Fitch Solutions

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Chile

Renewables Report

Includes 10-year forecasts to 2027

Contents

Key View

Key View: *Chile's non-hydro renewables sector will remain one of the regional outperformers over the short to medium term, benefiting from strong investor interest in a range of sectors as well as an attractive business environment and high level of government commitment to the expansion of renewable (and conventional) energy infrastructure. Successful power auctions have significantly boosted the project pipeline and a large volume of new capacity is expected to come online in the next five years, before growth slows over the latter half of the forecast period.*

RENEWABLES HEADLINE FORECASTS (CHILE 2017-2023)

Indicator	2017e	2018f	2019f	2020f	2021f	2022f	2023f
Generation, Non-Hydropower Renewables, TWh	10.054	11.307	11.952	17.547	18.214	18.423	20.002
Generation, Non-Hydropower Renewables, % y-o-y	-8.909	12.464	5.701	46.815	3.800	1.145	8.575
Capacity, Non-Hydroelectric Renewables, MW	4,135.0	4,736.5	5,069.6	6,754.7	6,984.3	7,060.6	7,675.1
Capacity, Non-Hydroelectric Renewables, % y-o-y	20.1	14.5	7.0	33.2	3.4	1.1	8.7

e/f = Fitch Solutions estimate/forecast. Source: CNE, Systep, EIA, Fitch Solutions

Latest Updates And Structural Trends

- Chile's previous power auctions have attracted a large volume of bids with a focus on new wind and solar capacity. Most projects awarded are due to come online by 2024, supporting our expectation that after rapid growth over the next five years, growth in the renewables market will slow over the latter stages of forecast period. Oversupply, as new capacity outstrips demand, could also dampen investment in the market.
- The election of Sebsatián Piñera will ensure policy continuity for the renewables sector. Renewable energy targets could potentially reach 100% by 2040 which would necessitate major investment in the development of new capacity, as well as expansion of transmission and distribution infrastructure.
- Wind power currently leads the renewables market, accounting for 42.3% of non-hydro generation in 2018. There are numerous projects underway in the wind power sector, such as **AR Coihue** (a subsidiary of **Mainstream Renewable Power**) which plans to build a 310.5MW wind park, dubbed Entre Ríos Wind Farm, in the Bío Bío region. The USD497mn scheme includes the installation of 69 wind turbines, each of 4.5MW, in the communes of Mulchén, Negrete and Los Angeles.
- The solar power sector, currently accounting for 34.8% of non-hydro generation, is also attracting investment. **Sonnedix** recently announced the acquisition of the 138MW Meseta de Los Andes project which is due to enter construction in 2020. Spanish firm **AR Energia** will develop the project. Despite steady growth over the next decade, solar power's share of the renewables mix will decline to 25.5% by 2027 as it is outpaced by the wind power sector.
- Our current forecasts show very limited growth in the small geothermal sector, however we do note that growth potential in the sector is significant. The Ministry of Energy recently worked with the geothermal energy industry to report on growth potential under the Geothermal Table, noting that there is potential for 600MW of geothermal energy to be developed by 2030 (followed by 1,500MW between 2031 and 2050).

SWOT

Renewables SWOT

SWOT Analysis	
Strengths	• Stable policy environment and well-established, business-friendly investment climate. • Supportive regulatory environment and fully privatised power sector. • Solar levels and wind speeds are ideal for the development of renewables projects. • A growing mining sector and robust economic expansion will support long-term growth in power consumption.
Weaknesses	• Chile's power market is of modest size relative to much larger Latin American markets like Argentina, Brazil and Mexico, thus limiting growth potential. • Chile needs to import all its hydrocarbon fuels, exposing electricity prices to fluctuations in the price of natural gas, oil and coal. • Significant investment into the transmission network is needed to allow the full implementation of planned renewables capacity. • Economic growth is exposed to changes in demand for minerals and commodities prices.
Opportunities	• The new government of Sebastian Piñera is committed to strengthening the non-hydro renewables sector and the transmission infrastructure. • A carbon tax introduced in 2017 will increase the cost-competitiveness of renewable energy projects. • Government's use of energy auctions to award long-term PPAs gives visibility to investors in terms of returns from renewables projects. • Mining activities in remote areas present opportunities for renewables developers through bilateral PPAs.
Threats	• The transmission network will be at risk of bottlenecks until new transmission lines and the SIC-SING grids integration will be completed. • The development of some solar and wind power projects have suffered delays in the past. • The high costs of developing geothermal power will limit growth in the sector compared to solar and wind, which are much more competitive. • The switching of clients from the regulated to the free market is reducing the volume of power needed to be secured via auctions.

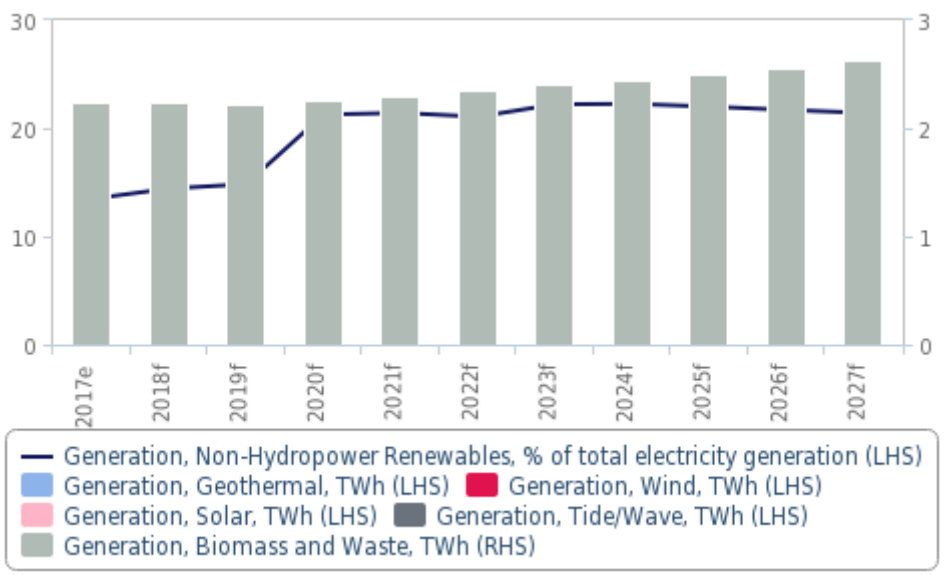
Industry Forecast

Chile Renewables Forecast Scenario

Key View: *Chile's non-hydro renewables sector is poised for robust growth for much of the forecast period (from 2018 to 2027), particularly in terms of wind and solar power. The project pipeline is expansive, with around 34.5GW of new capacity at various stages of development. A potential decline in consumer demand means that we are not currently including all planned new capacity into our forecasts for the renewables sector, particularly in light of the propensity for delays caused by inadequate transmission and distribution infrastructure, though most sectors will still make strong gains in capacity and generation.*

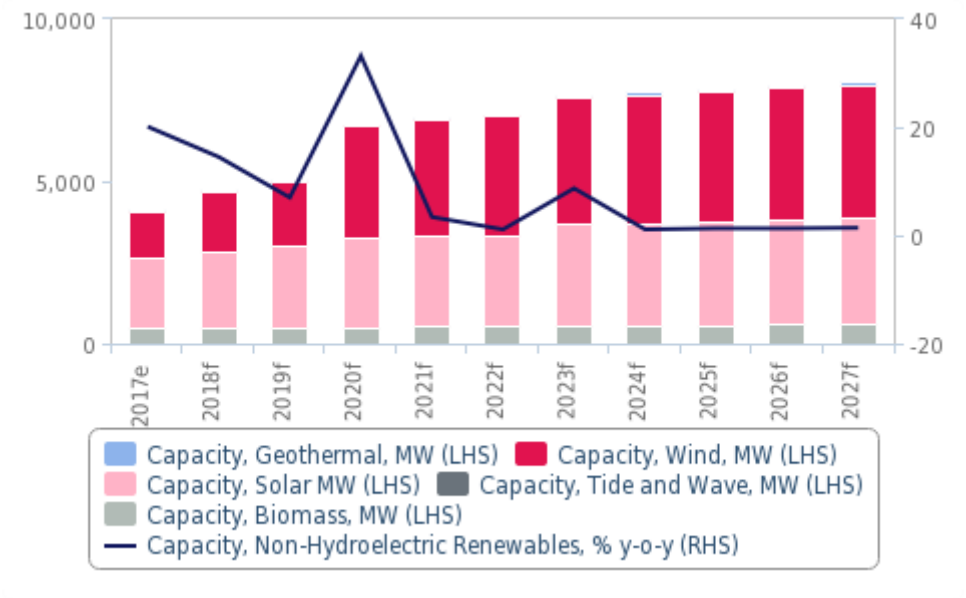
Non-Hydro Renewables Generation By Type And Share Of Total Electricity Generation

Non-Hydro Renewables Generation By Type And Share Of Total Electricity Generation (2017-2027)



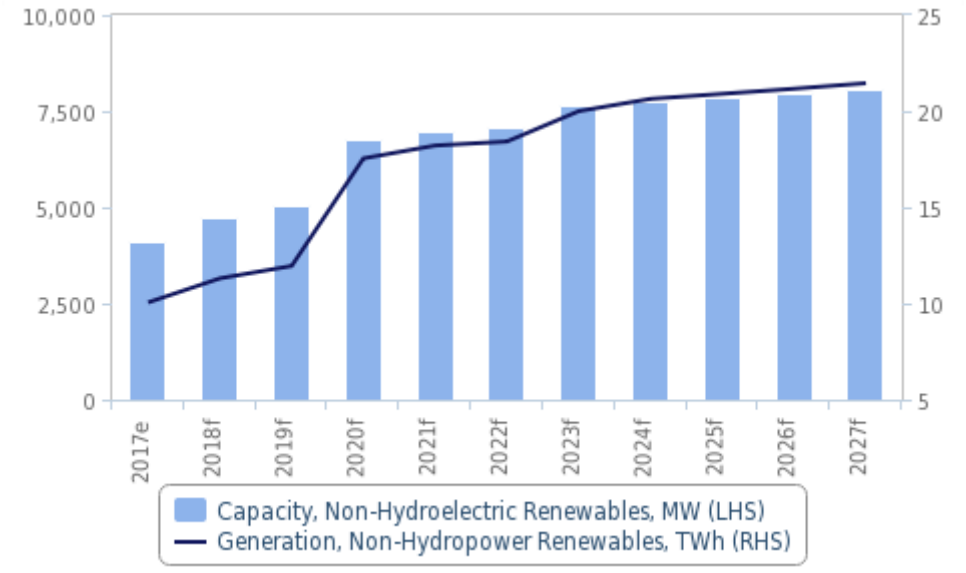
e/f = Fitch Solutions estimate/forecast. Source: CNE, Systep, EIA, Fitch Solutions

Non-Hydro Renewables Capacity By Type And Growth
(2017-2027)



e/f = Fitch Solutions estimate/forecast. Source: CNE, Systep, EIA, Fitch Solutions

Non-Hydro Renewables Capacity And Generation
(2017-2027)



e/f = Fitch Solutions estimate/forecast. Source: CNE, Systep, EIA, Fitch Solutions

TOTAL ELECTRICITY GENERATION DATA AND FORECASTS (CHILE 2016-2021)

Indicator	2016e	2017e	2018f	2019f	2020f	2021f
Generation, Total, TWh	73.877	74.647	78.420	80.569	82.548	85.045
Generation, Total, % y-o-y	2.136	1.042	5.054	2.740	2.456	3.025
Generation, Non-Hydropower Renewables, TWh	11.037	10.054	11.307	11.952	17.547	18.214
Generation, Non-Hydropower Renewables, % y-o-y	23.117	-8.909	12.464	5.701	46.815	3.800
Generation, Non-Hydropower Renewables, % of total electricity generation	14.940	13.469	14.419	14.834	21.257	21.417

Indicator	2016e	2017e	2018f	2019f	2020f	2021f
Generation, Geothermal, TWh	0.000	0.350	0.350	0.354	0.354	0.354
Generation, Geothermal, % y-o-y			0.000	1.000	0.000	0.000
Generation, Geothermal as % of total non-hydropower renewables generation	0.000	3.481	3.095	2.958	2.015	1.941
Generation, Wind, TWh	2.252	3.732	4.783	5.264	10.371	10.961
Generation, Wind, % y-o-y	6.629	65.735	28.149	10.049	97.038	5.687
Generation, Wind, % of total non-hydropower renewables generation	20.403	37.123	42.300	44.040	59.106	60.180
Generation, Solar, TWh	2.550	3.732	3.930	4.113	4.568	4.600
Generation, Solar, % y-o-y	105.977	46.367	5.307	4.653	11.042	0.700
Generation, Solar, % of total non-hydropower renewables generation	23.103	37.123	34.760	34.416	26.030	25.253
Generation, Tide/Wave, TWh	0.000	0.000	0.000	0.000	0.000	0.000
Generation, Tide/Wave, % of non-hydropower renewables generation	0.000	0.000	0.000	0.000	0.000	0.000
Generation, Biomass and Waste, TWh	6.235	2.239	2.244	2.221	2.255	2.300
Generation, Biomass and Waste, % y-o-y	11.050	-64.086	0.200	-1.000	1.500	2.000
Generation, Biomass and Waste, % of non-hydropower renewables generation	56.494	22.274	19.845	18.587	12.850	12.627

e/f = Fitch Solutions estimate/forecast. Source: CNE, Systep, EIA, Fitch Solutions

TOTAL ELECTRICITY GENERATION DATA AND FORECASTS (CHILE 2022-2027)

Indicator	2022f	2023f	2024f	2025f	2026f	2027f
Generation, Total, TWh	87.474	90.079	92.758	95.027	97.599	100.176
Generation, Total, % y-o-y	2.856	2.978	2.974	2.446	2.706	2.641
Generation, Non-Hydropower Renewables, TWh	18.423	20.002	20.641	20.902	21.168	21.455
Generation, Non-Hydropower Renewables, % y-o-y	1.145	8.575	3.195	1.263	1.274	1.354
Generation, Non-Hydropower Renewables, % of total electricity generation	21.061	22.205	22.253	21.996	21.689	21.417
Generation, Geothermal, TWh	0.354	0.584	0.589	0.593	0.598	0.601
Generation, Geothermal, % y-o-y	0.000	65.064	0.900	0.800	0.700	0.600
Generation, Geothermal as % of total non-hydropower renewables generation	1.919	2.917	2.852	2.839	2.823	2.802
Generation, Wind, TWh	11.071	11.863	12.395	12.519	12.644	12.770
Generation, Wind, % y-o-y	1.000	7.156	4.483	1.000	1.000	1.000
Generation, Wind, % of total non-hydropower renewables generation	60.094	59.308	60.049	59.893	59.731	59.522
Generation, Solar, TWh	4.646	5.156	5.207	5.286	5.365	5.460
Generation, Solar, % y-o-y	1.000	10.987	1.000	1.500	1.500	1.774
Generation, Solar, % of total non-hydropower renewables generation	25.216	25.777	25.229	25.288	25.344	25.449
Generation, Tide/Wave, TWh	0.000	0.000	0.000	0.000	0.000	0.000
Generation, Tide/Wave, % of non-hydropower renewables generation	0.000	0.000	0.000	0.000	0.000	0.000
Generation, Biomass and Waste, TWh	2.353	2.400	2.450	2.504	2.562	2.623
Generation, Biomass and Waste, % y-o-y	2.300	2.000	2.100	2.200	2.300	2.400
Generation, Biomass and Waste, % of non-hydropower renewables generation	12.771	11.998	11.871	11.980	12.102	12.227

f = Fitch Solutions forecast. Source: CNE, Systep, EIA, Fitch Solutions

ELECTRICITY GENERATING CAPACITY DATA AND FORECASTS (CHILE 2016-2021)						
Indicator	**2016e**	**2017e**	**2018f**	**2019f**	**2020f**	**2021f**
Capacity, Net, MW	23,761.0	25,355.0	26,574.5	27,414.0	29,363.4	30,233.0
Capacity, Net, % y-o-y	9.8	6.7	4.8	3.2	7.1	3.0
Capacity, Non-Hydroelectric Renewables, MW	3,443.0	4,135.0	4,736.5	5,069.6	6,754.7	6,984.3
Capacity, Non-Hydroelectric Renewables, % y-o-y	72.9	20.1	14.5	7.0	33.2	3.4
Capacity, Non-Hydroelectric Renewables, % of total capacity	14.5	16.3	17.8	18.5	23.0	23.1
Capacity, Geothermal, MW	0.0	48.0	48.0	48.0	48.0	48.0
Capacity, Geothermal, % y-o-y			0.0	0.0	0.0	0.0
Capacity, Geothermal, % of total non-hydroelectric renewables capacity	0.0	1.2	1.0	0.9	0.7	0.7
Capacity, Wind, MW	1,298.0	1,421.0	1,821.0	2,025.0	3,425.0	3,619.8
Capacity, Wind, % y-o-y	43.0	9.5	28.1	11.2	69.1	5.7
Capacity, Wind, % of total non-hydroelectric renewables capacity	37.7	34.4	38.4	39.9	50.7	51.8
Capacity, Solar MW	1,666.0	2,183.0	2,384.5	2,489.5	2,764.4	2,783.8
Capacity, Solar, % y-o-y	170.0	31.0	9.2	4.4	11.0	0.7
Capacity, Solar, % of total non-hydroelectric renewables capacity	48.4	52.8	50.3	49.1	40.9	39.9
Capacity, Tide and Wave, MW	0.0	0.0	0.0	0.0	0.0	0.0
Capacity, Tide and Wave, % of total non-hydroelectric renewables capacity	0.0	0.0	0.0	0.0	0.0	0.0
Capacity, Biomass, MW	479.0	483.0	483.0	507.2	517.3	532.8
Capacity, Biomass, % y-o-y	2.8	0.8	0.0	5.0	2.0	3.0
Capacity, Biomass, % of total non-hydroelectric renewables capacity	13.9	11.7	10.2	10.0	7.7	7.6

e/f = Fitch Solutions estimate/forecast. Source: CNE, Systep, EIA, Fitch Solutions

ELECTRICITY GENERATING CAPACITY DATA AND FORECASTS (CHILE 2022-2027)						
Indicator	**2022f**	**2023f**	**2024f**	**2025f**	**2026f**	**2027f**
Capacity, Net, MW	30,445.3	31,091.4	31,343.6	31,497.9	31,630.2	31,813.1
Capacity, Net, % y-o-y	0.7	2.1	0.8	0.5	0.4	0.6
Capacity, Non-Hydroelectric Renewables, MW	7,060.6	7,675.1	7,757.1	7,856.4	7,957.7	8,069.9
Capacity, Non-Hydroelectric Renewables, % y-o-y	1.1	8.7	1.1	1.3	1.3	1.4
Capacity, Non-Hydroelectric Renewables, % of total capacity	23.2	24.7	24.7	24.9	25.2	25.4
Capacity, Geothermal, MW	48.0	81.0	81.0	81.0	81.0	81.0
Capacity, Geothermal, % y-o-y	0.0	68.8	0.0	0.0	0.0	0.0
Capacity, Geothermal, % of total non-hydroelectric renewables capacity	0.7	1.1	1.0	1.0	1.0	1.0
Capacity, Wind, MW	3,656.0	3,917.6	3,956.7	3,996.3	4,036.3	4,076.6
Capacity, Wind, % y-o-y	1.0	7.2	1.0	1.0	1.0	1.0
Capacity, Wind, % of total non-hydroelectric renewables capacity	51.8	51.0	51.0	50.9	50.7	50.5
Capacity, Solar MW	2,811.6	3,120.5	3,151.7	3,199.0	3,247.0	3,304.6
Capacity, Solar, % y-o-y	1.0	11.0	1.0	1.5	1.5	1.8
Capacity, Solar, % of total non-hydroelectric renewables capacity	39.8	40.7	40.6	40.7	40.8	40.9
Capacity, Tide and Wave, MW	0.0	0.0	0.0	0.0	0.0	0.0

Indicator	2022f	2023f	2024f	2025f	2026f	2027f
Capacity, Tide and Wave, % of total non-hydroelectric renewables capacity	0.0	0.0	0.0	0.0	0.0	0.0
Capacity, Biomass, MW	545.1	556.0	567.6	580.1	593.5	607.7
Capacity, Biomass, % y-o-y	2.3	2.0	2.1	2.2	2.3	2.4
Capacity, Biomass, % of total non-hydroelectric renewables capacity	7.7	7.2	7.3	7.4	7.5	7.5

f = Fitch Solutions forecast. Source: CNE, Systep, EIA, Fitch Solutions

Chile Renewables Projects Database

CHILE - TOP 10 RENEWABLES PROJECTS BY CAPACITY

Project Name	Capacity (MW)	Status	Renewables Companies
Andes Tamarugal Solar Plant, Pozo Almonte, Tarapaca	1,100	At planning stage	Andes Green Energy [Operator]{South Korea}
El Loa Solar Plant, Calama, Antofagasta	1,000	At planning stage	Andes Green Energy [Operator]{South Korea}
South Campos Sol Project, Copiapo, Atacama	698	At planning stage	Empresa de Desarrollo de Energias Renovables Alen Walung [Operator]{Chile}
Colbun Taltal Wind Farm Project, Antofagasta	607	Contract Awarded	Chile Government [Sponsor]{Chile}, Colbun SA [Operator]{Chile}
Cielos De Tarapaca Solar Park, Pozo Almonte, Tarapaca	600	At planning stage	Valhalla Energy [Operator]{Chile}
LOA Wind Farm, Antofagasta	528	Approved	Ibereolica SL [Operator]{Spain}
Talinay II Wind Farm, Ovalle, Coquimbo	500	Approved	Parque Talinay Sur SA [Operator]{Chile}
Talinay Wind Farm (Oriente), Ovalle, Coquimbo	500	Approved	Vestas Wind Systems [Equipment]{Denmark}, Vestas Wind Systems [Construction]{Denmark}, Eksport Kredit Fonden (EKF)[Financier]{Denmark}, Citigroup [Financier]{United States}, Enel Green Power SpA [Operator]{Italy}
Cabo Leones Wind Farm, Huasco, Atacama	489	Under construction	Gamesa [Equipment]{Spain}, EDF Energies Nouvelles [Sponsor]{France}, Ibereolica SL [Sponsor]{Spain}
Luz del Oro Solar Project, Atacama	475	Approved	First Solar Group [Equipment]{United States}, First Solar Group [Operator]{United States}

Source: Fitch Solutions Key Projects Database

Renewables Glossary

	Definition
bn	billion
capex	capital expenditure
CEE	Central and Eastern Europe
CHP	combined heat and power plants
DoE	US Department of Energy
e/f	estimate/forecast
EBRD	European Bank for Reconstruction and Development
EIA	US Energy Information Administration
EM	emerging markets
EU ETS	European Union Emissions Trading System
EU	European Union
EWEA	European Wind Energy Association
FDI	foreign direct investment
FiT	feed-in tariff
FTA	free trade agreement
GDP	gross domestic product
GHG	greenhouse gas
GW	gigawatt (10^9 watts)
GWh	Gigawatt hour (1 GWh = 3.6 TJ)
GWEC	Global Wind Energy Council
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IMF	International Monetary Fund

	Definition
IPO	initial public offering
IPP	independent power producer
km	kilometres
kW	kilowatt (10^3 watts)
kWh	kilowatt hour
LNG	liquefied natural gas
MEA	Middle East and Africa
mn	million
MoU	memorandum of understanding
MW	megawatt (electric) (10^6 watts)
MWh	megawatt hour
na	not available/applicable
NGL	natural gas liquids
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PV	solar photovoltaics
RES	renewable energy sources
R&D	research and development
t	metric ton = tonne (1 t = 1,000 kg)
TPES	total primary energy supply
trn	trillion
TW	terawatt (10^{12} watts)
TWh	terawatt hour (1 TWh = 3.6 PJ)

Renewables Methodology

Industry Forecast Methodology

Fitch Solutions' industry forecasts are generated using the best-practice techniques of time-series modelling and causal/ econometric modelling. The precise form of model we use varies from industry to industry, in each case being determined, as per standard practice, by the prevailing features of the industry data being examined.

Common to our analysis of every industry is the use of vector autoregressions. Vector autoregressions allow us to forecast a variable using more than the variable's own history as explanatory information. For example, when forecasting oil prices we can include information about oil consumption, supply and capacity.

When forecasting for some of our industry sub-component variables, however, using a variable's own history is often the most desirable method of analysis. Such single-variable analysis is called univariate modelling. We use the most common and versatile form of univariate models: the autoregressive moving average model (ARMA).

In some cases, ARMA techniques are inappropriate because there is insufficient historic data or data quality is poor. In such cases, we use either traditional decomposition methods or smoothing methods as a basis for analysis and forecasting.

Fitch Solutions mainly uses OLS estimators, and in order to avoid relying on subjective views and encourage the use of objective views **Fitch Solutions** uses a 'general-to-specific' method. **Fitch Solutions** mainly uses a linear model, but simple non-linear models, such as the log-linear model, are used when necessary. During periods of 'industry shock', for example poor weather conditions impeding agricultural output, dummy variables are used to determine the level of impact.

Effective forecasting depends on appropriately selected regression models. **Fitch Solutions** selects the best model according to various different criteria and tests, including but not exclusive to:

- R2 tests explanatory power; adjusted R2 takes degree of freedom into account;
- Testing the directional movement and magnitude of coefficients;
- Hypothesis testing to ensure coefficients are significant (normally t-test and/or P-value);
- All results are assessed to alleviate issues related to auto-correlation and multi-collinearity;

Fitch Solutions uses the selected best model to perform forecasting.

Human intervention plays a necessary and desirable role in all of **Fitch Solutions'** industry forecasting. Experience, expertise and knowledge of industry data and trends ensure analysts spot structural breaks, anomalous data, turning points and seasonal features where a purely mechanical forecasting process would not.

Sector-Specific Methodology

Generation Data

Total generation is defined as the process of producing electric energy or the amount of electric energy produced by transforming other forms of energy, commonly expressed in kilowatt hours (kWh) or related units. Gross electricity production is measured at the terminals of all alternator sets in a station, and thus includes the energy taken by station auxiliaries and losses in transformers that are considered integral parts of the station. Net electricity production is defined as gross production less own use by power plants. According to the International Energy Agency (IEA), the difference between gross and net production is generally about 7% for conventional thermal stations, 1% for hydro stations and 6% for nuclear.

Historical figures for electricity generation are based on data published in UN statistical databases and by the Energy Information Administration (EIA) and the World Bank, and consider net electricity production. Whenever possible, we compare these data with accounts published by government/ministry sources and official data of the companies operating in each country.

Fitch Solutions' electricity generation forecasts examine the sector with a bottom-up approach, forecasting electricity production for each resource in order to calculate the value of total generation. The regression model used to calculate generation considers real GDP, industrial production, fixed capital formation, population and fiscal expenditure.

Example of generation model:

$$Generation = \alpha + \beta 1\ Real\ GDP + \beta 2\ \%\ industrial\ production + \beta 3\ fixed\ capital\ formation + \beta 4\ population + \beta 5\ fiscal\ expenditure + u$$

Consumption and generation capacity are forecast using a similar regression model.

Capacity Data

Electricity generation capacity is defined as the maximum output, commonly expressed in megawatts (MW) or related units, that generating equipment can supply to system load, adjusted for ambient conditions.

Historical figures for electricity generation capacity are based on data published in the UN statistical databases and by the EIA. Whenever possible, we compare these data with accounts published by government/ministry sources and official data of the companies operating in each country.

Fitch Solutions' electricity generation capacity forecasts examine the sector with a bottom-up approach, forecasting capacity for each resource in order to calculate the total value of capacity in each country. **Fitch Solutions'** electricity generation capacity forecasts are based on a regression similar to the model illustrated above for electricity generation.

Sources

Fitch Solutions uses publicly available information to compile country reports and collate historical data. Sources used in power industry reports include those from international bodies mentioned above, such as the EIA, the World Bank and the UN, as well as local energy ministries, officially released company figures, national and international bodies and associations and news agencies.

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