The Role of Smart Contracts in the Market of Green Hydrogen Guarantees Of Origin

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Agenda

Definitions and literature review

- What is green hydrogen?
- What are guarantees of origin?
- How do GOs work?
- What are smart contracts?

How smart contracts can support the markets for green hydrogen guarantees of origin?

Research needs

Fully funded PhD (recruiting now!)

2. What is Green Hydrogen?

Prefixes (hydrogen)	Definition	Sources
Green	Hydrogen produced from renewable energy	Poullikkas (2007); Clark II (2008); Clark II and Rifkin (2006); Clark II et al. (2005); Clark (2007); FCH-JU (2014); Kameyama et al. (2011); Kramer et al. (2007); Ota et al. (2010); Public Citizen (2003); Rifkin (2002); State of California (2006); Tada et al. (2012); Weidong and Zhuoyong (2012)
Green	Renewable hydrogen with an explicit mention to carbon intensity/reduction.	Blieschwitz and Bader (2008); Certifhy (2016); Galich and Marz (2012); Gazey et al. (2012); AFHYPAC (2016); CEP (2013); TÜV SÜD (2011a)
Green	Renewable hydrogen with an explicit mention to air pollution, energy security and global climate problems	NREL (1995)
Green	Renewable and nuclear hydrogen	Naterer et al. (2008)Public Citizen (2003)
Green	Any low carbon hydrogen	DECC (2015); Dincer (2012)
Grey	Any hydrogen with a carbon intensity over 36.4 gCO_2e/MJ_{H2}.	Certifhy (2016)
Brown / Black	Hydrogen produced from fossil fuel feedstocks	Bellaby et al. (2012); Clark (2007); Galich and Marz (2012); Rifkin (2002); Public Citizen (2003); State of California (2006)
Black	Hydrogen produced from nuclear power	Rifkin (2002); Clark (2007)
Clean	Hydrogen produced from fossil fuels with CCS	Kramer et al. (2007)
Low carbon	Hydrogen produced from non-renewables with a low carbon intensity	Certifhy (2016)

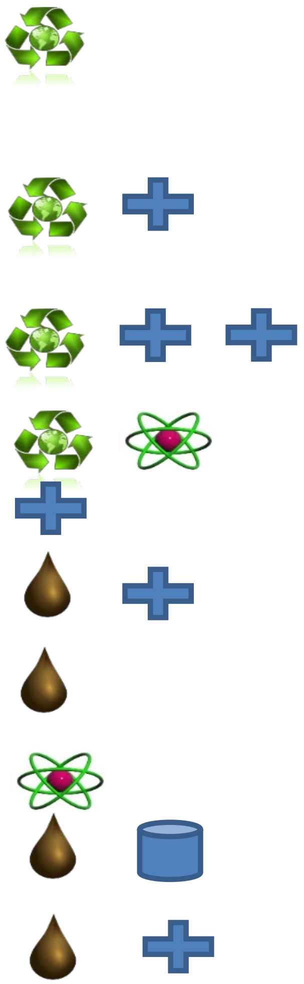

Table 1. Velazquez Abad, A. and P. E. Dodds (2018). "Conceptualisation of Green Hydrogen Standards." Renewable and Sustainable Energy Reviews (in preparation).

What are Guarantees of Origin?

General Information of the installation where the energy was produced	GO Identity
	International identification number (GSRN)
	Location
	Country
	Source of energy
	Start-up date (when the facility became operational)
	Installed capacity (e.g. kWh/MWh)
	Kind and amount of investment support
Specific Information of the energy batch	Unique identification number
	Specify whether the GO relates to electricity, gas or heating and cooling
	Date of production (start/end energy batch production)
	Generated Energy (total MWh in the batch)
	Benefits of the unit of energy from a national support scheme and type

CertifHy GO:
- investment supported
- production supported
- Supported scientific/demo/pilot project
- Unsupported
- no information available

Table 2. Details specified in the RED for renewable energy sources GO. Adapted from: European Commission (2017).

How Guarantees of Origin work?

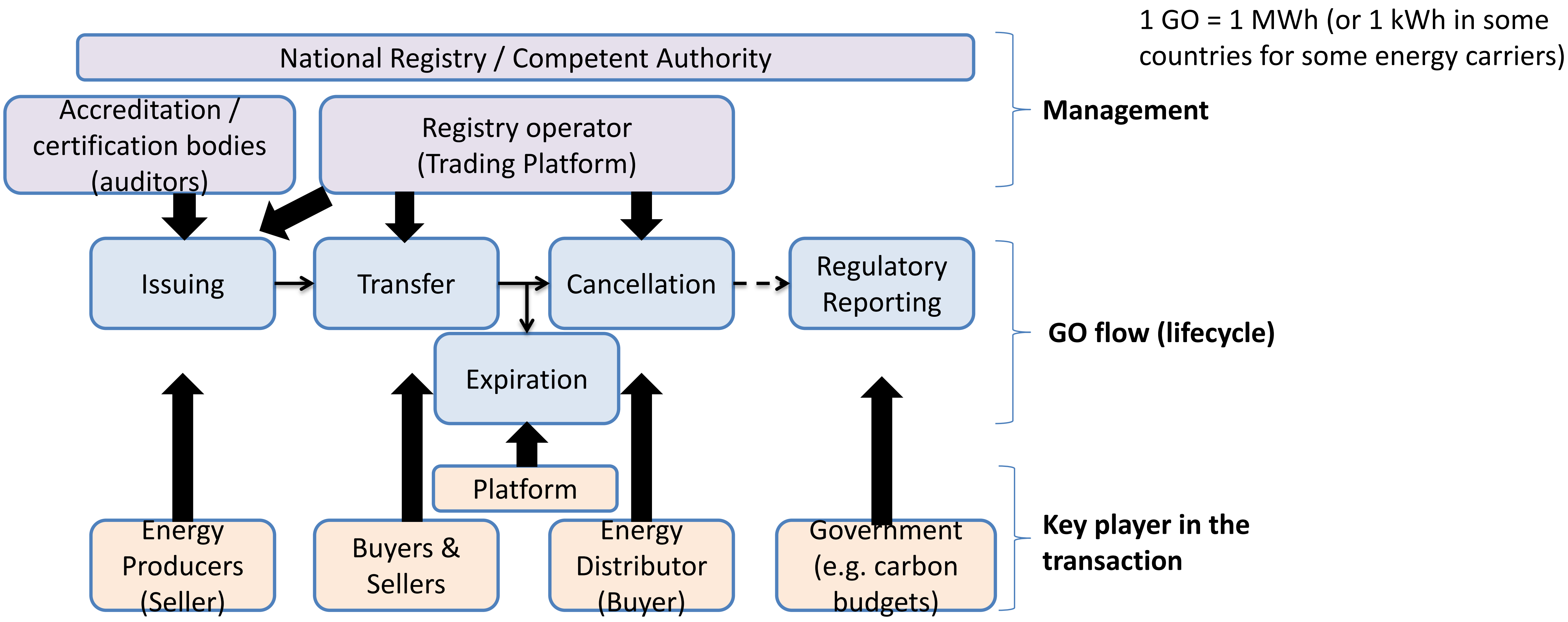

Figure 2. Scheme of how a GO scheme works.

Green Hydrogen Guarantees of Origin (Certifhy Scheme / TUV-SUD)

1 Guarantee of Origin = 1 MWh H_2

–> Very different carbon footprints within the threshold.

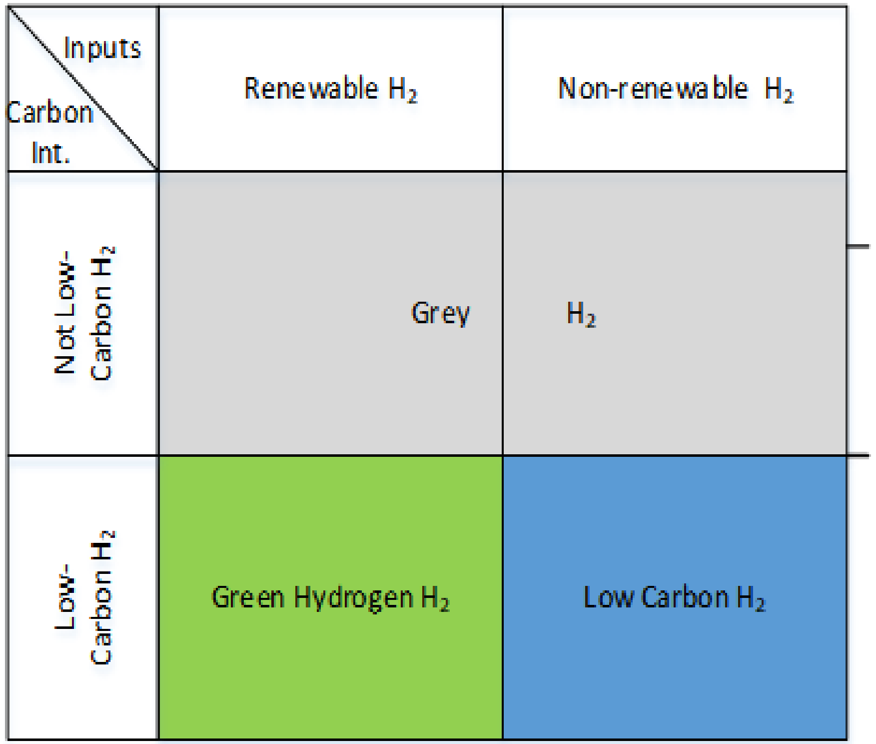

Figure 1. Redrawn from Green Hydrogen GO Scheme. CertifHy (2018)

Production process	End Use	Baseline (gCO_2e/MJ)	Minimum emissions reduction level to be "green"
Electrolysis	Transportation	83.8	75%
	Other	89.7	75%
SBMR and Pyro-reforming of glycerine	Transportation	83.8	60%
	Other	89.7	60%

Table 3. Green Hydrogen Standard . Source: TUV-SUD

What are smart contracts?

Smart Contracts are small pieces of code that are stored in the blockchain network that enable, execute and enforce the negotiation of a contract (agreement) using distributed ledger technology. NOT SMART AND NOT CONTRACTS.

- Advantages when dealing with green hydrogen GO
  - Transparency
  - Harmonisation
  - Elimination of double counting, double selling, double disclosing
  - Reduction of transactional fees and infrastructure deployment
- Challenges
  - GHG emissions
  - Capacity (operations / second)
  - Time
  - Trust

Can distributed ledgers reduce costs?

Market fees charged for RES-E GO		Unit	Payee	Proof-of-work	Proof-of-stake (e.g. Hedera)
Current market price		€/GO	Seller	Same	Same
Fees charged for GO transaction					
Issuance		€/GO	EXX	?	?
Transfer		€/GO	EXX	higher	?
Cancellation/Clearing		€/GO	ECC	higher	?
Delivery		€/GO	ECC	higher	?
Fees charged for the use of the EXX Platform (Emerging and Environmental Markets / GO)					
First 12 months		€/year	EXX	N/A	N/A
After 12 months		€/year	EXX	N/A	N/A
Fees charged for the use of the ECC Clearing system?					
First 12 months		€/year	ECC	N/A	N/A
After 12 months		€/year	ECC	N/A	N/A
Technical fees					
EEX TT Screen		€/year	ECC	N/A	N/A
Eurex T7 GUI and/or Eurex Clearing GUI		€/year	ECC	N/A	N/A

Table 4. Transactional costs of RES-E GO contracts. Details valid as per 22nd September 2017. Data sources: European Commodity Clearing AG (2017); European Energy Exchange AG (2017).

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What could Smart Contracts do for the trade of GO?

- Aggregate smaller productions of H2 to accrue to the 1000 GO required by EEX.
  (1MWh≈ 30 kg H2 LHV x Min tradeable in GO platform EEX (1 GWh = 30t H2 – A lot !!!)
- IOT. GO can be claimed by energy distributors; smaller sale transactions could aggregate demand of end consumers to trigger cancellation GO (e.g. blockchain at pump).
- Offer cheaper GO before expiration date; if expired initiate auction automatically
- Once a GO is cancelled, based on the GO specifics, the department of energy could use this information to update in real time national carbon budgets. If GO is cancel, then send details to BEIS to update carbon budgets.
- A typical GO doesn't include an specific carbon intensity value; however, a smart contract could attach this and make simple calculations with it (CertifHy will include this value)
- Aggregate demand to enable automatisation cancellation of GO in peer-to-peer energy grids; this requires regulatory transfer cancellation GO from utilities to end consumer

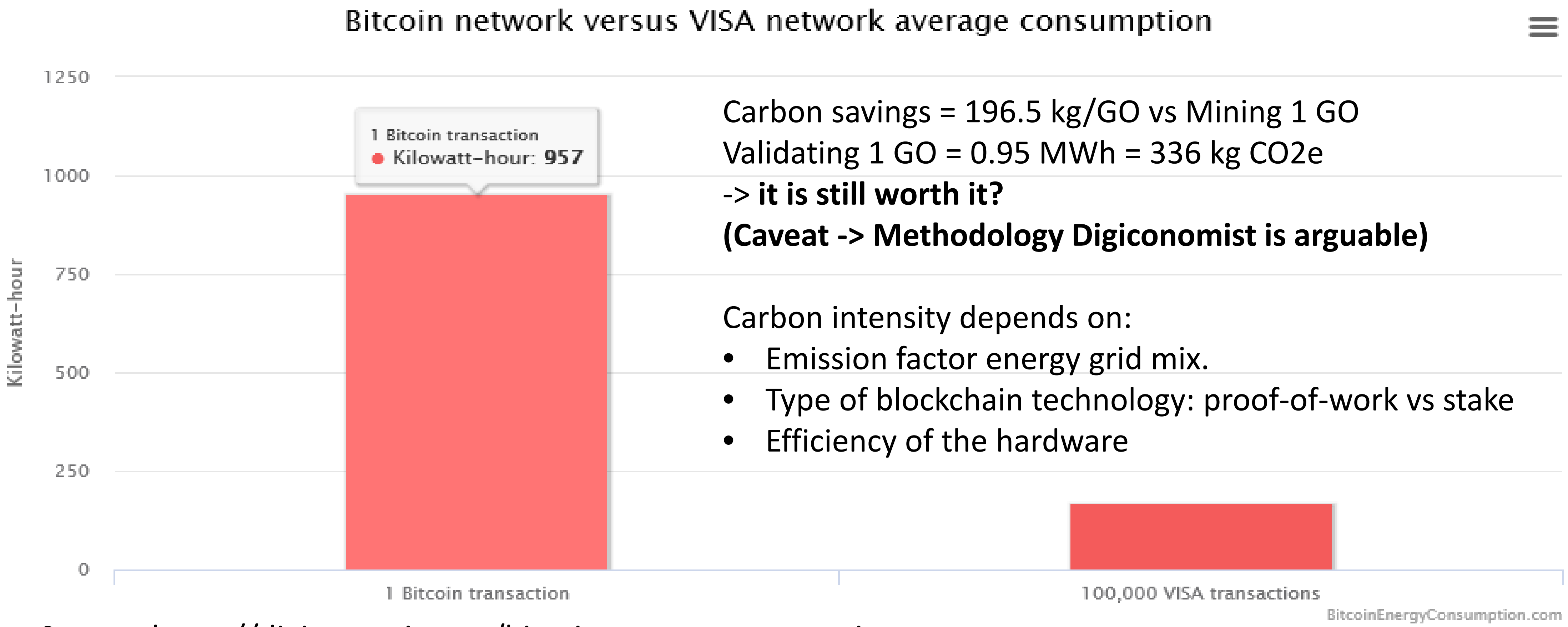
(if supplier is x, add consumption clients 1..n until consumption = 1MWh, then cancel GO ID)

What we need to investigate?

- Role of smart contract / distributed ledger technologies in the incumbent system: Complementary vs disruptive
  - For Issuing bodies, energy producers, energy distributors, final consumer
  - For policy makers / regulatory bodies
  - Still need for auditors
- Costs savings: incumbent vs new
  - Fewer infrastructure
- Trust
- Data protection / confidentiality
- Operational challenges: time vs volatility of prices
- Regulatory frameworks : Policy changes to enable distributed ledger technologies and changes on legal framework for GO (for P2P networks)
- Carbon emissions incumbent vs new: 1 GO = 1MWh = ≥ 327 kg CO_2e/MWh (SMR) - ≤131 kg CO_2e/MWh (GH)

  Carbon savings = 196.5 kg/MWh (GO) vs Mining 1 GO

GHG Emissions



Carbon savings = 196.5 kg/GO vs Mining 1 GO
Validating 1 GO = 0.95 MWh = 336 kg CO2e
-> **it is still worth it?**
(Caveat -> Methodology Digiconomist is arguable)

Carbon intensity depends on:

- Emission factor energy grid mix.
- Type of blockchain technology: proof-of-work vs stake
- Efficiency of the hardware

Source: https://digiconomist.net/bitcoin-energy-consumption

1 GO = 1 MWh= savings of 196.5 kgCO2e/MWh **1 Transaction = 957 kWh x 0.35156= 336 kgCO2e/MWh**

Our current work in this area …

We are sponsoring a PhD thesis:

- Determining the role of distributed ledger technologies in the markets of guarantees of origin for renewable energy

Our students' MSc dissertations are about:

- What is the environmental and economic impact of blockchain technologies in the trade of renewable energy guarantees of origin certificates?
- Socio-economic value and policy implications of smart contracts blockchain technologies for the UK national grid
- Authentication and tracking of Guarantees of Origin of renewable energy using Distributed Ledgers

Other work:

- H2FC Supergen – Role of Hydrogen in the UK Industrial Strategy (Experts survey)
- Members of the CertifHy GO WG4 – Regulatory Framework, IEA, etc.

Now recruiting …

Fully funded PhD Studentship: Determining the role of distributed ledger technologies in the markets of guarantees of origin for renewable energy

Project Description

The UCL Energy Institute invites applications for a fully funded 4-year PhD studentship covering UK/EU fees plus stipend. It will focus on the assessment of distributed ledger technologies applied to the trade of guarantees of origin for renewables, the development of models to maximise energy affordability and minimise energy and GHG emissions, as well as evaluating and suggesting regulatory policies to overcome potential challenges

Any Questions?

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