 GW	8.9%	3% of power generation in 2030
Gas	57.7 GW	59.1 GW	38.9%	27% of power generation in 2030 (LNG)
Nuclear	39.5 GW	35.2 GW	0.9%	20-22% of power generation in 2030 (under contention due to public opposition to nuclear restarts)
Renewables	94.2 GW	120 GW	17.5%	22-24% of power generation in 2030 (8.8-9.2% hydropower, 7% solar, 1.7% wind, 3.7-4.6% biomass, 1-1.1% geothermal)
Total	319.6 GW	348.2 GW	100%	Japan's Long-term Energy Supply and Demand Outlook for FY 2030 projects power generation to reach 1.06 TWh in 2030

Source: Enerdata Global Energy & CO_2 Data, EnerFuture, Countries' Energy Policies

Nuclear/Gas Latest Developments in Japan

Japan allegedly in talks with US to prevent China acquiring Westinghouse

10 April, 2017

Westinghouse's nuclear business is likely to be sold. Reuters reported that the Trump administration and the Japanese government are in discussions to ensure that the bankruptcy of Toshiba Corp's U.S. unit Westinghouse Electric Co does not lead to U.S. technology secrets and infrastructure falling into Chinese hands, a U.S. official said on Thursday. Westinghouse filed for bankruptcy last month hit by billions of dollars of cost overruns at four nuclear reactors under construction in the U.S. Southeast.

Why Japan must start weaning itself off oil imports for energy

01 March, 2017

Japan outlined a long-term approach to energy security amidst low crude oil prices" based on three policy goals. They are:

1) facilitating global investment in upstream development;
2) establishing LNG markets in readiness for crude oil price volatility, and;
3) exporting Japan's energy-saving technologies to reduce worldwide dependence on crude oil.

Japan predicted to junk problematic Monju fast reactor

26 September, 2016

A series of technical, economic, and safety problems has been lashing Japan's prototype fast-breeder nuclear reactor at Monju in Fukui Prefecture since it achieved criticality in 1994. It has only been operational for 250 days prior to the March 2011 Fukushima accident.

The Ministry of Education, Culture, Sports, Science and Technology, which oversees the Monju project, estimated that at least $5.7b (JPY580b) will be needed to restart the reactor.

Ninth LNG Train Starts at Bintulu

25 January, 2017

Japanese JX Nippon Oil & Energy Corp said January 23 that its joint venture partner, Malaysian state-owned Petronas, has commenced operations at the ninth liquefaction train at the Petronas LNG complex in Bintulu, Sarawak, Malaysia.

Source : Enerdata Energy Business Intelligence, Key Energy News

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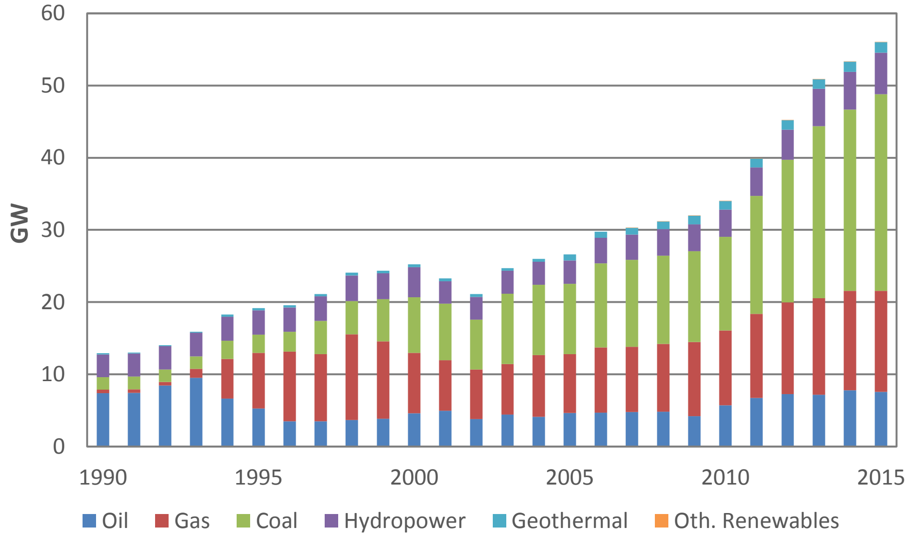
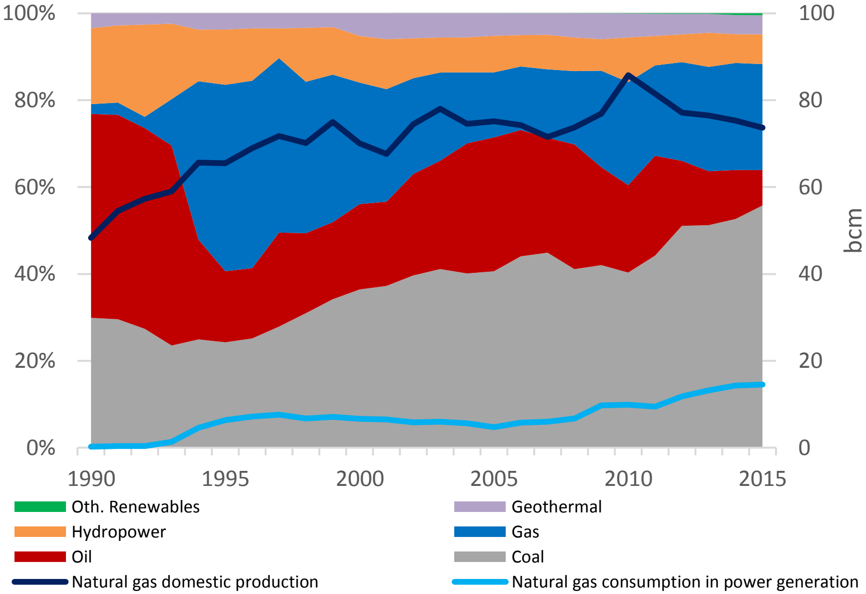
Indonesia relies mainly on coal and gas for power generation

Growth in Indonesia's Power Capacity	Power generation mix evolution in Indonesia



Source: Global Energy & CO2 Database



- The share of natural gas in Indonesia's power generation mix reached a high of 43% in 1995, but subsequently declined to 15% in 2005 and has since stabilized around 24% over the last 3 years. The cheap availability and on-demand ability of domestic coal has not only led to the increasing adoption of coal power, but has mitigated the demand for alternative power sources such as hydropower.
- Between 2005 and 2015, the growth in gas-fired capacity (5.5% per year) was just half of coal-fired capacity growth (10.8% per year), but gas-fired power generation increased at double the growth (11.6% per year) over the same time period.
- Indonesia's renewable energy electricity production is dominated by hydropower and geothermal power.
- PT PLN's latest ten-year electricity supply business plan (RUPTL 2016-2025) has revised the share of gas and coal in additional capacity by 2025 from 20% and 60% in the previous plan to 29% (23 GW) and 43% (34.8 GW) respectively.

PT PLN's 35,000 MW Plan aims to help Indonesia meet projected electricity demand growth of 8.6% per year and achieve an electrification rate of 97.35% by 2019

Source : PT PLN 35,000 MW Plan

The government supports the 35 GW plan using the following legislation:

- Law No.2/2012 and Presidential Decree No.30/2015 (on land acquisition for public interests)
- Ministerial Decree No.3/2015 (on electricity purchase procedures)
- Ministerial Decision ESDM 74K/21/MEM/2015 (on the legalization of PT PLN's electricity supply business plan RUPTL to develop power plants)

Indonesia's Peak Load is expected to grow from 36.7 GW in 2015, to 50.5 GW by 2019 and 74.5 GW by 2024

Indonesia – Electricity Targets

**Renewable capacity includes hydropower, biomass, solar, wind, geothermal (total capacity is slightly different due to rounding)*

	2015 installed capacity	2020 forecast capacity (EnerBlue)	2015 share of power generation	Electricity Targets
Coal	27.2 GW	30.7 GW	55.8%	34.8 GW by 2025; 45-50% share of power generation by 2025
Oil	7.6 GW	8.6 GW	8.1%	Completely phased out by 2025
Gas	14.0 GW	26.7 GW	24.4%	23 GW by 2025; 30% share of power generation (including LNG) by 2025
Nuclear	n.a.	n.a.	n.a.	No Nuclear
Renewables	7.2 GW	10 GW	11.7%	14.5 GW of hydropower, 6 GW of geothermal, 2.2 GW other renewables by 2025; 20-25% share of power generation by 2025
Total	56.0 GW	75.7 GW	100%	Capacity targets – PT PLN's RUPTL 2016-2025; Power generation targets – the government's RUKN 2015-2034

Source: Enerdata Global Energy & CO_2 Data, EnerFuture, Countries' Energy Policies

Gas/LNG Latest Developments in Indonesia

Indonesia commissions 500 MW of new mobile power plants

22 March, 2017

Eight gas-fired mobile power plants with a cumulated capacity of 500 MW have been officially inaugurated in Indonesia. The plants' capacities range between 25 MW and 100 MW and the eight projects have been installed in Lombok (West Nusa Tenggara), on Bangka Island, in Lampung (South Sumatra), in Pontianak (West Kalimantan), in Bengkalis (Riau Islands), on Belitung Island and in Nias and Medan in North Sumatra. Some of the plants started operations in 2016.

ADB lends US$400m for third Tangguh LNG train (Indonesia)

20 December, 2016

The Asian Development Bank (ADB) has signed a US$400m loan to finance the expansion of the 7.6 Mt/year Tangguh LNG plant in Indonesia.

The Tangguh LNG plant was commissioned in 2009 and consists of two liquefaction trains of 3.8 Mt/year each. BP is the operator of the liquefaction plant with a 40.22% stake, in partnership with Mitsubishi-Inpex (16.3%), CNOOC (13.9%), Nippon Oil (12.23%), KG (10%) and LNG Japan (7.35%).

Indonesia's shifting rules threaten coal-fired plants' bankability

5 April, 2017

The new regulation (Regulation No. 10/2017 on Principles of Power Purchase Agreements) appears to require developer-owners to bear bigger risks. The new regulation stipulates that the current tariff model, which includes a capacity (or take-or-pay) component, may not last for the entire life of a PPA. Rather, PLN will only be required to cover capacity payments for the 15 years typically required for debt repayment, only half the characteristic 30-year life of a PPA.

Wartsila to Supply 135-MW Combined Cycle Plant to Indonesia

3 November, 2016

Wartsila and PT PP (Persero) Tbk, have been selected to supply a 135-MW combined-cycle power plant to a power center under construction at Lombok Island in Indonesia.

The two companies will also operate and maintain the power plant for five years, with power supplied to PT PLN, the Indonesian state utility.

Wartsila and PT PLN plan to build out additional power generation in Indonesia in the future. When the Lombok plant is operational, Wartsila’s total contributed capacity in the country will exceed 3.1 GW.

Source : Enerdata Energy Business Intelligence, Key Energy News

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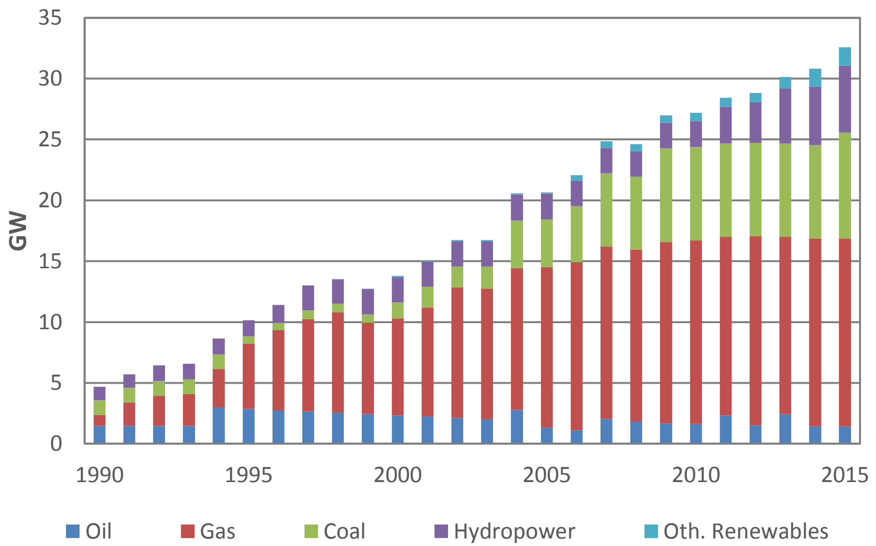
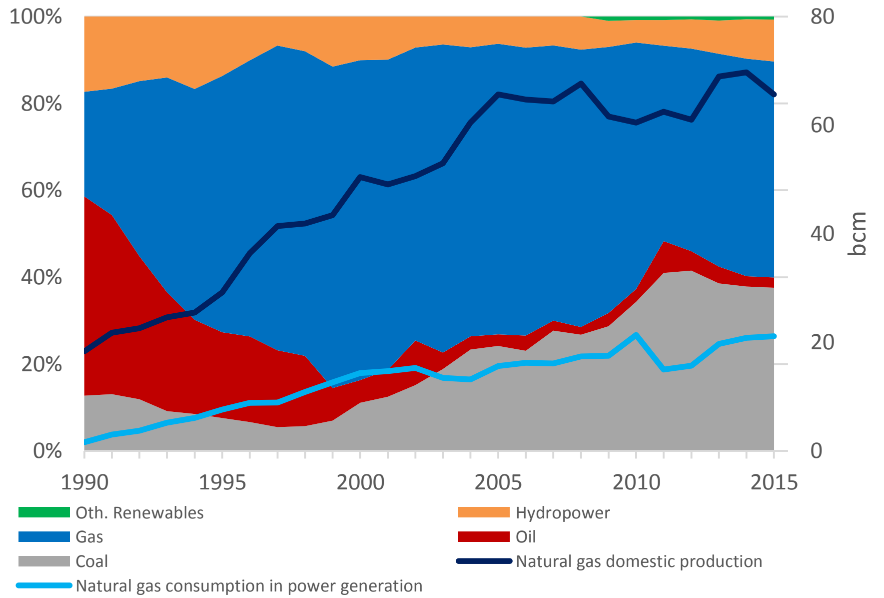


Source: Global Energy & CO2 Database

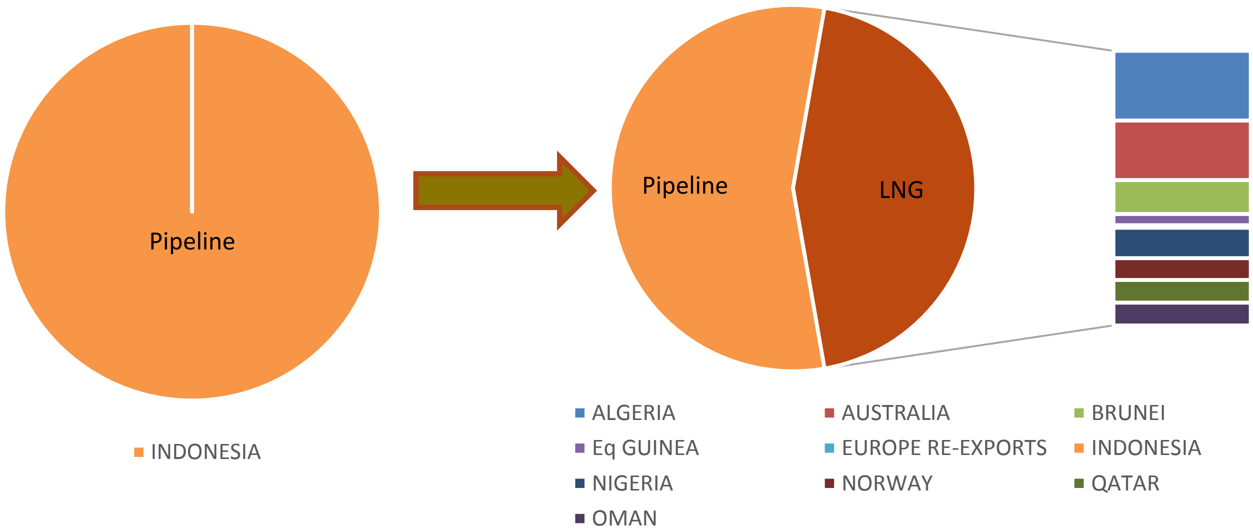
Power generation mix evolution in Malaysia



- ➢ New power capacity added has been 4% y-o-y from 2010 to 2015
- ➢ For the period 2010-2015, Oil Capacity has been declining, with gas capacity remaining flat. New additions were on coal power generation and Hydropower. Renewables such as wind and solar are still less than 1% of the total power capacity installed
- ➢ Domestic energy resources are continuing to depleting and Malaysia is moving to more LNG import
- ➢ LNG import needed to continue selling LNG and provide Gas
- ➢ Coal power capacity used to replace Gas power production and allow Malaysia to export LNG
- ➢ Malaysia needs to work harder in adding more renewable capacity

Shortage of gas in peninsular Malaysia necessitated LNG imports

Change in Gas Imports Matrix from 2012 to 2015



Import Volume (2012): 2.34 bcm

Import Volume (2015) : 4.7 bcm

Source: Enerdata World LNG Database

**import volume does not include gas transported from the Malaysia-Thailand Joint Development Area*

Key Insights

a) A traditional LNG exporter had to look at LNG imports to meet the gas demand. Melaka LNG terminal was commissioned in 2013 and another one is planned for 2019

b) Besides LNG imports, Government also aims to increase domestic gas production through enhanced recovery, developing small fields and increasing the exploration activities

c) Fuel Switching and new industries will add more gas demand

Malaysia LNG imports by source and regasification capacity

Regasification Terminal	Type	Operator	Status	Commissioning	Capacity (Mt/y)
Melaka	FSRU	Petronas	Operational	2013	3.80
Pengerang	Onshore	Petronas	Approved	2019	3.80

Malaysia – Electricity Targets

**Renewable capacity includes hydropower, biomass, solar, wind, geothermal (total capacity is slightly different due to rounding)*

	**2015 installed capacity**	**2020 forecast capacity (EnerBlue)**	**2015 share of power generation**	**Electricity Targets**
Coal	8.7 GW	12.8 GW	37.6%	24.9 GW in Peninsular Malaysia with 20% reserve margin, 1.8 GW in Sabah with 34% reserve margin, 5.1 GW in Sarawak with 19% reserve margin by 2020
Oil	1.4 GW	1.3 GW	2.3%	
Gas	15.4 GW	20.1 GW	49.7%	
Nuclear	n.a.	n.a.	n.a.	No Nuclear
Renewables	7.0 GW	9 GW	10.4%	2,080 MW (67% biomass and waste, 24% mini-hydro, 9% solar PV)
Total	32.6 GW	43.3 GW	100%	Malaysia's Renewable Energy Policy & Action Plan 2010, 11th Malaysia Energy Plan 2016-2020

Source: Enerdata Global Energy & CO_2 Data, EnerFuture, Countries' Energy Policies

RE/Gas/Power Latest Developments in Malaysia

Second competitive bid process for a 460 MW project in Malaysia

6 March, 2017

The Malaysian Energy Commission (Suruhanjaya Tenaga) has recently announced it plans to start a second competitive bid process in order to select developers for large scale PV projects which would have a combined capacity of 460 MW. The involved projects are a 360 MW project in the Malaysian peninsula and a 100 MW in the Labuan territory.

The projects will be completed in 2019-2020 and will deliver their output to the utility companies Tenaga Nasional Berhad (TNB) or Sabah Electricity Sdn Bhd (SESB).

Thailand approves 15-year LNG import deal with Malaysia

9 December, 2016

The energy policy committee of Thailand has approved a 15-year LNG import contract signed by state-owned oil and gas company PTT with Malaysia's LNG producer Petronas. Under the terms of the agreement, PTT will import 1 Mt/year (1.35 bcm/year) of Malaysian LNG in 2017 and 2019; deliveries will rise to 1.2 Mt/year (1.6 bcm/year) as of 2019 and until the end of the contract (2032). The agreement will be submitted for approval to the Cabinet.

Sarawak Energy selects contractors for 400 MW CCGT project (Malaysia)

4 November, 2016

Malaysian power group Sarawak Energy Bhd (SEB) has selected a consortium of GE and Sinohydro as the Engineering, Procurement and Construction (EPC) contractor for the construction of a 400 MW gas-fired CCGT power project at Tanjung Kidurong in Bintulu (Sarawak, Malaysia).

The RM1bn (US$240m) project will replace the existing open cycle turbines at the Tanjung Kidurong power plant. Construction will start in late November 2016 and the new plant should be commissioned by mid-2019.

Malakoff commissions 1 GW USC coal-fired power project (Malaysia)

25 March, 2016

Malakoff Corporation Berhad (MCB), the largest independent power producer (IPP) in Malaysia, has commissioned its 1,000 MW Tanjung Bin 4 ultra-supercritical coal-fired power plant on the site of the existing 2,100 MW coal-fired Tanjung Bin Power Plant (TBPP) in Johor, in Malaysia.

Power will be sold to Malaysia's national power utility, Tenaga Nasional Berhad (TNB), under a 25-year Power purchase agreement.

Source : Enerdata Energy Business Intelligence, Key Energy News

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Feasibility Study Elements for a Power Project

Policy and Regulatory Assessment

- Government policies & regulations
- Targets & obligations
- Carbon
- Ownership restriction
- Applicable codes, law, standards & guides
- Land & water use
- Environmental
- Financial incentives
- Labour
- Tax system
- Outlook

Market Assessment

- Analysis and forecasts of market fundamentals including supply, demand and prices
- Gas Market: Reserves, production, imports (pipeline, LNG), domestic supply, gas transport infrastructure, gas prices, demand, end users, exports, gas contracts, trade volumes etc.
- Electricity Market: production, generation technologies, fuel mix, renewables, nuclear, capacity planning, transmission planning, demand by end user etc.
- Quantify risks using Enerdata Risk Index

Market Sizing

- Bottom up analysis and forecast of the market for estimation of market size specific to the business opportunity
- Geographical constraints, demography, energy use patterns, access to energy infrastructure and many other factors influence the final market size of the business and can be different from the macro level country analysis.

Technology Selection

- Site Selection – land access, socio-economic impact, environmental sensitivity, permitting and licensing
- Available technical options, capex requirements, technical configurations, development time
- Operational requirements, OPEX etc

Economic Analysis

- Revenues based on forecasted prices and volumes
- Analysis of different revenue streams
- Costs – raw material, labor, capital, maintenance, operations etc
- Financial indicators - NPV, IRR, ROI

Risk Assessment

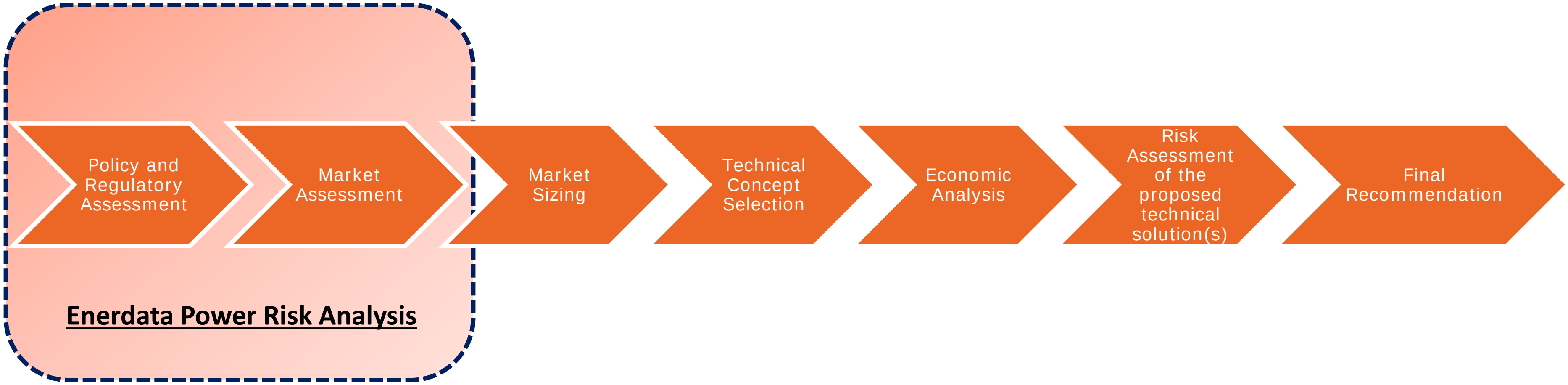
- Critical factors for project success
- Sensitivity Analysis of ROI
- Scenario Analysis
- Ranking Analysis of technical solutions, if more than one solution is possible – ROI, time to operation, modularity, environmental risk, regulation risk etc
- Risk Mitigation Plan

Final Recommendation

- Most feasible solution with a complete understanding of the underlying risks together with risk mitigation plan

Enerdata's expertise

Power Risk Analysis is applied to first two steps



- The Power Risk Analysis Framework can be applied to either single market or multiple markets, if benchmarking is required

Enerdata Risk Index (ERI)

a) Asian Power markets tend to be relatively opaque compared to the more developed European and North American markets.

b) Objective of ERI: to provide an independent and transparent methodology in order to better assess these markets.

c) The risk assessment index for each country is calculated based on data from over 400 energy related information sources worldwide.

d) Methodology adopted is regularly reviewed and updated to reflect the changing availability of comparative data.

Enerdata Risk Index (ERI)

- <u>5 Risk Categories</u>: Commercial, Socio-Economic, Financial, Environment, Security
- 25 Key Performance Indicators
- <u>18 Countries</u>: Australia, Cambodia, China, Hong Kong, India, Indonesia, Japan, Laos, Malaysia, Myanmar, New Zealand, Pakistan, Philippines, Singapore, South Korea, Taiwan, Thailand, Vietnam

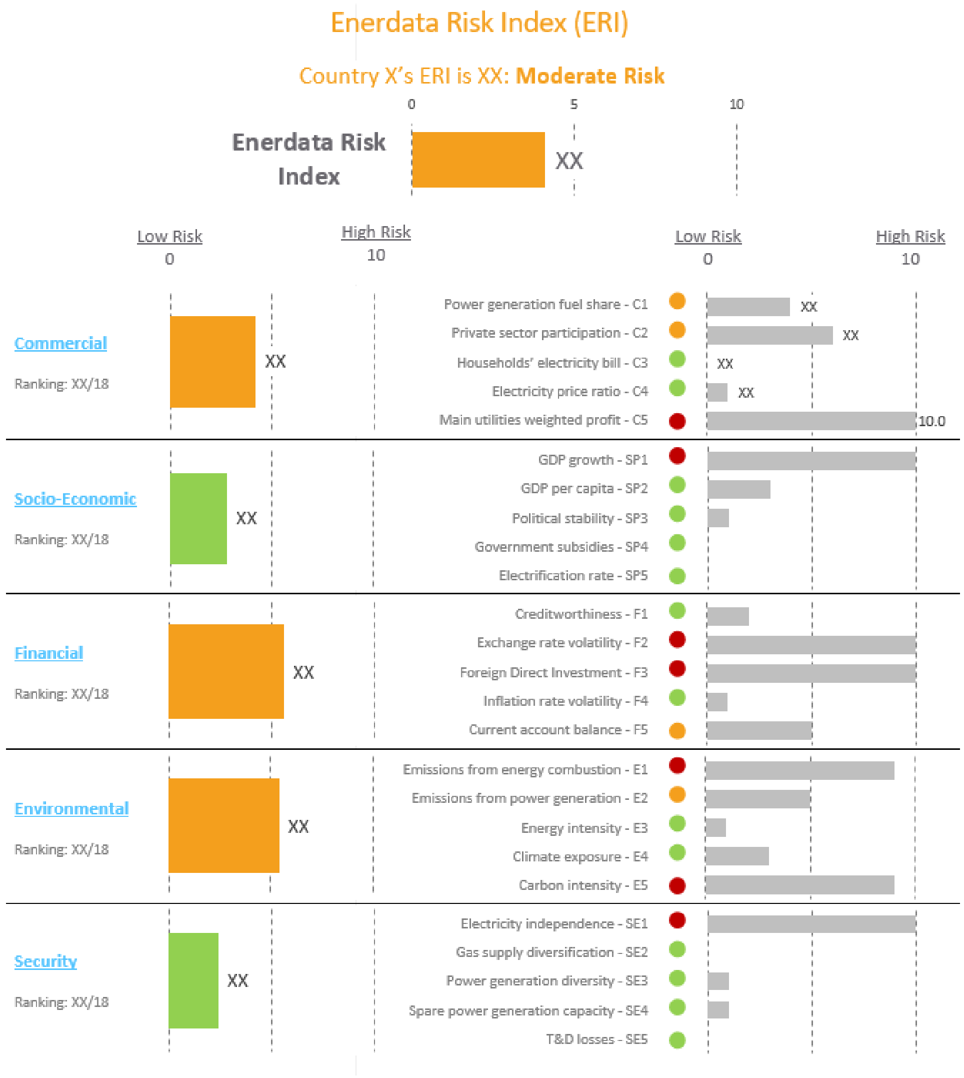
Enerdata Risk Index (ERI)	C – Commercial	C1 – Power generation fuel share
		C2 - Private sector participation
		C3 - Households' electricity bill
		C4 – Household-Industry electricity price ratio
		C5 – Main utilities weighted profit
	SP - Socio-Economic	SP1 - GDP growth
		SP2 - GDP per capita
		SP3 – Political stability
		SP4 - Government subsidies
		SP5 - Electrification rate
	F - Financial	F1 - Creditworthiness
		F2 - Exchange rate volatility
		F3 - Foreign direct investment
		F4 - Inflation rate volatility
		F5 - Current account balance
	E - Environmental	E1 - Emissions from energy combustion
		E2 - Emissions from power generation
		E3 - Energy intensity
		E4 - Climate exposure
		E5 - Carbon intensity
	SE - Security	SE1 - Electricity independence
		SE2 - Gas supply diversification
		SE3 - Power generation diversity
		SE4 - Spare power generation capacity
		SE5 - T&D losses

Enerdata Risk Index (ERI)

a) In order to evaluate the risk rating associated with each risk category, each KPI is scored on a scale from 0 (lowest risk countries) to 10 (highest risk countries).

b) The arithmetic mean of the score in each category provides the 5 risk category ratings; and the average of these 5 ratings will provide the Enerdata Risk Index for the particular country.

c) A higher ERI indicates a higher risk for the country evaluated, vice versa.



Ranking against the other Asia-Pacific countries assessed: Australia, Cambodia, China, Hong Kong, India, Indonesia, Japan, Laos, Malaysia, Myanmar, New Zealand, Pakistan, Philippines, Singapore, South Korea, Taiwan, Thailand and Vietnam;
*Indicates that KPI has been assigned a score of 5 according to the methodology

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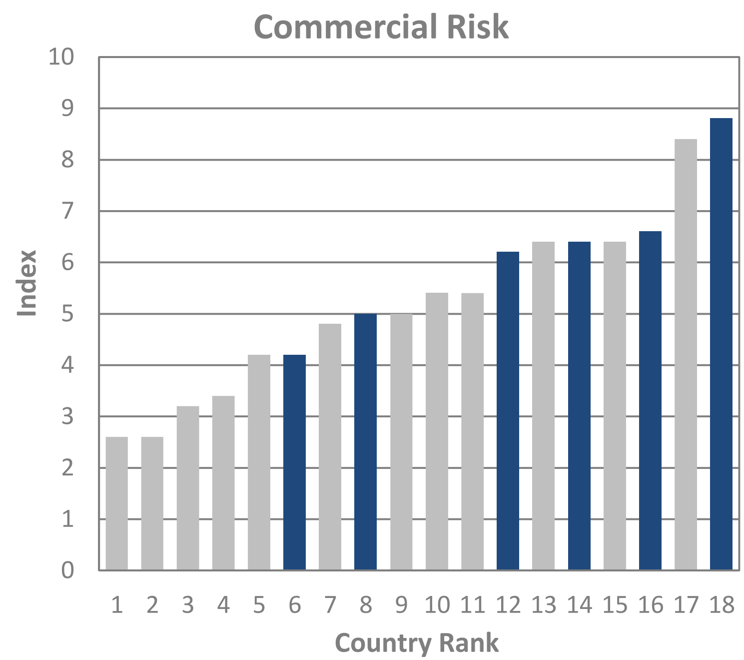
Enerdata Risk Index (ERI)

- **Commercial Risk** refers to the risk of potential losses arising from trading (including procurement) in the market. A key consideration when assessing this risk is pricing, the level of pricing, and participant competition.

KPI:	Description
Power Generation Fuel Share	The percentage share of the predominant generation fuel, which provides an indication of fuel competition.
Private Sector Participation	The cumulative percentage market share of the top 3 private power generation companies.
Households' Electricity Bill	The percentage of household income spent on electricity.
Household-Industry Electricity Price Ratio	The ratio between the average household and industrial electricity tariffs.
Main Utilities Weighted Profit	The ratio of operating profits to revenues of the top 3 companies (weighted against their market shares) to indicate any concentration in profitability potential.

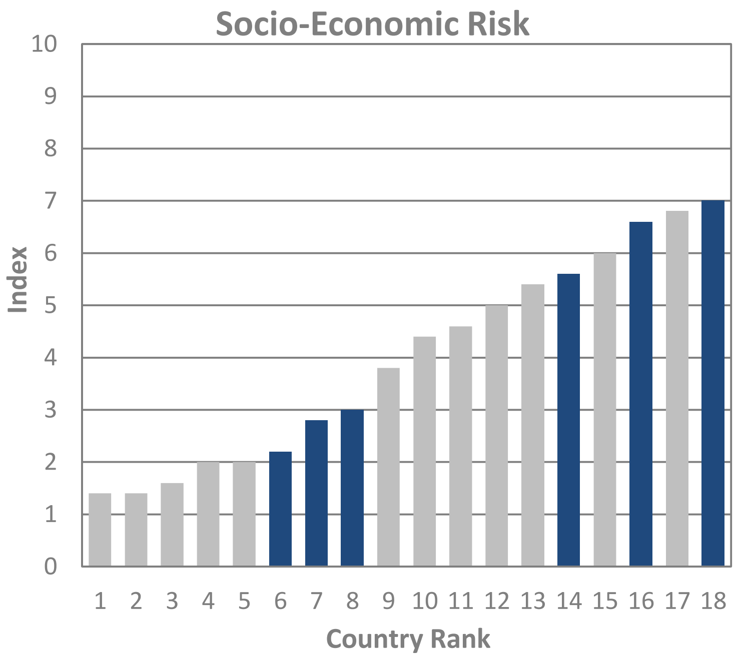


Country	ERI Rank	C1	C2	C3	C4	C5	Commercial Risk
China	12	8	10	0	8	5	6.2
Japan	6	4	6	0	1	10	4.2
India	18	9	10	9	8	8	8.8
South Korea	14	4	10	10	4	4	6.4
Indonesia	16	6	10	10	6	1	6.6
Malaysia	8	5	3	10	5	2	5.0

Enerdata Risk Index (ERI)

- **Socio-Economic Risk** refers to the risk associated with the causal correlation between social and economic development. A key consideration when assessing this risk is the impact of deep social divides on power and gas markets, particularly in developing markets.

KPI:	Description
GDP Growth	The percentage year-on-year GDP growth.
GDP per Capita	Measured in GDP (USD) at constant purchasing power parity per capita. Indicates the average economic wealth of a country.
Political Stability	Index is provided by the Heritage Foundation.
Government Subsidies	The total subsidy for fossil fuels and electricity (expressed in real 2013 US billions) sourced from the IEA.
Electrification Rate	The percentage of the country's population with access to electricity.

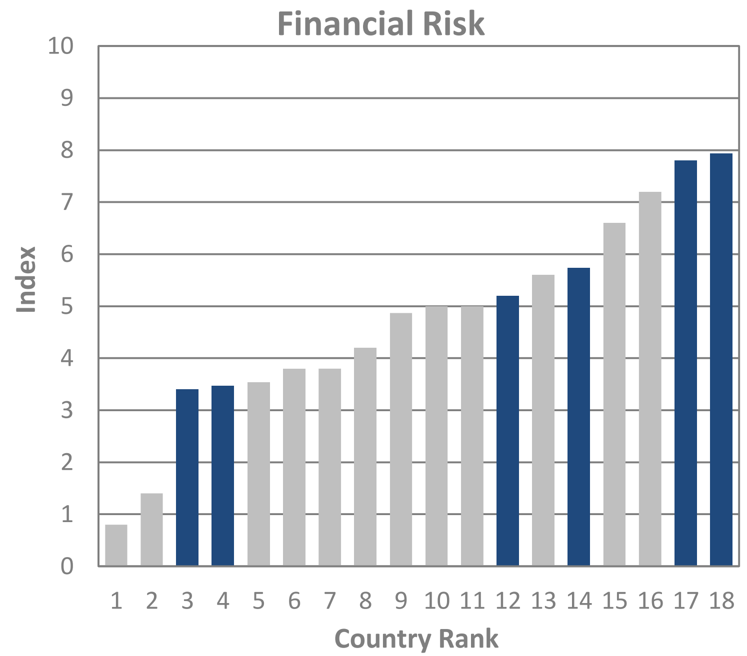


Country	ERI Rank	SP1	SP2	SP3	SP4	SP5	Socio-Economic Risk
China	14	0	8	9	10	1	5.6
Japan	7	10	3	1	0	0	2.8
India	16	0	10	8	10	5	6.6
South Korea	6	6	3	2	0	0	2.2
Indonesia	18	4	9	7	10	5	7.0
Malaysia	8	4	5	2	4	0	3.0

Enerdata Risk Index (ERI)

- **Financial Risk** refers to the risk associated with a country's ability to attract new investment, which is pivotal to the market's development.

KPI:	**Description**
Creditworthiness	The short term credit rating assessed by Standard & Poor's.
Exchange Rate Volatility	The absolute value of the year-on-year percentage change in the exchange rate versus the US dollar.
Foreign Direct Investment	The share of foreign direct investment in the gross fixed capital formation in the country.
Inflation Volatility	The maximum inflation rate over the previous 3 years.
Current Account Balance	The share of the sum of net exports of goods and services and net primary and secondary income in the GDP.

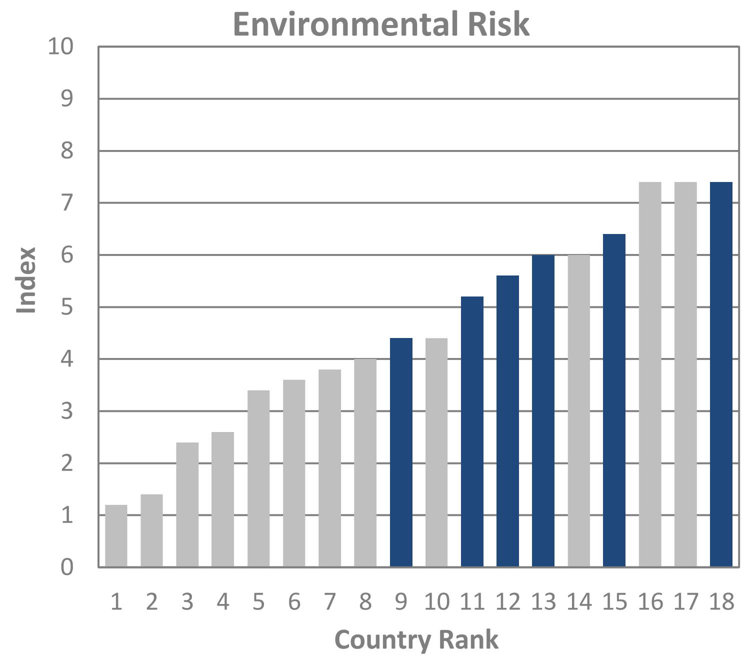


Country	ERI Rank	F1	F2	F3	F4	F5	Financial Risk
China	3	2	0	10	1	4	3.4
Japan	14	4	10	10	1	5	6.0
India	17	6	5	10	10	8	7.8
South Korea	4	2	4	10	1	0	3.4
Indonesia	18	7	10	10	5	8	7.9
Malaysia	12	4	10	9	2	2	5.4

Enerdata Risk Index (ERI)

- **Environmental Risk** refers to the risk associated with the costs and benefits of environmental issues. For example, there is a cost associated with emissions mitigation (ie. pass-through carbon costs), and there is a social benefit from less pollution and less energy consumption.

KPI:	Description
Emissions from Energy Combustion	The total CO_2 emissions per capita from energy combustion.
Emission from Power Generation	The average emissions per kWh produced in gCO_2 per kWh.
Energy Intensity	The total energy consumption per unit of GDP, with GDP measured in purchasing power parity.
Climate Exposure	The country's vulnerability to climate change and readiness to improve its resilience to climate induced events, provided by the ND-Gain index.
Carbon Intensity	The average emission per unit of energy consumed.

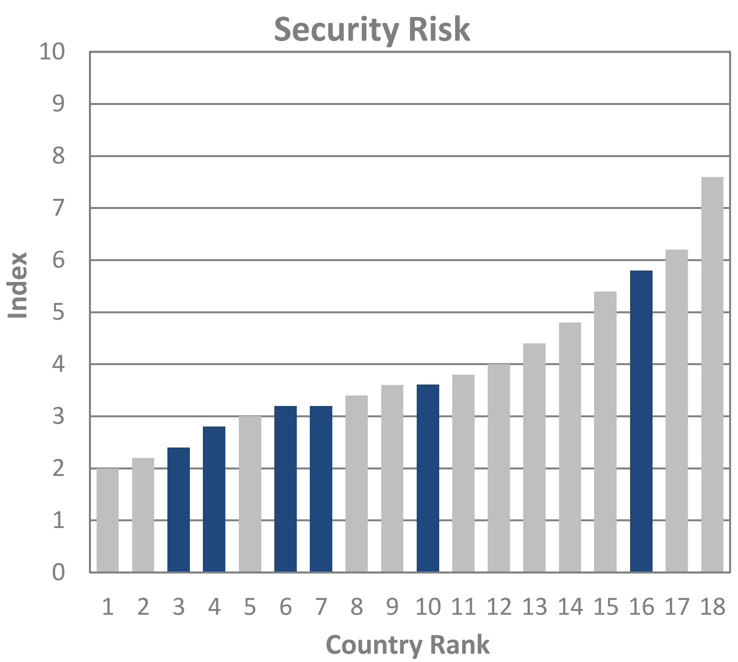


Country	ERI Rank	E1	E2	E3	E4	E5	Environmental Risk
China	18	6	8	10	5	8	7.4
Japan	11	9	5	1	3	8	5.2
India	12	1	10	3	6	8	5.6
South Korea	13	10	4	7	3	6	6.0
Indonesia	9	1	10	1	5	5	4.4
Malaysia	15	7	8	5	4	8	6.4

Enerdata Risk Index (ERI)

- **Security Risk** refers to the risk associated with energy supply security. A key consideration when planning infrastructure development is the costs associated with maintaining supply security.

KPI:	**Description**
Electricity Independence	The percentage of electricity supply derived from domestic resources.
Gas Supply Diversification	The diversity (Herfindahl-Hirschman Index) of gas supplies, weighted by the share of gas imports in total gas consumption.
Power Generation Diversity	Measured by the Herfindahl-Hirschman Index, which is a measure of market concentration.
Spare Power Generation Capacity	The percentage of total installed capacity that is not used in electricity production.
Transmission and Distribution Losses	The percentage of electricity 'lost' between the sources of supply and the end user.



Country	ERI Rank	SE1	SE2	SE3	SE4	SE5	Security Risk
China	4	1	0	9	2	2	2.8
Japan	3	10	0	1	1	0	2.4
India	16	4	3	9	3	10	5.8
South Korea	10	9	1	2	6	0	3.6
Indonesia	6	1	4	3	3	5	3.2
Malaysia	7	5	4	4	3	0	3

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Conclusions

Booming market	All scenarios confirm substantial growth on electricity demand all around the world
Global Opportunities	Asia will play an important role on the power market with both new installations and change of regulations moving towards deregulated markets
RE Drivers	All started with the emissions reduction objective but nowadays RE projects are economically competitive versus fossil fuels too
Power Project plenty of risks to mitigate	Each country, each technology present a different challenge and risks to be accounted for to ensure the project will be profitable in the long run. Understanding of the "Local" market dynamics is a must

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