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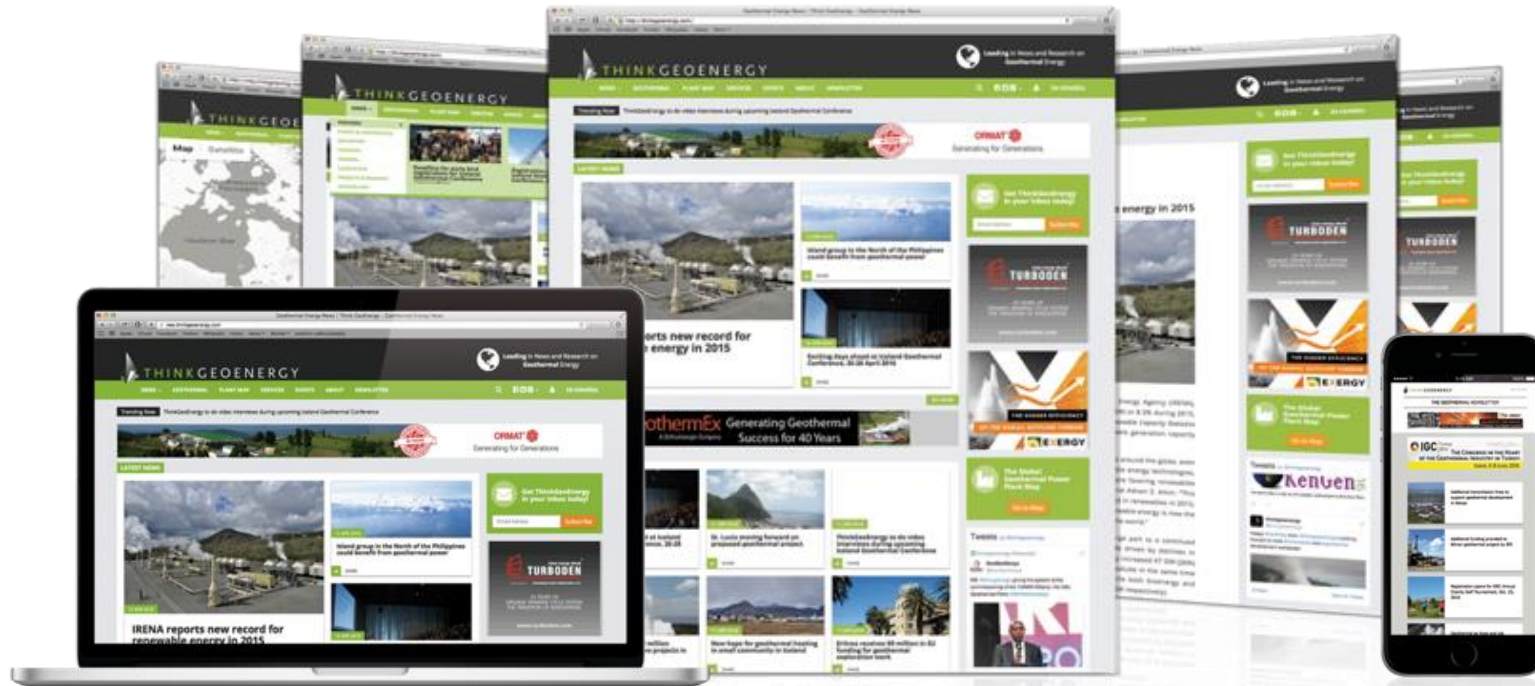
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# GLOBAL GEOTHERMAL DEVELOPMENT

CURRENT STATUS OF DEVELOPMENT AND OUTLOOK  
JULY 2019

CARLOS JORQUERA  
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# THINKGEOENERGY LEADING IN NEWS AND RESEARCH ON GEOTHERMAL ENERGY



Focus on power generation and direct use ... also internationally in **Spanish (PiensaGeotermia.com)** and in Turkish (JeotermalHaberler.com)

# AGENDA



- Geothermal Development in America Latina
- Geothermal and Mining
- Focus for the geothermal development in the mining sector

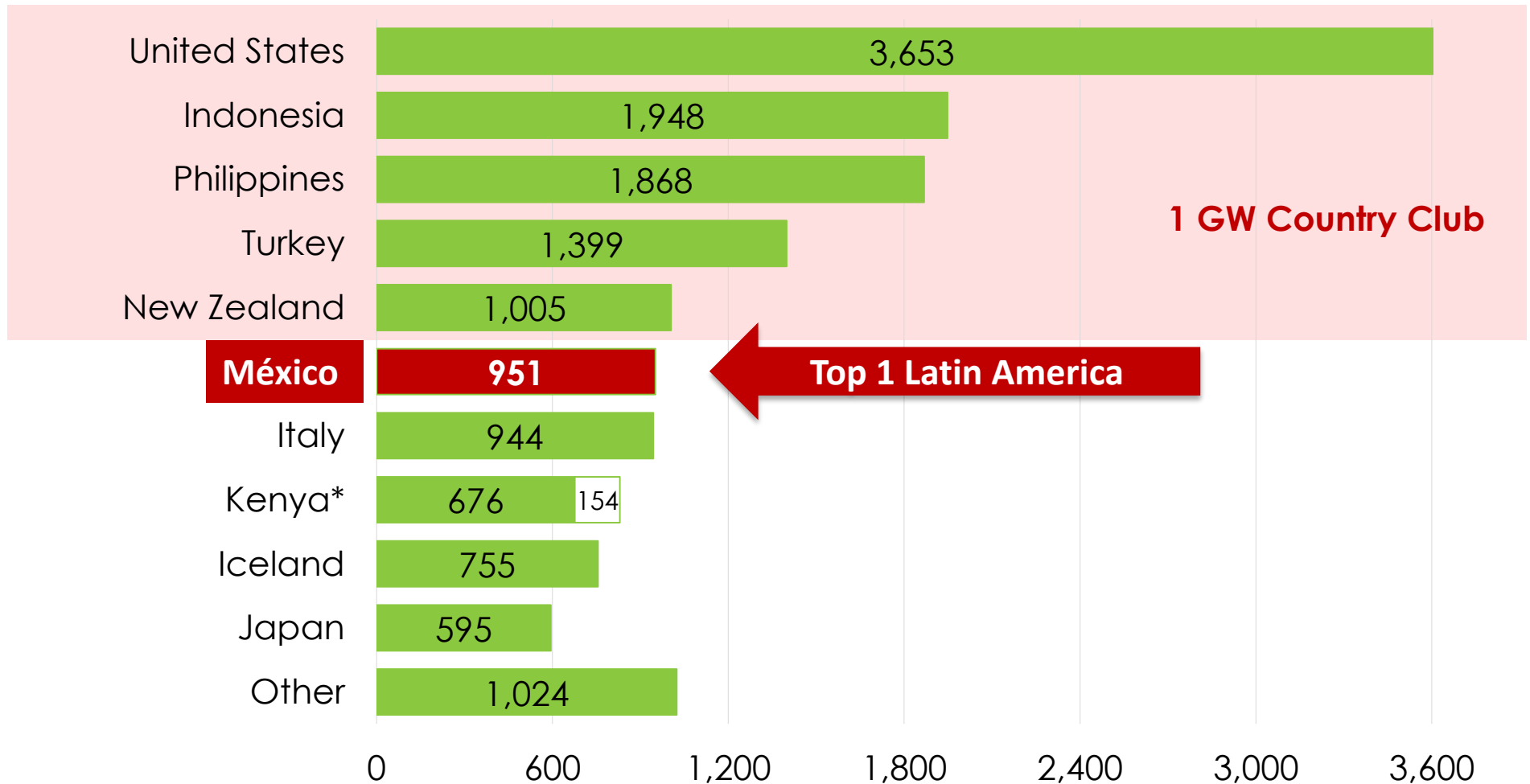
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# TOP 10 GEOTHERMAL COUNTRIES

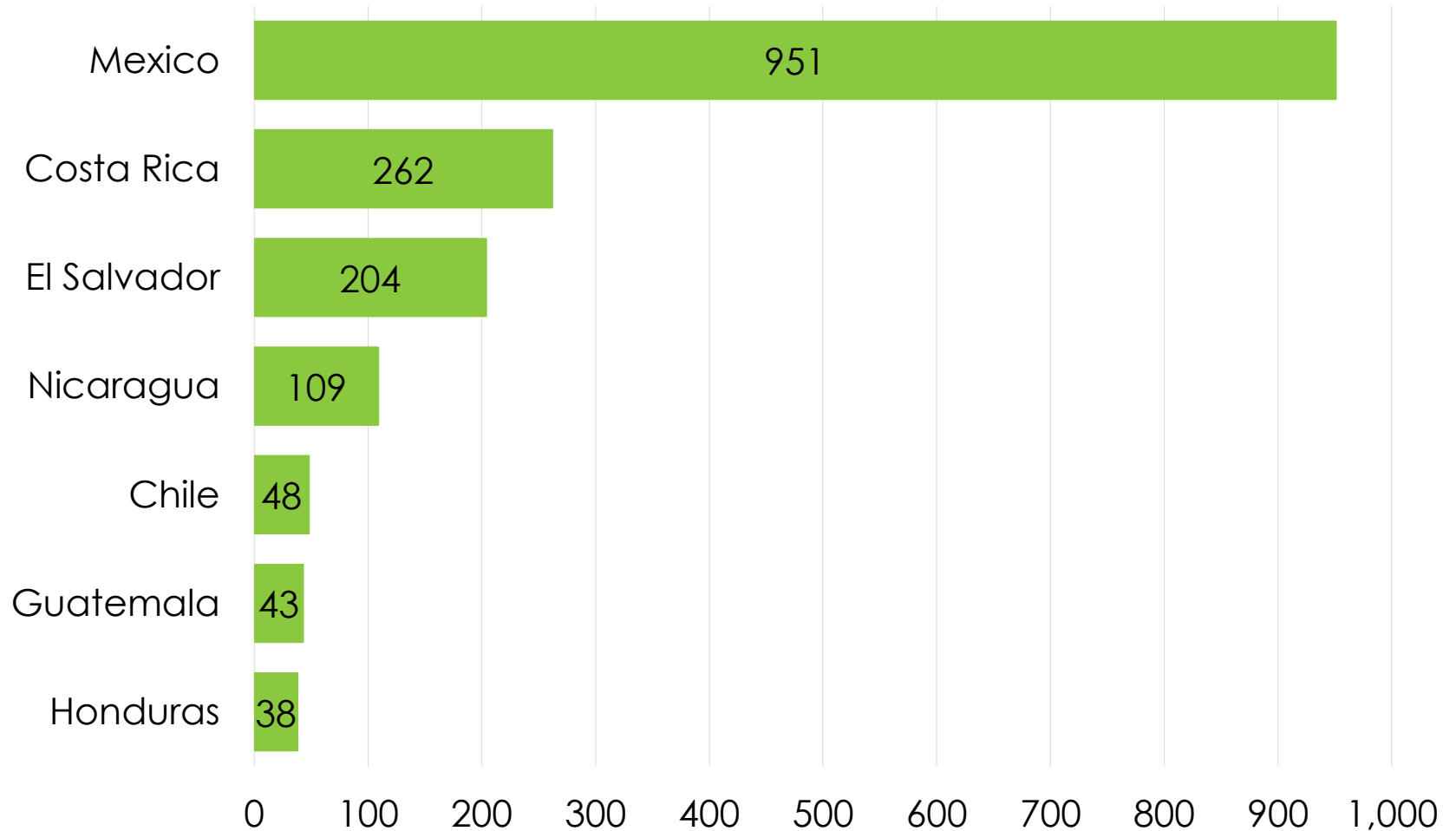
INSTALLED CAPACITY - MW (JULY 2019) – 14,818 MW IN TOTAL



\* Kenya – 154 MW Olkaria V in commissioning - Source: TGE Research (2019), GEA (2016), IGA (2015), JESDER (2019)

# GEOTHERMAL POWER – LATIN AMERICA & CARIBBEAN

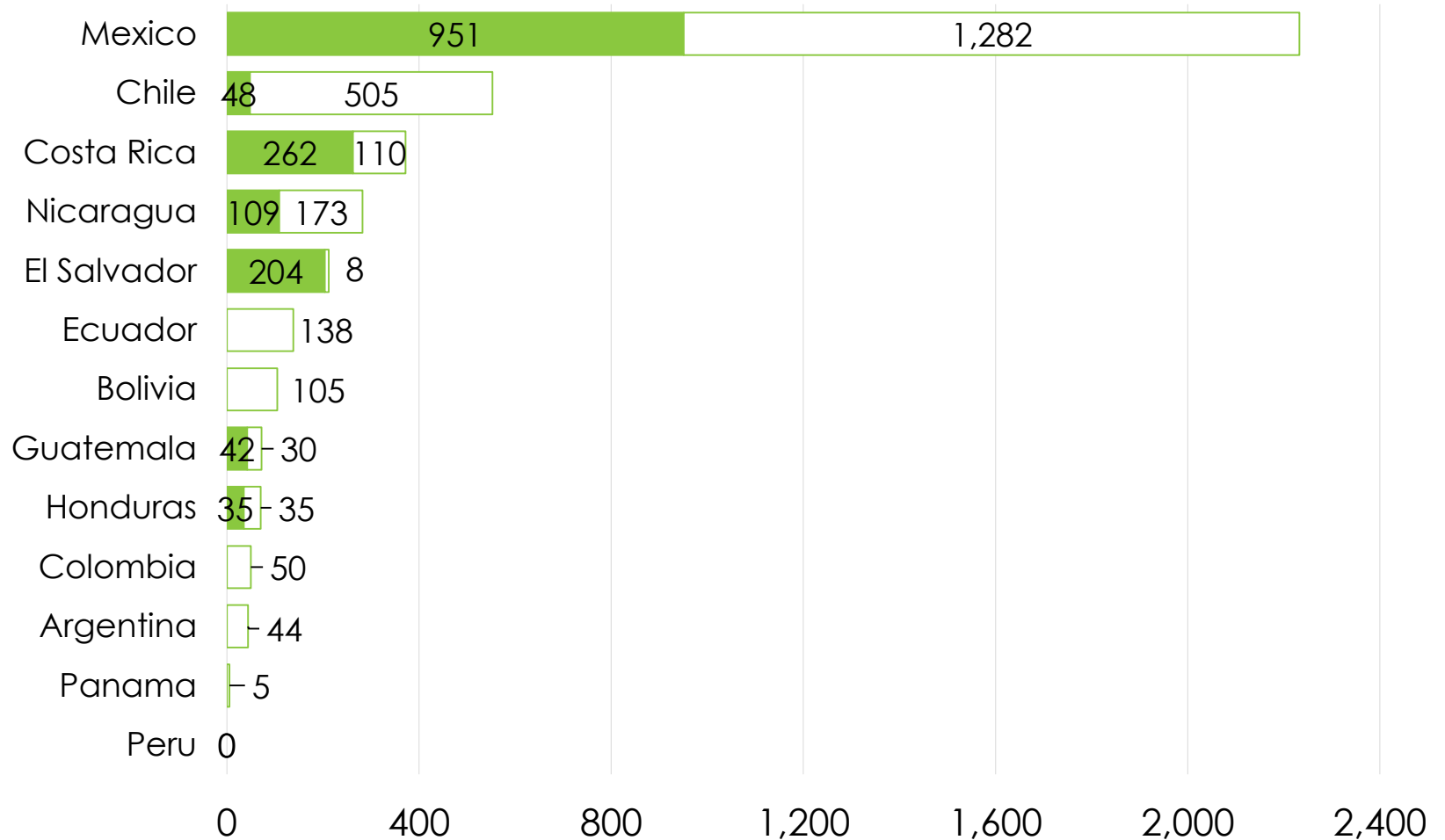
INSTALLED CAPACITY - MW (JULY 2019) – 1,655 MW IN TOTAL



Source: TGE Research (2019), GEA (2016), IGA (2015)

# GEOTHERMAL POWER – LATIN AMERICA

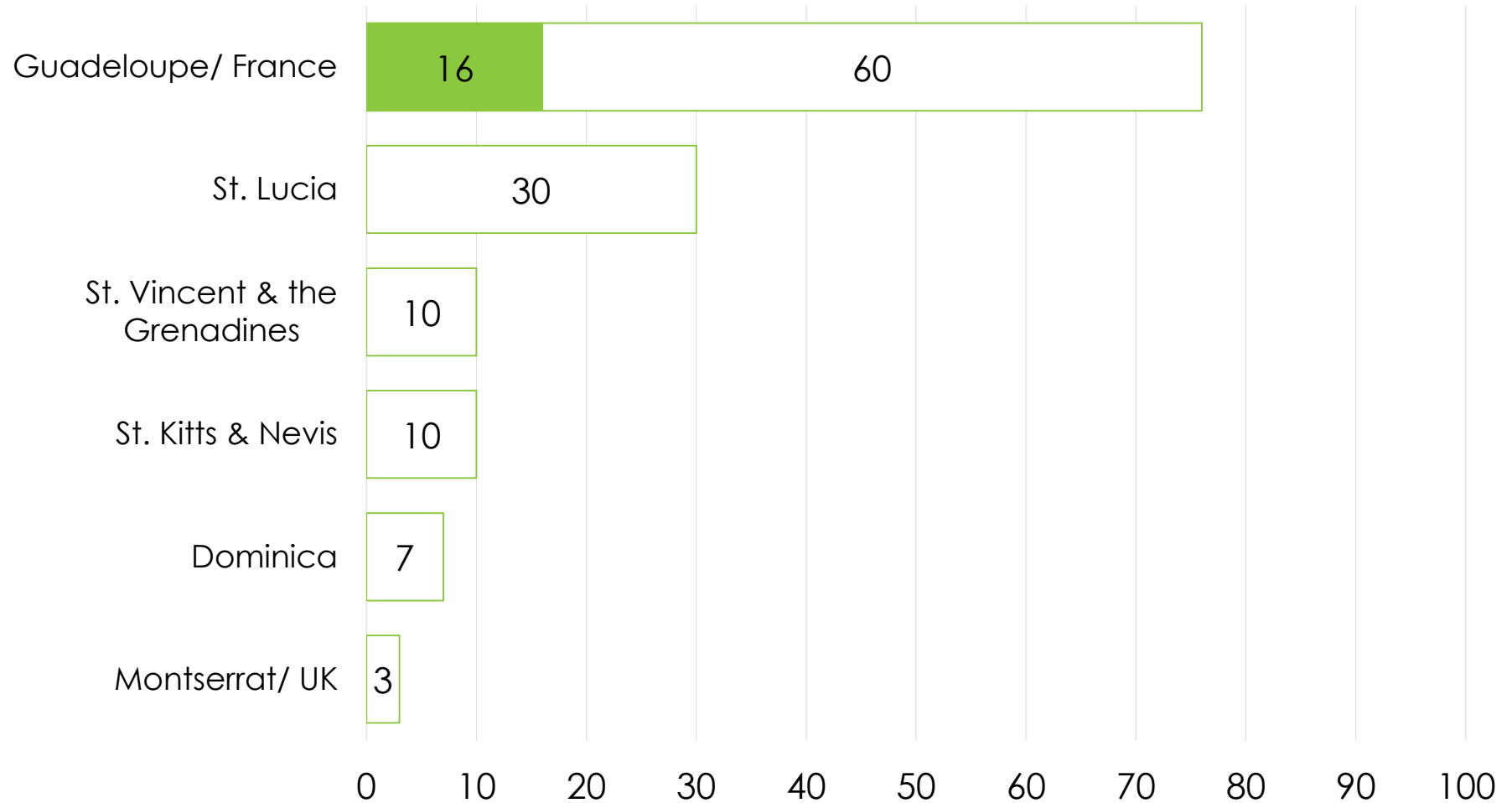
## INSTALLED CAPACITY & PROJECTS - MW (JULY 2019)



Source: TGE Research (2019), GEA (2016), IGA (2015)

# GEOTHERMAL POWER – CARIBBEAN

## INSTALLED CAPACITY & PROJECTS - MW (JULY 2019)



Source: TGE Research (2019), GEA (2016), IGA (2015)



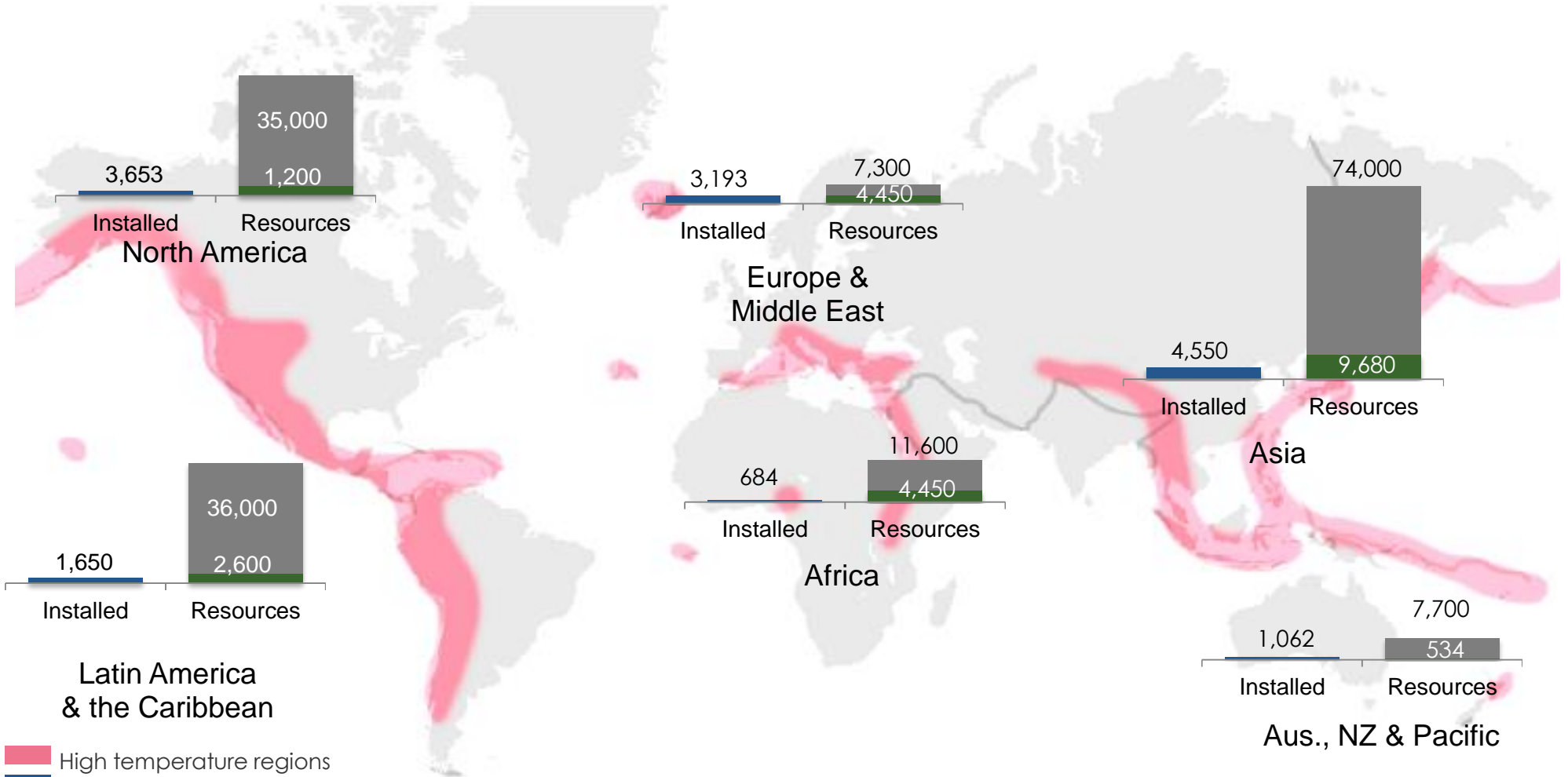
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# GLOBAL GEOTHERMAL POTENTIAL

POWER GENERATION POTENTIAL (MWe) – JULY 2019



- High temperature regions
- Current installed capacity
- Projects & inferred resources
- Hydrothermal resource estimates

Sources: ThinkGeoEnergy, IGA, Chevron  
 Note: Installed Capacity of 2019, resource estimates combined (1999-2012) – IGA estimates a conservative total potential of 70,000 MW and with technology improvements (extended use of low heat and EGS resources) at around 150,000 MW in power generation capacity.

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# ECONOMIC MODEL & BUSINESS CASE



- Geothermal areas far away from cities / populated areas
- Development of geothermal energy with focus on Power Production
  - Dedicated and specialized Investors
  - Business model for power production
  - Project size, reservoir type, technology definition, development period, regulatory framework → for power production
  - Finance model based on power production (large investment upfront and low operational costs; risk profile; long term contract)
- Geothermal heat is a secondary business for a geothermal power setup project
  - Deregulated power market → no benefit for the developer
  - Markets with special regulations like FiT can include geothermal heat in the tariff structure → benefit for the developer

# GEOHERMAL HEAT: ECONOMIC MODEL & BUSINESS CASE



- Requires specialized technical knowledge for matching geothermal development with industrial need → impact in the investment
- Geothermal Heat
  - Investor type: Final user, ESCO
  - Final user: define demand profile, technology and process restrictions, timing for the implementation
  - Business model
    - Investment → Operational cost reduction / production increase due to better efficiency
    - Investment structure
      - Geothermal part (exploration, drilling, pumping, piping) → set pressure on project size & less development period & risk
      - Process solution (heat exchanger)
  - Finance model based on heat production (amortization period & IRR)

# CHILE: GEOTHERMAL AND MINING SECTOR



- Geothermal Energy and Mining activity are very close connected in the northern part of the country
- Mining sector has not being an active actor in the geothermal development. Collahuasi is the principal actor in the geothermal sector (power production)
- Dilemma in Chile: water rights / mining process water v.s. geothermal brine
- Geothermal regulation provides the right for using the heat contained in the geothermal brine
- Environmental law
  - Power production: heat use from geothermal brine (force reinjection)
  - Mineral extraction: apply waste water regulation → barrier for the business and can be improved



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