Modeling wind and PV power plants using the MERRA reanalysis

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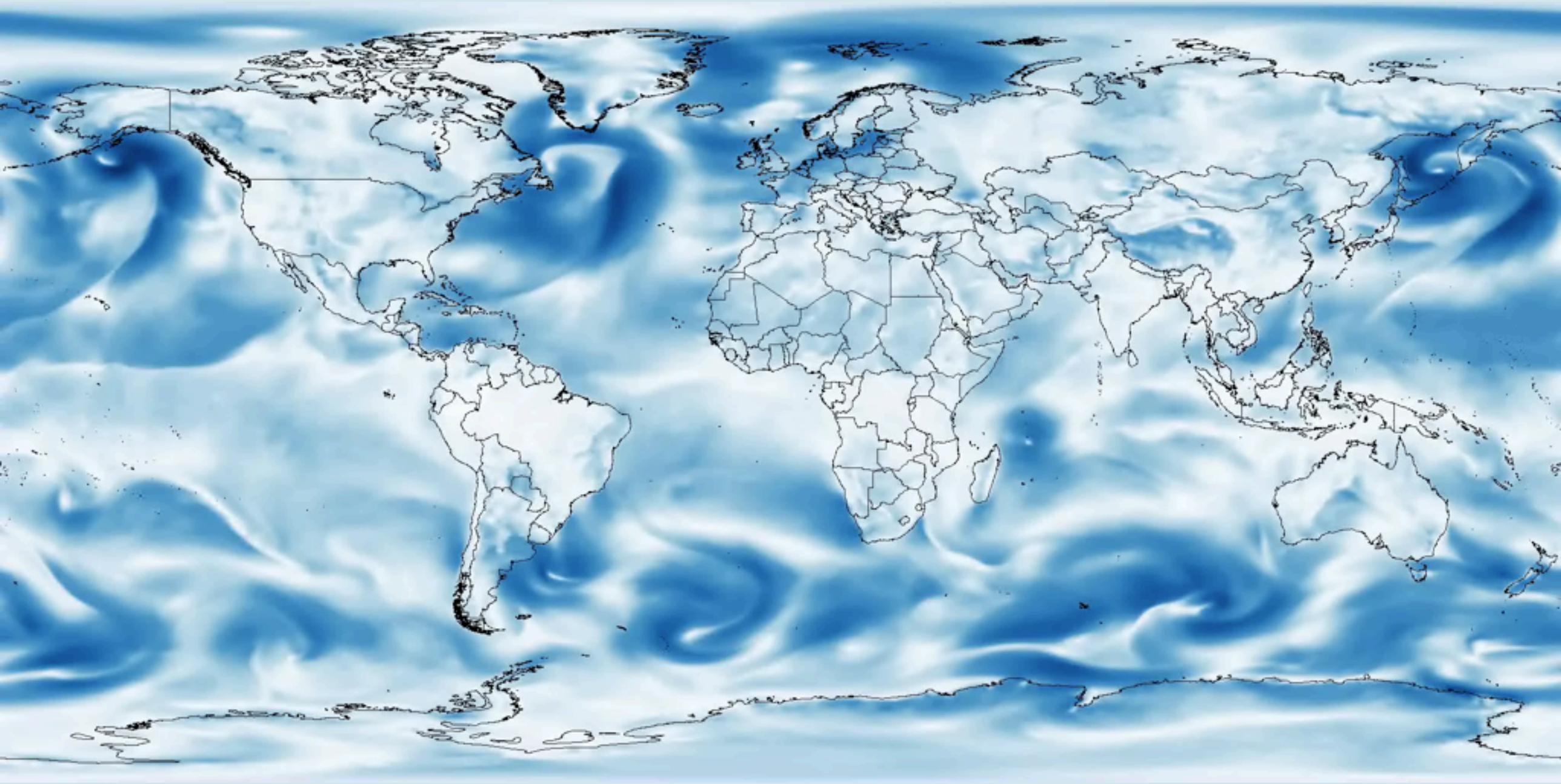
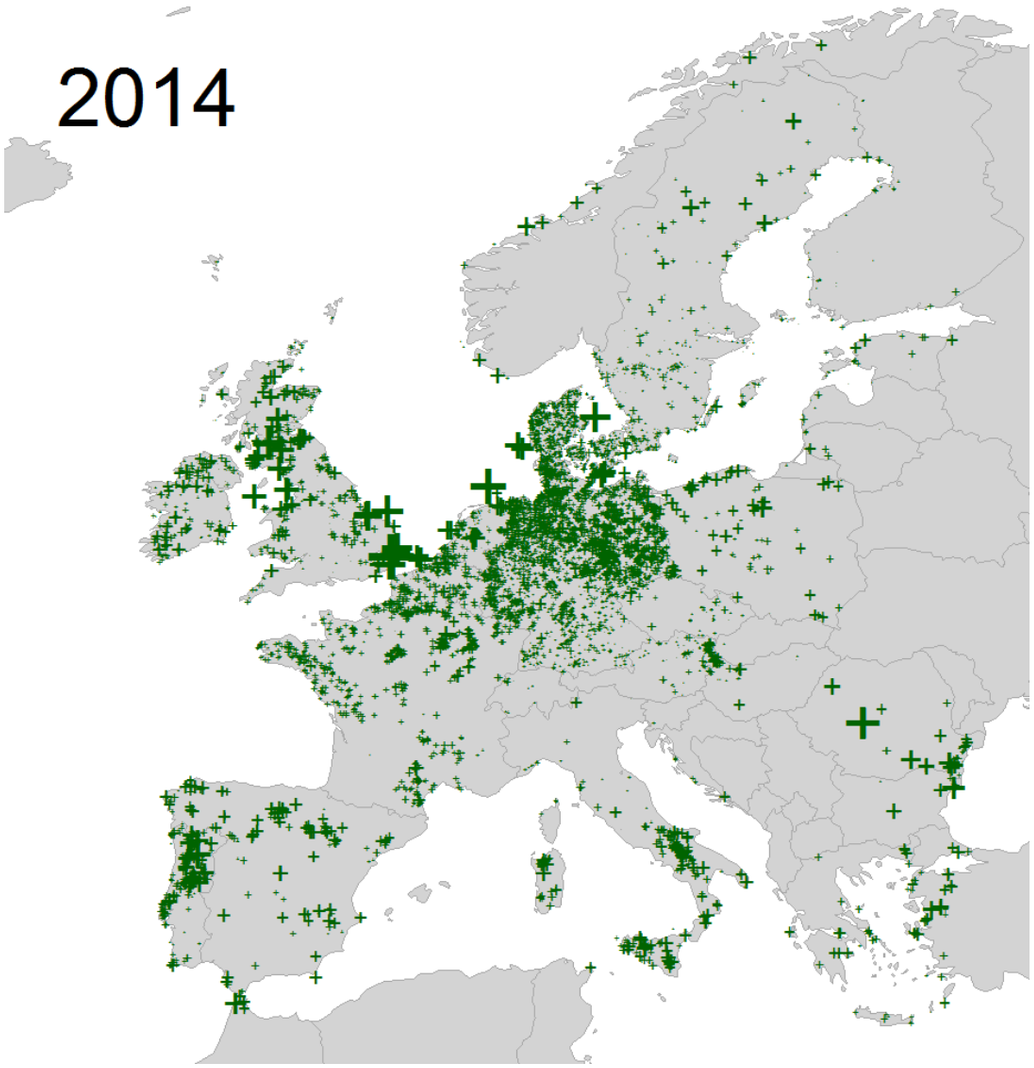
Image sources:
http://www.2050publications.com/wp-content/uploads/2012/10/offshore-wind-turbines1.jpg
http://inweekly.net/wordpress/wp-content/uploads/2011/03/cooling-towers-of-a-nuclear-power-station.jpg
http://assets.inhabitat.com/wp-content/blogs.dir/1/files/2012/12/rooftop-solar-array-537x359.jpg

Modeling wind



Wind power is becoming big

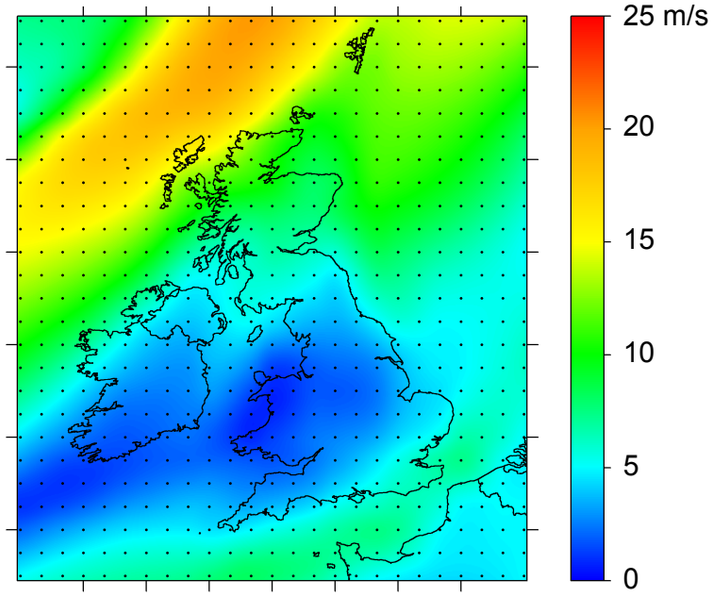


330 GW of capacity
at the start of 2014

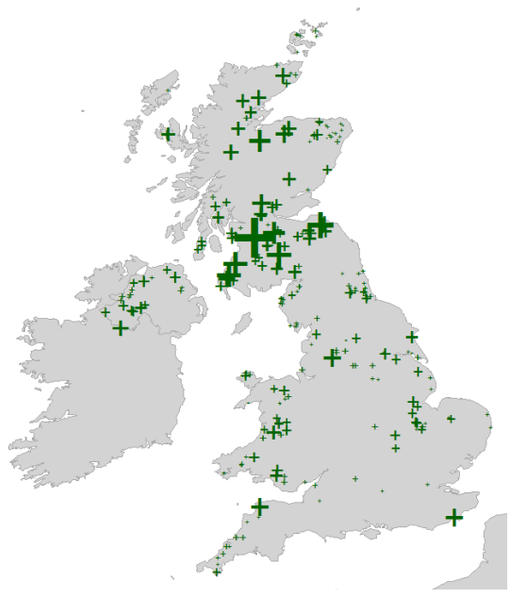
33% growth globally

UK has 6th largest capacity
(1st for offshore)

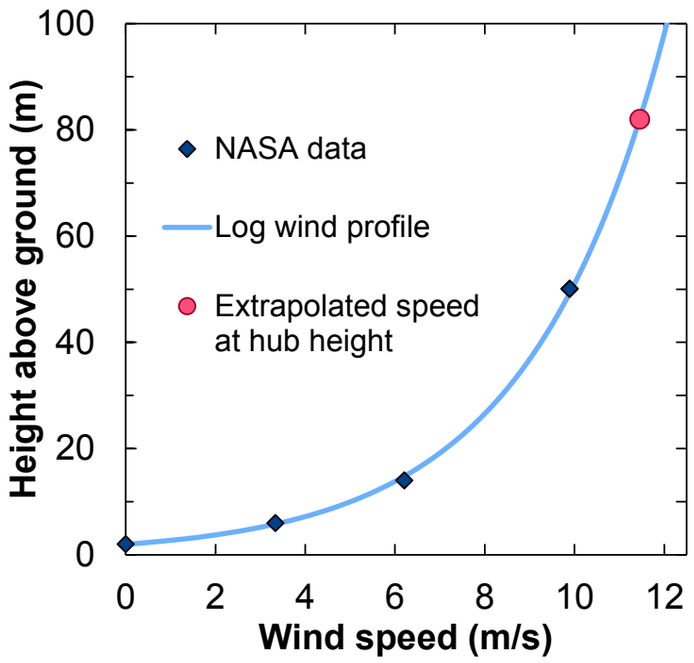
Wind model approach



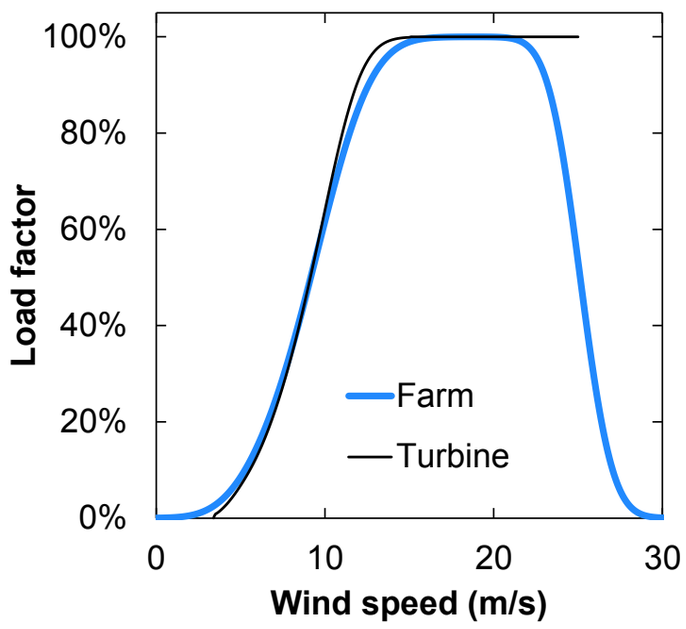
① Take hourly wind speeds from MERRA



② Interpolate from grid points to site of each wind farm



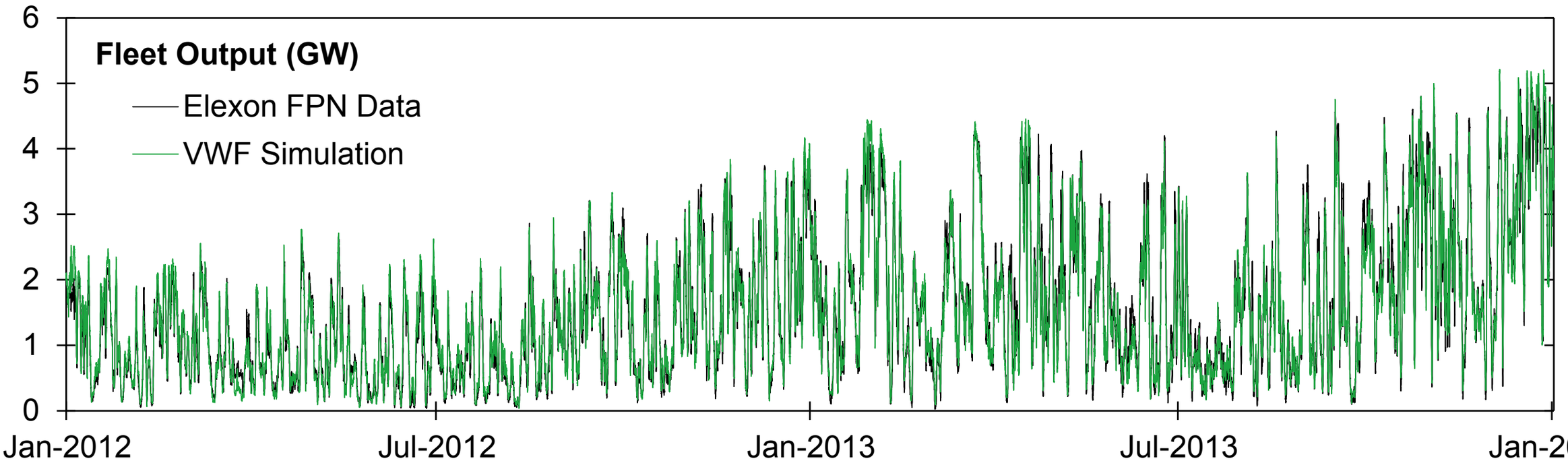
③ Extrapolate wind speeds to hub height with place- and time-specific parameters



④ Convert from wind speed to power output using whole-farm power curve

I. Staffell and R. Green. 2014. How Does Wind Farm Performance Decline with Age? Renewable Energy, 66, 775–786.

Wind model validation



Results from simulating the Great Britain fleet over two years

Comparison made against historic data from the 48 farms which report their half-hourly output

I. Staffell and R. Green. 2015. Is There Still Merit In The Merit Order Stack? The Impact of Dynamic Constraints on Optimal Plant Mix. IEEE Transactions on Power Systems, in press.

Wind validation sites

Monthly data

Germany:
192 monthly obs. (1999–2014)
5,000 turbines (7,900 MW)

Sweden:
180 monthly obs. (1999–2013)
1,300 turbines (1,900 MW)

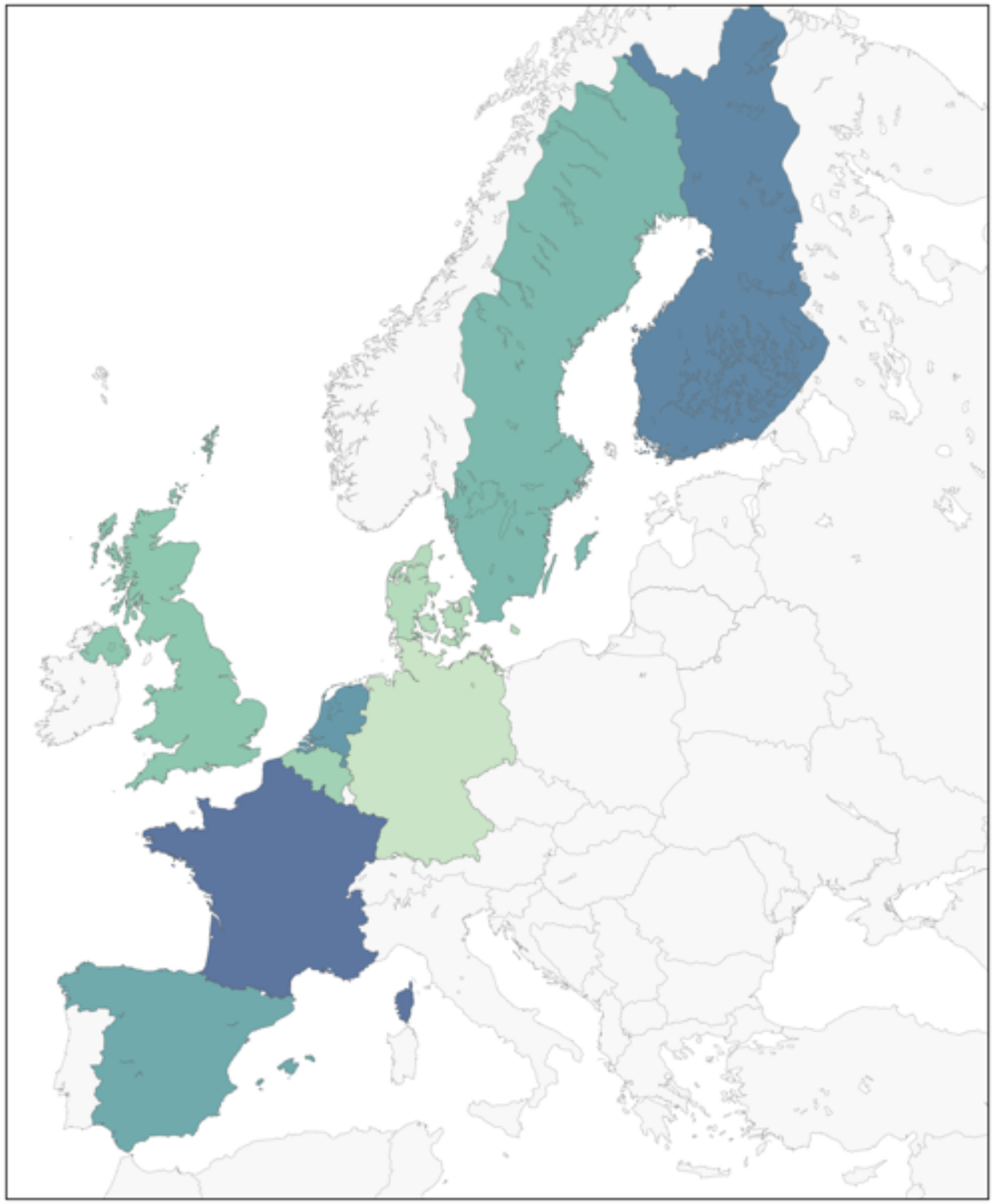
Finland:
90 monthly obs. (2005–2012)
100 turbines (165 MW)

Belgium:
140 monthly obs. (1994–2005)
25 turbines (10 MW)

Netherlands:
70 monthly obs. (1998–2004)
100 turbines (180 MW)

Denmark:
160 monthly,
22 yearly obs. (1980–2014)
8000 turbines (5,400 MW)

UK:
160 monthly obs. (2002–2014)
640 farms (12,000 MW)



Hourly data

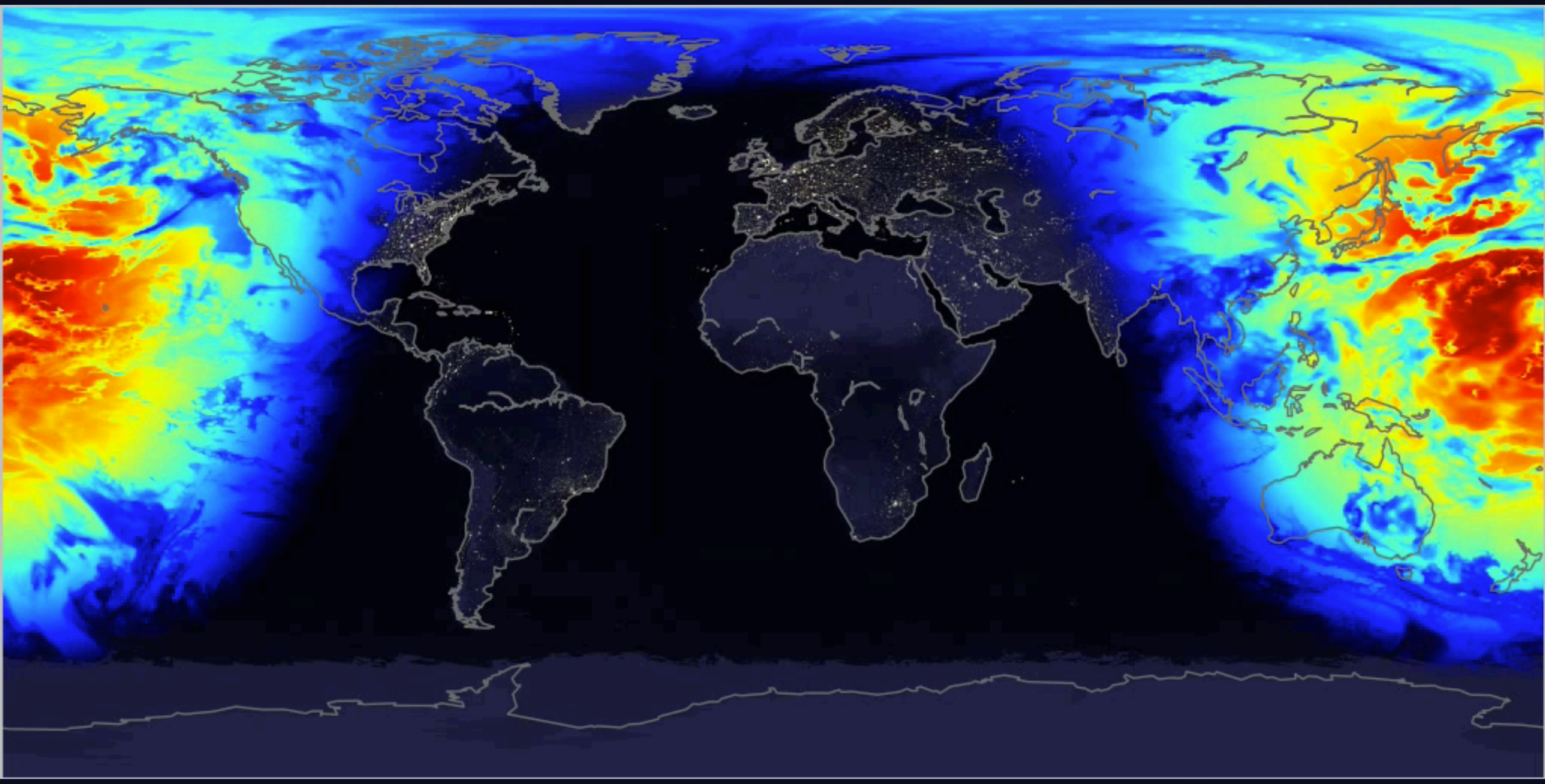
France:
35,000 hourly obs. (2011–2014)
National aggregate (9,000 MW)

Spain:
70,000 hourly obs. (2007–2014)
National aggregate (17,000 MW)

UK:
80,000 hourly obs. (2006–2014)
National aggregate (10,000 MW)

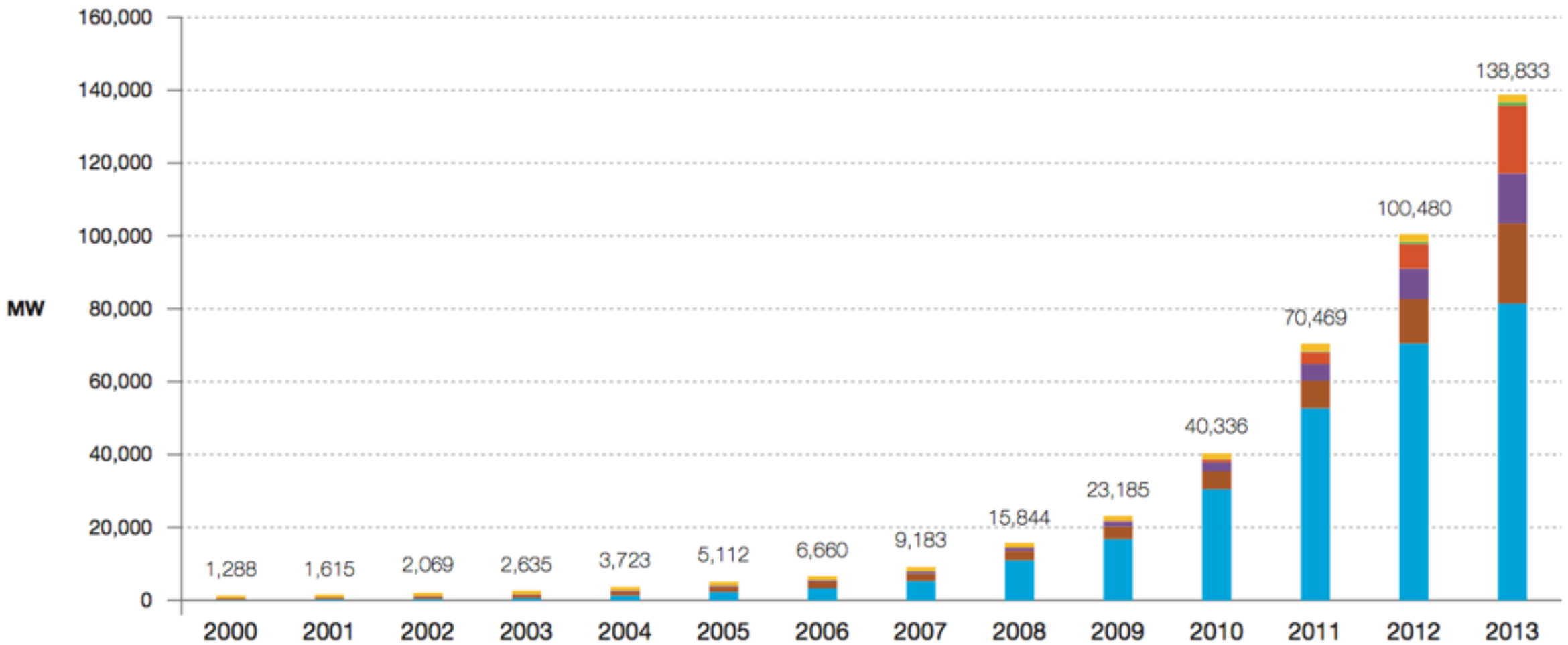
In process of being collected:
Italy, Germany, Austria
and Portugal

Modeling PV



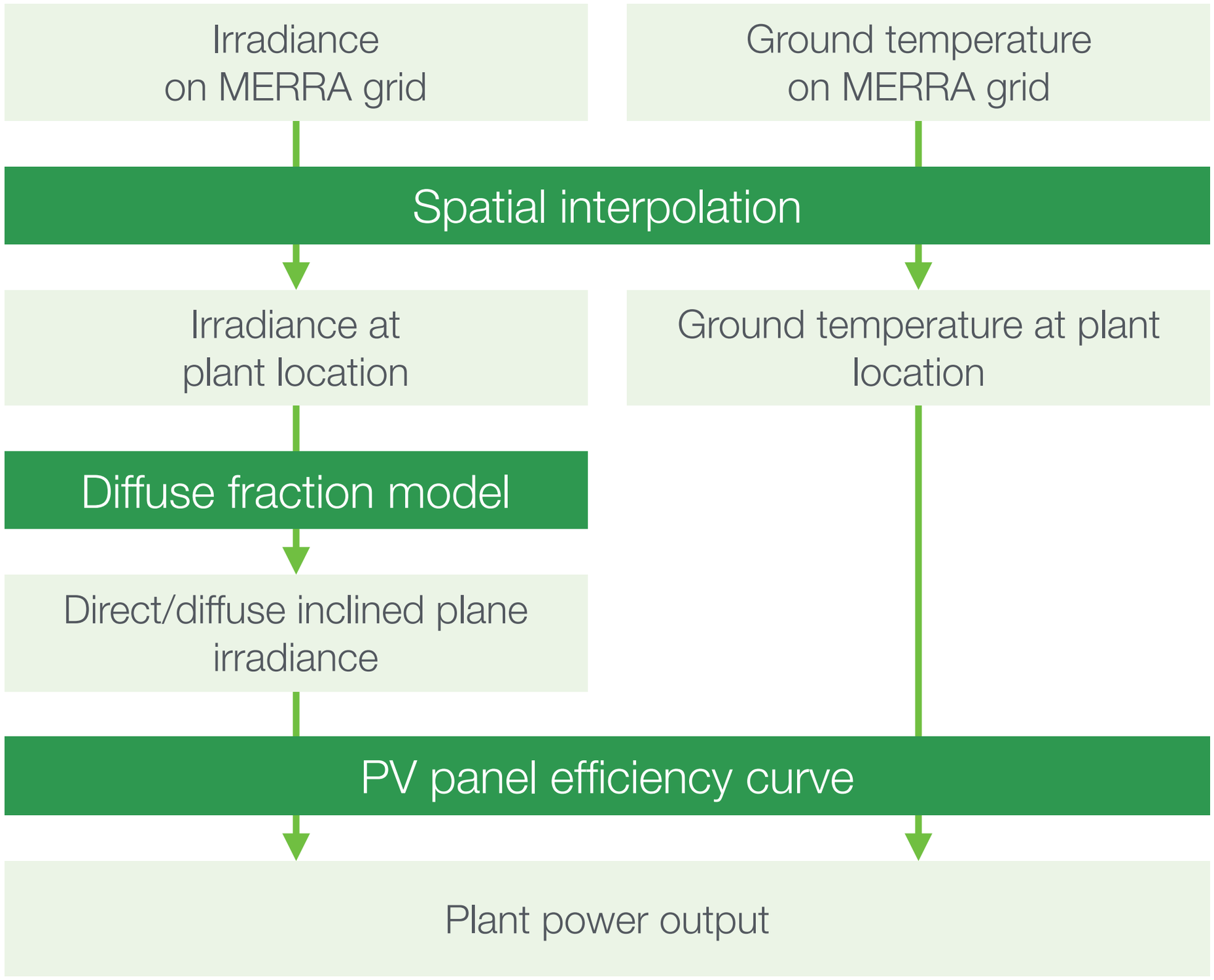
PV is becoming big

Average annual growth rate of almost 45% since 2000



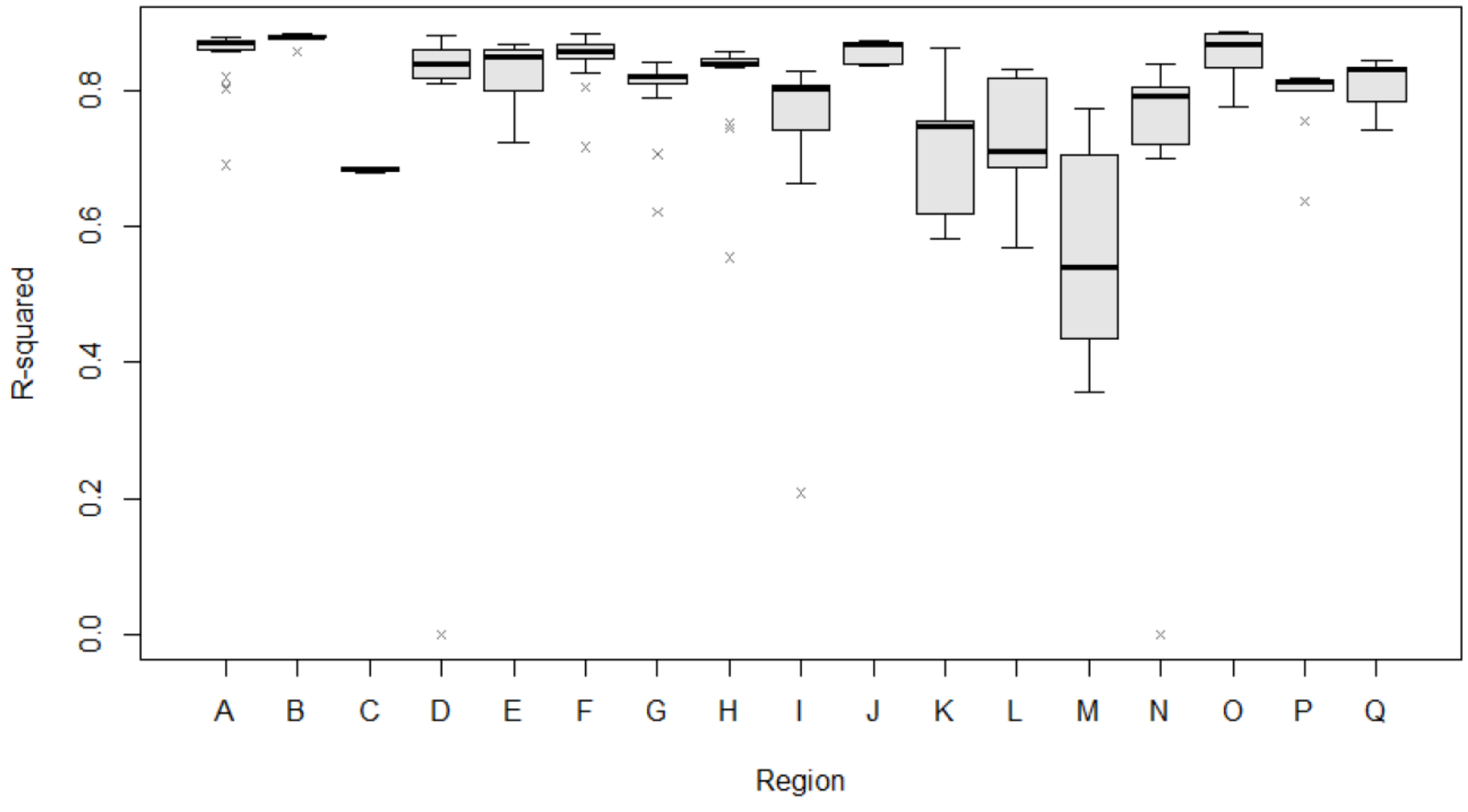
Source: EPIA, 2014. Global Market Outlook For Photovoltaics 2014-2018, European Photovoltaic Industry Association. Available at: http://www.epia.org/news/publications/

PV model approach



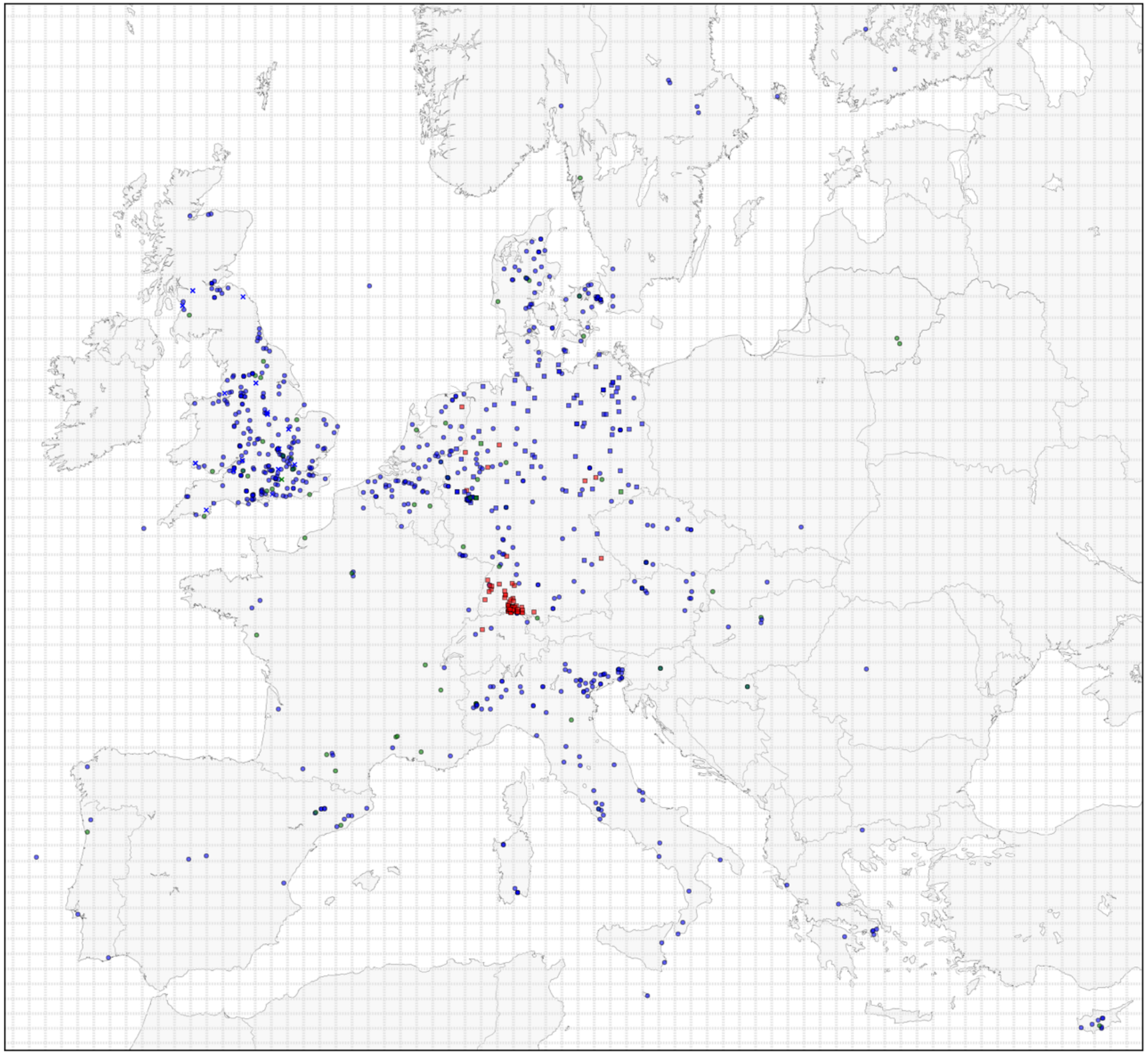
PV validation

- Model works relatively well for 17 locations in the UK
- Quality more dependent on metadata than solar data



Source: S. Thalanany, 2014. Challenges In Accurately Modelling Solar Energy Potential In The Middle East And North Africa

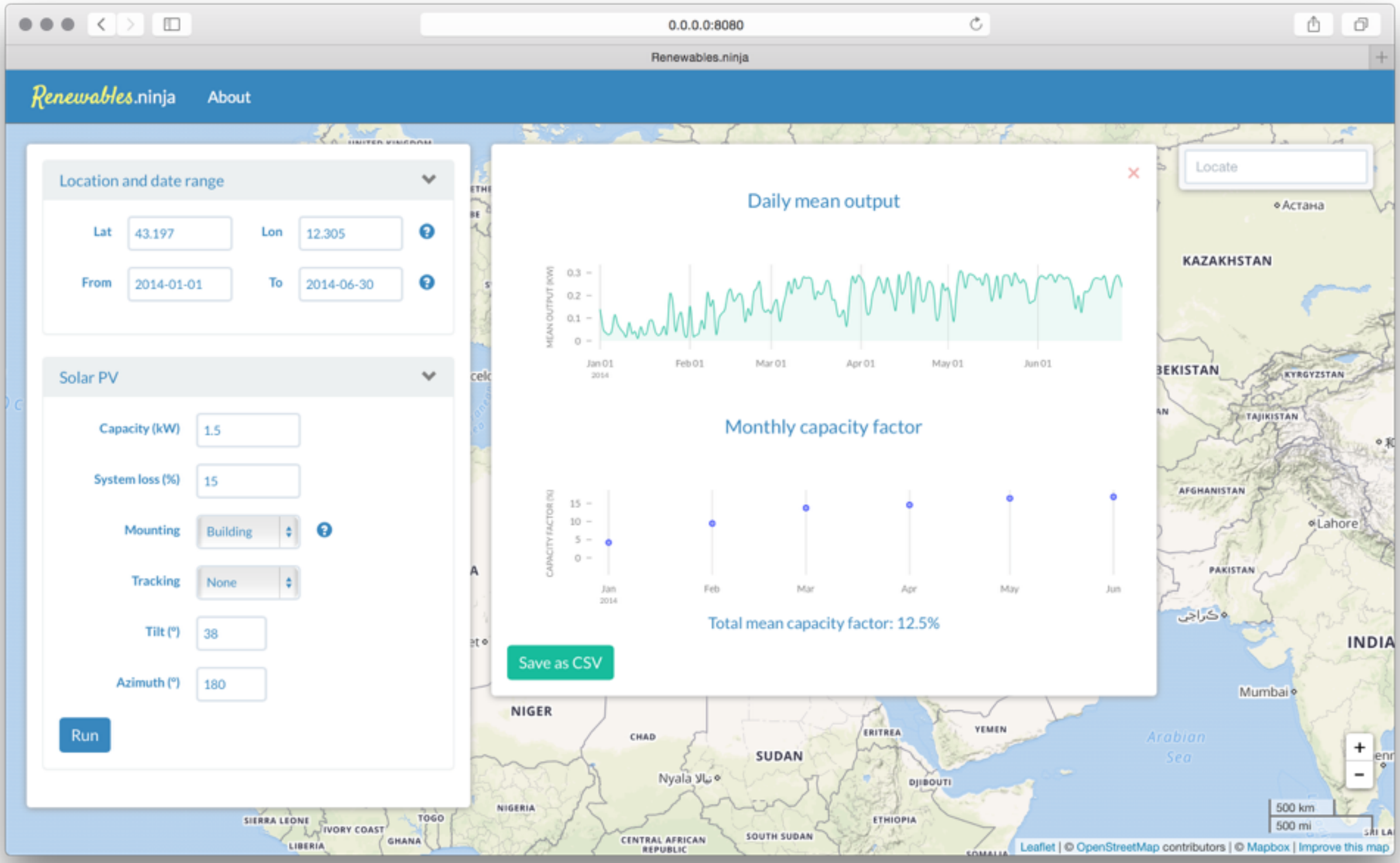
PV validation sites



1174 sites across Europe

- >5 years
- 1-5 years
- <1 year

Web application



Contact

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Contact us for questions:

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