# Can plant conversions and abatement technologies prevent asset stranding in the power sector?

Yangsiyu Lu[1,2], Francois Cohen[1,2,3], Stephen Smith[1], Alex Pfeiffer[1]

[1]Smith School of Enterprise and the Environment, University of Oxford

[2]Institute for New Economic Thinking, University of Oxford

[3]Department of Economics, University of Barcelona

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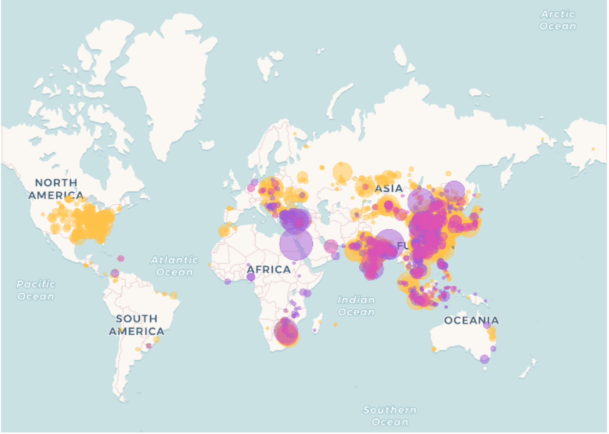
# The fossil fuel power plants



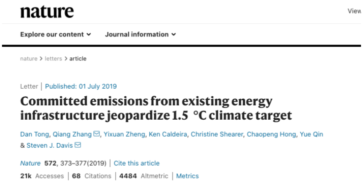

Global coal power plants in 2020

Yellow: Operating; Pink and purple: under construction and planned

Illustration: Carbon Brief

# Stranded assets

- Emissions from existing fossil fuel power plants go beyond carbon budgets consistent with Paris Agreement
  (Davis et al., 2010; Davis and Socolow, 2014; Rozenberg et al., 2015; McGlade and Ekins, 2015; Pfeiffer et al., 2016; Shearer et al., 2017; Tong et al., 2019)
- Fossil fuel assets may suffer from premature write-downs, devaluations, or conversion to liabilities
  (Caldecott et al., 2016; Carbon Tracker Initiative, 2015; McGlade and Ekins, 2015; Mercure et al., 2018; Pfeiffer et al., 2018)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Letter | Published: 01 July 2019

**Committed emissions from existing energy infrastructure jeopardize 1.5 °C climate target**

Dan Tong, Qiang Zhang, Yixuan Zheng, Ken Caldeira, Christine Shearer, Chaopeng Hong, Yue Qin & Steven J. Davis

*Nature* **572**, 373–377(2019) | Cite this article

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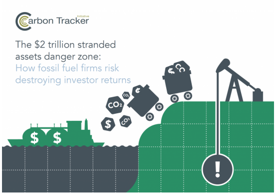



Illustration: Tong et al. 2018/ Carbon Tracker, 2015

# Bet on abatement technologies

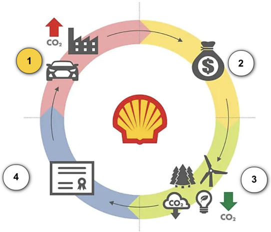
- CCS: prevent emissions from going to the atmosphere (Haszeldine 2009; Schrag 2007; Sgouridis et al. 2019)
- Bioenergy:absorb $CO_2$
- BECCS: negative emissions could expand carbon budget (Fuss et al.2014; Griscom et al.2017; Humpenöder et al. 2014)

Chevron turns on $2.5bn carbon capture plant in Australia

CCS project to reduce emissions suffered years of delays over technical issues

Chevron's Gorgon LNG project in Western Australia © Reuters

How Voluntary Carbon Offsets work




Illustrations:Financial Times/Shell website

# Alternative solution: plant conversions

- Fuel switching
  - **Coal-to-gas**:More than 100 coal-fired plants in the US have been converted to natural gas since 2011 (Aramayo, 2020)
  - **Coal-to-biomass**:Europe and Canada have projects in operation (IEA and IRENA 2013; Stutzman et al. 2017; Carbon Brief, 2015)
- CCS: 55% of existing coal fleet in China suitable for retrofit(IEA 2016)

Drax (Yorkshire,UK) and OPG(Ontario, Canada)

Illustration: Bioenergy International/Power Engineering

# This Paper

- **Research gap:** No study has rigorously analysed whether plant conversions and abatement technologies could mitigate asset stranding risk in the power sector

Illustration:EQ International

# Overview of Data

- **Global power plants**
  - Estimate current power plants' future production level
  - Compile unit-level data from CoalSwarm, WEPP, and WRI
- **Climate scenarios**
  - Model pathways of electricity production required to attain 2 °C target
  - Retrieve scenarios from AMPERE project
    - Model different technology availabilities

| **Technology scenarios** | **All technologies deployed scenarios** | **Single technology change scenarios** |
|---|---|---|
| CCS | Fully available | Not available |
| Bioenergy | Fully available | Limited to 100EJ/year |
| Nuclear | Fully available | Not available |
| Wind and Solar | Advanced | Limited to 20% |
| **Other scenarios** | | |
| Energy intensity | Improves at historical rates | Improves 1.5 times faster |

# Overview of method(1)

- **Definition of stranded assets:**
  - Lower electricity generation due to climate constraints (PWh)
  - Difference of electricity generation between existing power plants and climate scenarios
- **Four step method**
  - Compute future electricity generation from existing power plants
  - Estimate asset stranding for each climate scenario
  - Take plant conversions into account
  - Quantify the impact of technology availability
    - Compare between technology pair-wise scenarios

# Overview of method (2)

- **Plant conversion assumptions**

| | Plant suitability | Conversion percentage |
|---|---|---|
| Coal-to-gas | Have access to gas [1] | 25% to 50% [2] |
| Coal-to-biomass | All coal-fired units | 20% to 50% [3] |
| CCS | Capacity > 100MW, <20 years emit<1000g $CO_2$/KWh, located within CCS suitable area [4] | 50% to 100% |

[1] Around 98% coal-fired units are located in countries having access to gas
[2] 25% is the coal-to-gas conversion percentage in the US from 2011 to 2019
[3] Biomass co-firing could replace between 20% and 50% of coal (IEA 2013)
[4] Follow Caldecott et al.(2016), around 24% global fossil fuel units are CCS suitable

# Estimates of future electricity generation

- In total: 540 PWh could be produced from current plants

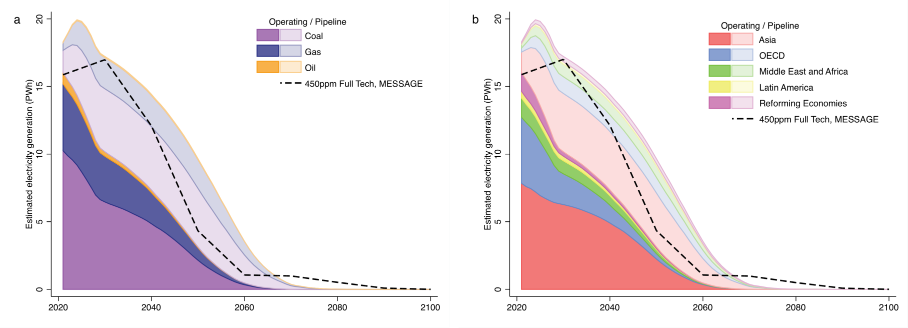



Fig.1 Forecasted electricity generation between 2021 and 2100 (a)by fuel, (b)by region

# Estimates of stranded assets

- In total: 270 PWh risk of stranding

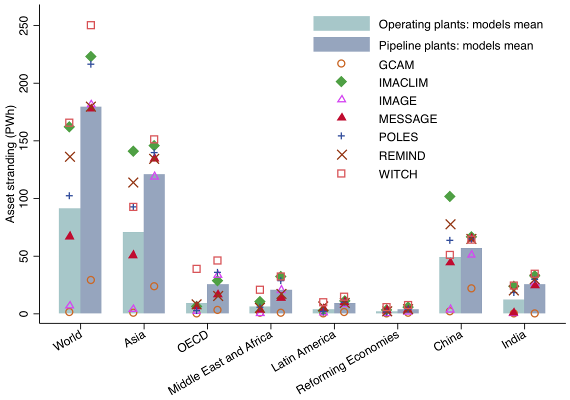



Fig.2 Estimated stranded assets in 2 °C "all technologies deployed" climate scenarios (2021-2100)

# Impact of plant conversions

- **Baseline:** 0% conversion, 270PWh asset stranding

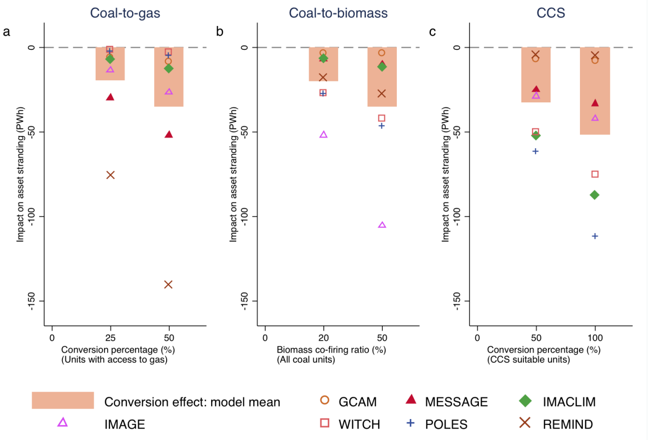



Fig.3 Impact of plant conversions on global asset stranding

# Depending on CCS and bioenergy availability

- **Baseline**: "all technologies deployed" scenarios

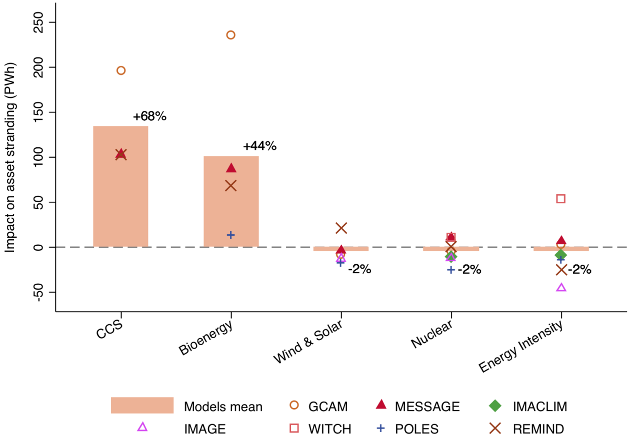



Fig.4 Impact of technology availability on global asset stranding

# Conclusions

- High stranding risk even under optimistic technology assumptions
  - 270 PWh $\approx$ 10 times global electricity generation in 2018
- Plant conversions have limited impact
  - Reduce to 220 PWh
- Stranding may be 68% or 44% higher if CCS or bioenergy not deployed
  - CCS: high cost, storage sites availability (Reiner, 2016; Scott et al., 2013)
  - Bioenergy: feedstock availability, deforestation, food security, biodiversity loss (Creutzig et al., 2015; Ember, 2019)

# Implications

- **Abatement technologies could reduce asset stranding**
  - Should strongly push the development of CCS and bioenergy
- **However, asset stranding risk remains substantial**
  - Stakeholders should act swiftly to minimize stranding risk
  - Existing plants: fuel-switching remains as an option with limited impact
  - Pipeline plants: very little or no fossil fuel plants can be commissioned

**Thank you!**

yangsiyu.lu@ouce.ox.ac.uk

@yangsiyulu

Smith School of Enterprise and the Environment
University of Oxford
Institute for New Economic Thinking at the Oxford Martin School