

# PROJECT DAEDALUS

## Reaching the Sun with Smart Solar Panels

**Colin Mallett**

CEO Trusted Renewables Ltd

Visiting Fellow, University of Hertfordshire

**LCEDN 7th Annual Conference**

30 May - 1 June 2018

Loughborough, UK.

# Agenda

- Introduction
- Smart Solar Panels
- Testbed & Specifications
- Exploiting blockchains
- Solar gardens
- Conclusions

# Agenda

- Introduction
- Smart Solar Panels
- Testbed & Specifications
- Exploiting blockchains
- Solar gardens
- Conclusions



# Innovate UK Energy Innovation Support



- Energy Catalyst covers...
  - Early-stage pre-industrial studies
  - Late stage experimental development
- Co-funded by BEIS, EPSRC & DFID
  - BEIS prioritises UK energy system projects
  - EPSRC supports energy sector university projects
  - DFID funds energy innovation in developing countries.
- Applicants with successful innovation track record encouraged



# Project Daedalus

Innovate UK  
Technology Strategy Board

## Reaching the Sun with Smart Solar Panels

Innovate UK Energy Catalyst feasibility study



- Develop prototype smart solar panels
- Build test-bed
- Contribute to DfID TEA programme
- Academic partner: University of Hertfordshire
- 15 month project (Jan 2017 - March 2018)

# DfID “Transforming Energy Access” (TEA) programme

- Scale up household solar market = affordable clean energy
- Innovative technology and business models
- Community microgrids gaining traction
- Private investment reduces long-term donor nation dependence



# Trusted Renewables.....

## “Private spin out” from BT Laboratories

- Highly experienced R&D professionals
- Many patents and publications
- Established 2008
- Wide international horizons



## What we do.....

### Research-led ICT innovation and thought leadership

- Smart homes, smart grid, renewables, e-commerce
- System integration



### Extensive knowledge of.....

- Fixed/ 2G - 5G mobile telecoms
- E commerce & converged services
- Emerging/disruptive technology
- M2M & wireless systems
- SIM & Java card technology
- IoT security
- Trust, privacy

# The Project

- Early-stage pre-industrial feasibility study
  - Test ideas on smart solar panels and blockchains
  - Prototype smart solar panels are key deliverables
- Assess viability against a range of use cases
  - Integration with energy grids
  - Technical potential of Cryptocurrencies, Blockchains & Distributed Ledger Technology
- Exploitation and adoption



# Agenda

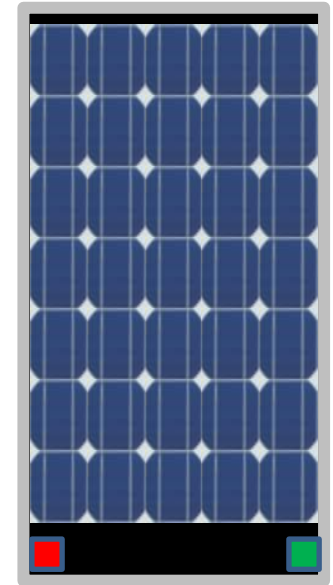
- Introduction
- Smart Solar Panels
- Testbed & Specifications
- Exploiting blockchains
- Solar gardens
- Conclusions

# TRL have invented the Smart Solar Panel



# The smart solar panel

- Embedded smartcard chip...
  - certifies how much renewable energy produced by each panel
  - provides cryptographic “root of trust”
  - runs industry standard smartcard software
- “System on a chip” for wireless connectivity
- Certifiable energy audit trail from individual panels
- Panels can be linked to e-wallet filled with cryptocurrencies
- “Solar gardens”



We have patented this in most sunny countries round the world....

# “Method and Apparatus for Secure Energy Delivery”

- Priority date 6 January 2009
- PCT application published 15 July 2010
- National phase in 34 Countries
- Granted in UK, Australia, US, S Africa
- EPO “notice of intention to grant”  
28 Countries selected
- Under/awaiting examination in Japan,  
& India

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)  
 (19) World Intellectual Property Organization  
 International Bureau  
 (43) International Publication Date  
 15 July 2010 (15.07.2010)  
 (10) International Publication Number  
**WO 2010/079325 A2**



(51) International Patent Classification:  
**H01L 31/042** (2006.01) **H02H 1/00** (2006.01)  
**G06F 17/40** (2006.01) **G01R 1/22** (2006.01)  
**H02J 13/00** (2006.01)

(21) International Application Number:  
 PCT/GB2010/000011

(22) International Filing Date:  
 6 January 2010 (06.01.2010)

(25) Filing Language:  
 English

(26) Publication Language:  
 English

(30) Priority Data:  
 0900082.9 6 January 2009 (06.01.2009) GB

(71) Applicant (for all designated States except US): **FULVENS LIMITED** [GB/GB]; Fulvens, Friston, Saxmundham, Suffolk IP17 1PP (GB).

(72) Inventors; and  
 (75) Inventors/Applicants (for US only): **COFTA, Piotr** [PL/GB]; 32 Bugsby Way, Kesgrave, Ipswich, Suffolk IP5 2WX (GB). **MALLETT, Colin Thomas** [GB/GB]; Fulvens, Friston, Saxmundham, Suffolk IP17 1 PP (GB).

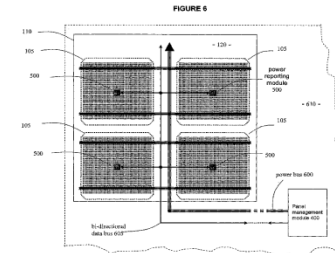
(74) Agent: **DUTTON, Erica Lindley Graham**; Rosemount, Pednor Vale Road, Chesham, Buckinghamshire HP5 2ST (GB).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TI, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BI, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

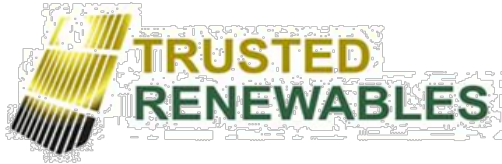
**Declarations under Rule 4.17:**  
 — as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))  
**Published:**  
 — without international search report and to be republished upon receipt of that report (Rule 48.2(g))

(54) Title: METHOD AND APPARATUS FOR SECURE ENERGY DELIVERY



(57) Abstract: A solar power conversion device has an embedded security module for creating trusted metering data in relation to power generated and for delivering it to a metering data output. The security module might for example be constructed as an integrated circuit card constructed using semiconductor chip fabrication and assembly techniques to be integral with the solar power conversion device. The device might comprise more than one solar cell mounted on a panel to form an array. There may further be provided a panel management module for collating data, for instance from multiple cells, prior to transmission over a network via the metering output. The panel management module might comprise for example a subscriber identity module and the metering data output may provide associated mobile telephone endpoint technology so that the metering data can be transmitted over an air interface.

# US Patent granted



## Continuation

- Published 16/02/2017
- Issued 06/02/2018
- Priority 06/01/2009

|  |   |
|--|---|
| (12) <b>United States Patent</b><br><b>Mallett et al.</b>  | (10) <b>Patent No.:</b> <b>US 9,887,971 B2</b><br>(45) <b>Date of Patent:</b> <b>*Feb. 6, 2018</b>  |
| (54) <b>METHOD AND APPARATUS FOR SECURE ENERGY DELIVERY</b>  | (58) <b>Field of Classification Search</b><br>CPC ..... H01L 31/02021; H01L 31/042; H04W 12/10; Y02E 10/50; Y02E 60/7853; (Continued)   |
| (71) Applicant: <b>Trusted Renewables Limited, Suffolk (GB)</b>  | (56) <b>References Cited</b><br>U.S. PATENT DOCUMENTS<br>7,188,003 B2 3/2007 Ransom<br>7,412,338 B2 8/2008 Wynans<br>(Continued)  |
| (72) Inventors: <b>Colin Thomas Mallett, Suffolk (GB); Piotr Cofa, Suffolk (GB)</b>  | FOREIGN PATENT DOCUMENTS<br>JP 2002-149060 5/2002<br>JP 2004-219181 8/2004<br>(Continued)   |
| (73) Assignee: <b>TRUSTED RENEWABLES LIMITED, Saxmundham, Suffolk (GB)</b>   | OTHER PUBLICATIONS<br>WhatIs.com. Roots of Trust (RoT). 1999, TechTarget, p. 1.*<br>(Continued)   |
| (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.<br>This patent is subject to a terminal disclaimer. | <i>Primary Examiner</i> — Sujoy Kundu<br><i>Assistant Examiner</i> — T. Anderson<br>(74) <i>Attorney, Agent, or Firm</i> — Nixon & Vanderhye P.C.   |
| (21) Appl. No.: <b>15/335,094</b>  | (57) <b>ABSTRACT</b><br>A solar power conversion device embedded security module creates trusted metering data in relation to power generated and outputs it as metering data. The security module might be constructed as an IC card using semiconductor chip fabrication and assembly techniques integral with the solar power conversion device. The device might include more than one solar cell mounted on a panel to form an array. There may be a panel management module for collating data, e.g., from multiple cells, prior to transmission over a network via the metering output. The panel management module might include a subscriber identity module and the metering data output may provide associated mobile telephone endpoint technology so that the metering data can be |
| (22) Filed: <b>Oct. 26, 2016</b>   |   |
| (65) <b>Prior Publication Data</b><br>US 2017/0048207 A1 Feb. 16, 2017   |   |
| <b>Related U.S. Application Data</b>   |   |
| (63) Continuation of application No. 13/143,374, filed as application No. PCT/GI32010/000011 on Jan. 6, 2010, now Pat. No. 9,515,522.  |   |
| <b>Foreign Application Priority Data</b><br>Jan. 6, 2009 (GB) ..... 0900082.9  |   |
| (51) <b>Int. Cl.</b><br><b>H04L 29/06</b> (2006.01)<br><b>H04L 9/32</b> (2006.01)<br>(Continued)   |   |
| (52) <b>U.S. Cl.</b><br>CPC ..... <b>H04L 63/0428</b> (2013.01); <b>H01L 31/02021</b>  |   |

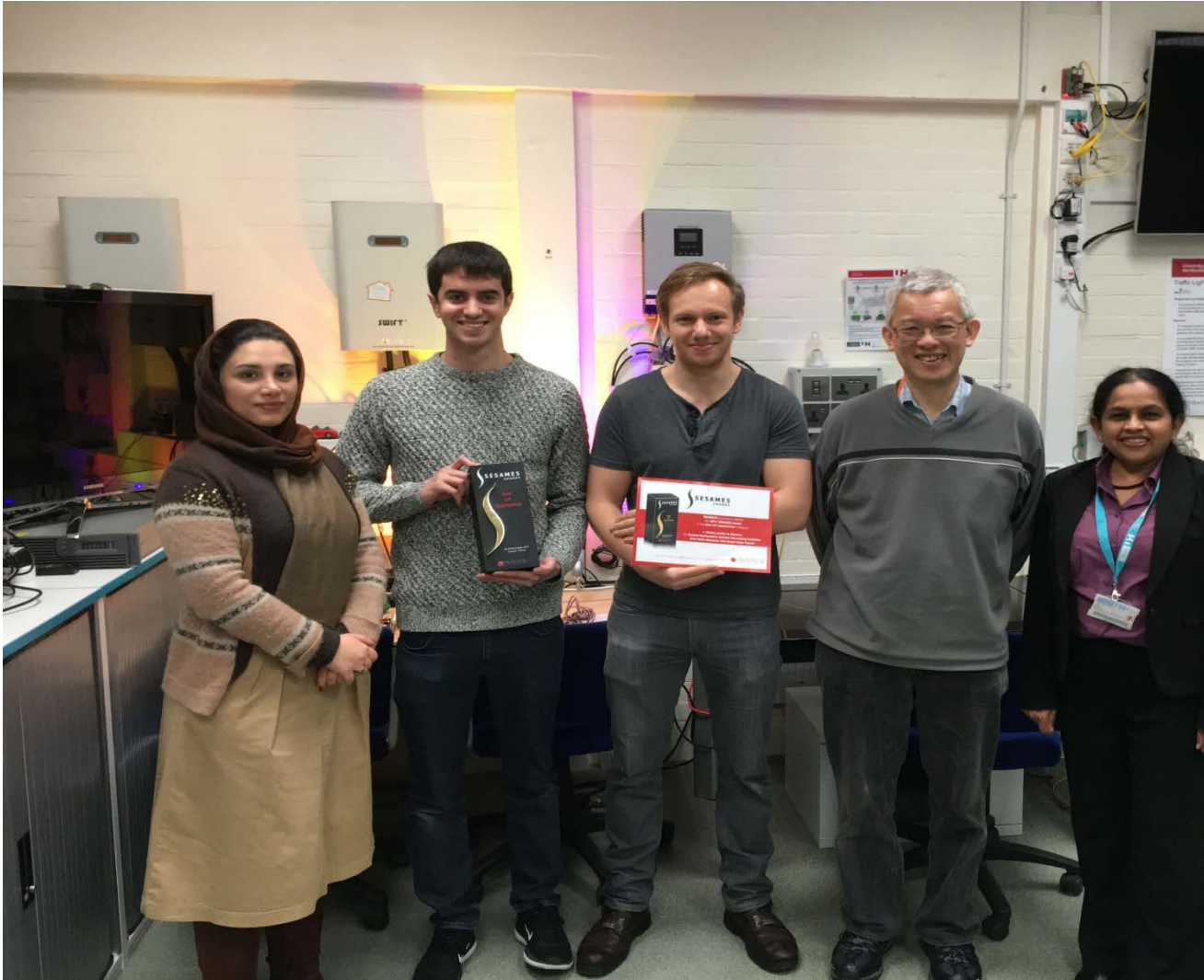
# Agenda

- Introduction
- Smart Solar Panels
- Testbed & Specifications
- Exploiting blockchains
- Solar gardens
- Conclusions

# The testbed



# UH Smart Lab team



30/05/2018



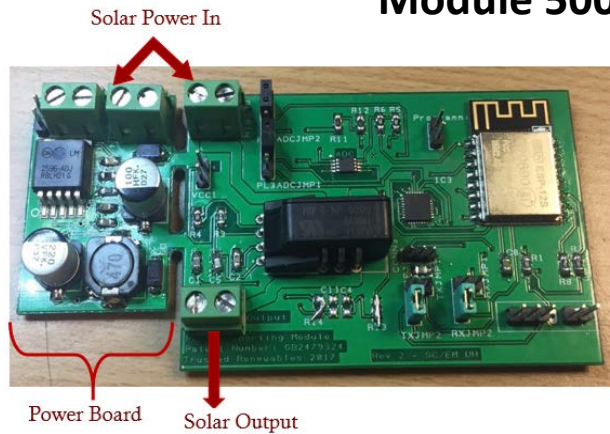
16





# Test bed hardware

## Module 500 - Embedded secure power reporting unit



Renewable Energy  
Generation Unit  
Server (REGUS)

## Module 400 - Secure power reporting unit

# 3D Printed Casing



# Developing a functional specification





- Alliance of > 100 distributed energy industry participants
- Address all aspects of PV power and energy storage assets
- Reduce cost, promote technology innovation and accelerate industry growth
- Information standards enable “plug & play” interoperability.

## **Recommendation**

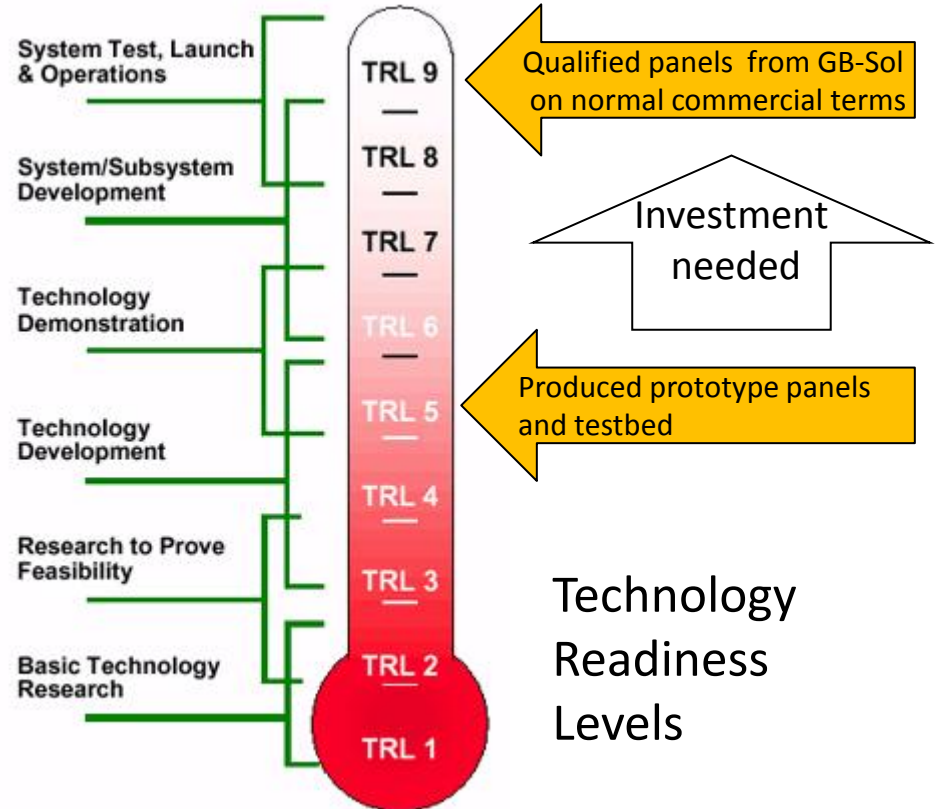
- Utilise SunSpec Information Models, Protocols and Testing/Certification

# Our Manufacturing Partner

# Making prototype panel



# Taking our innovation to market?

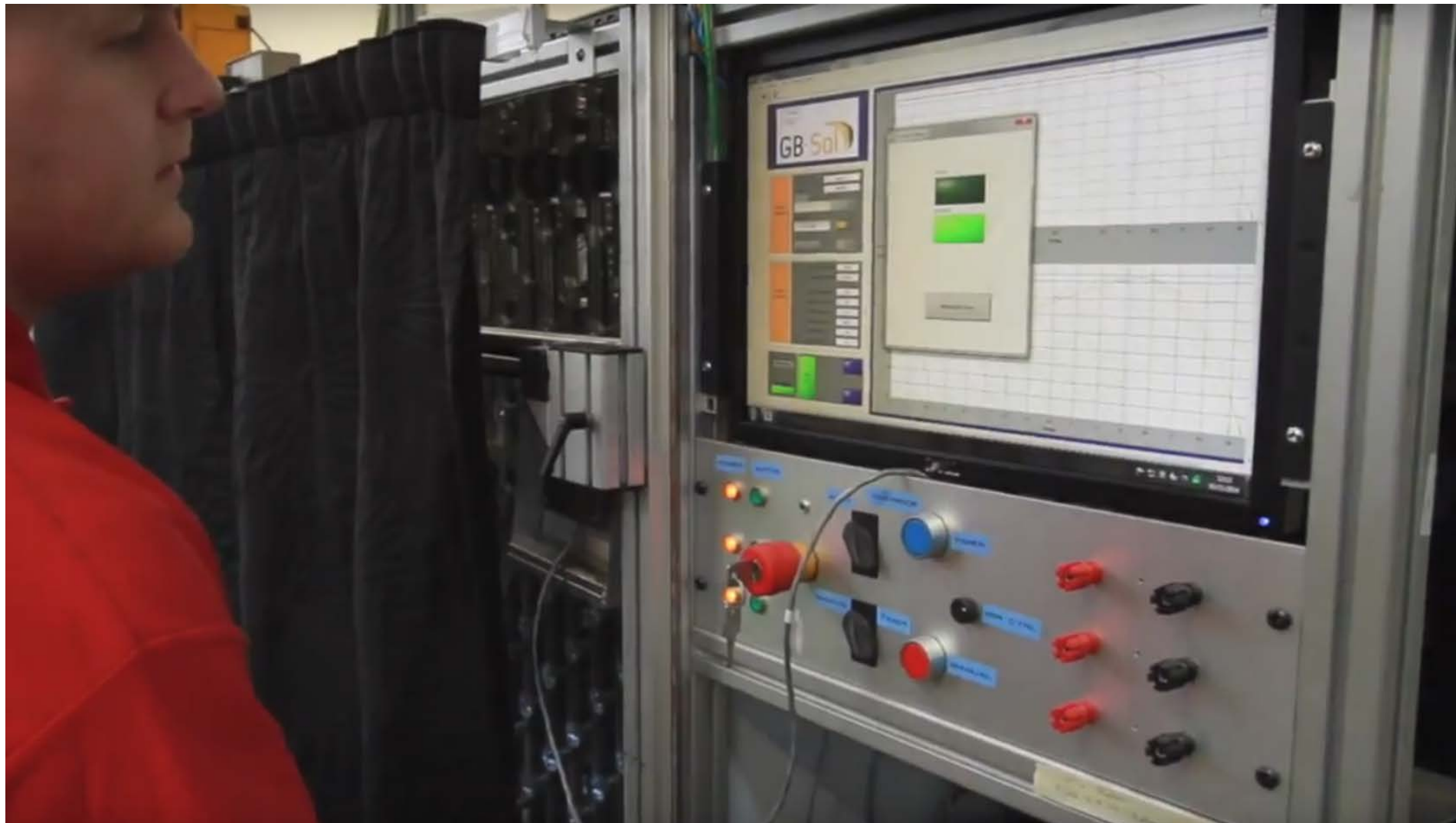


# Training at GB-Sol factory





# Qualification and Testing



# Agenda

- Introduction
- Smart Solar Panels
- Testbed & Specifications
- Exploiting blockchains
- Solar gardens
- Conclusions

# Cryptocurrencies and Blockchains

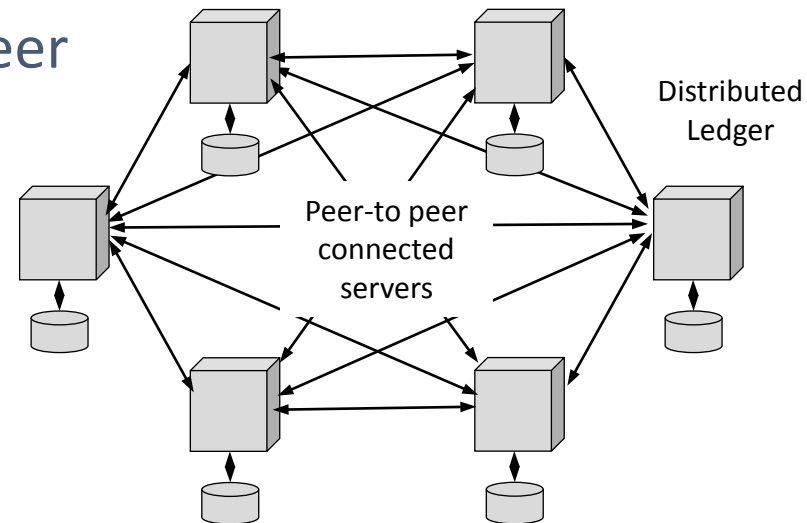
# Cryptocurrencies and Blockchains

“Biggest change to global financial services since the 16<sup>th</sup> century” ....

# Distributed blockchain ledgers

Every participant “owns” same copy of the ledger ...

- Can contain financial and/or non-financial transactions
- Ledgers replicated over peer-to-peer network in near real-time
- Records are “immutable”
- Consensus mechanisms make it hard to change historical records
- Cryptography and digital signatures prove identity, authenticity and enforce read/write access rights



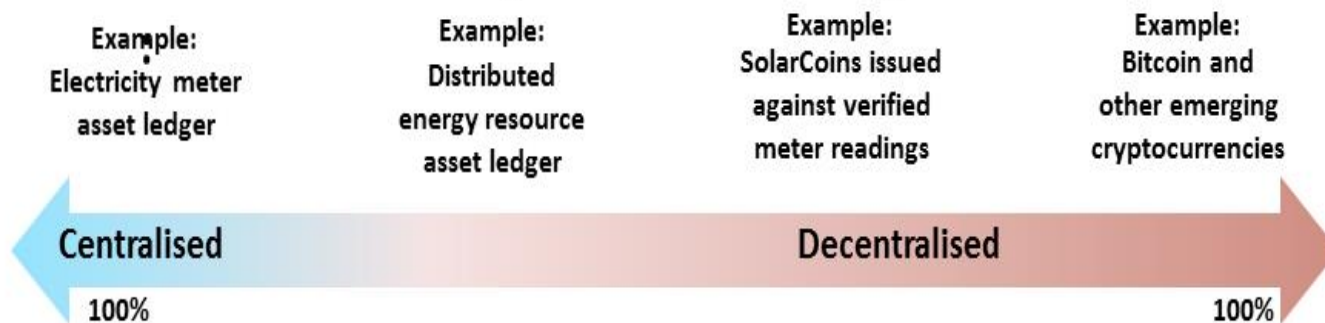
**All copies updated when any transaction is added**

# Distributed Ledger spectrum

Record every transaction made by every participant in decentralised system

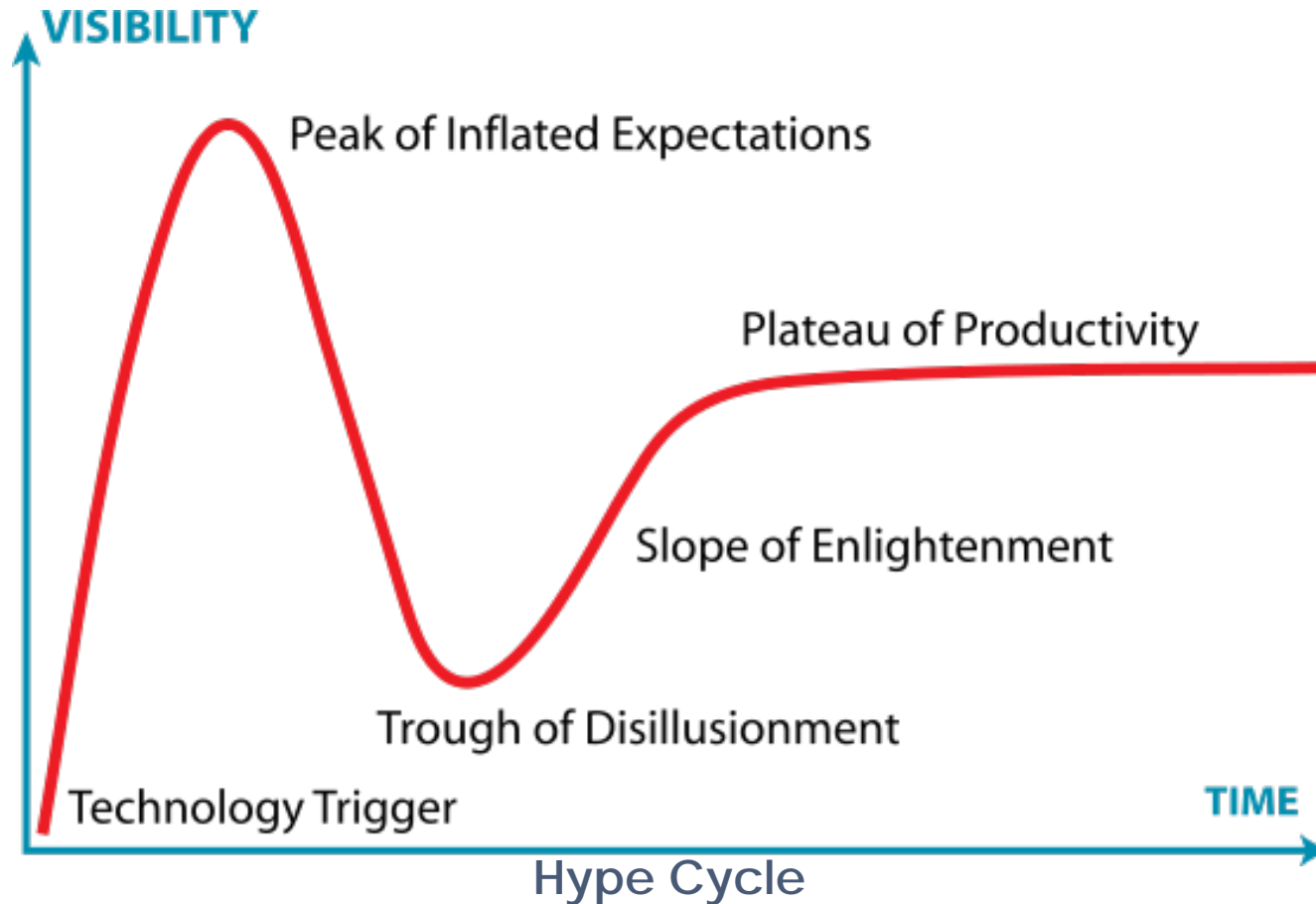


Distributed ledgers cover a broad range of uses

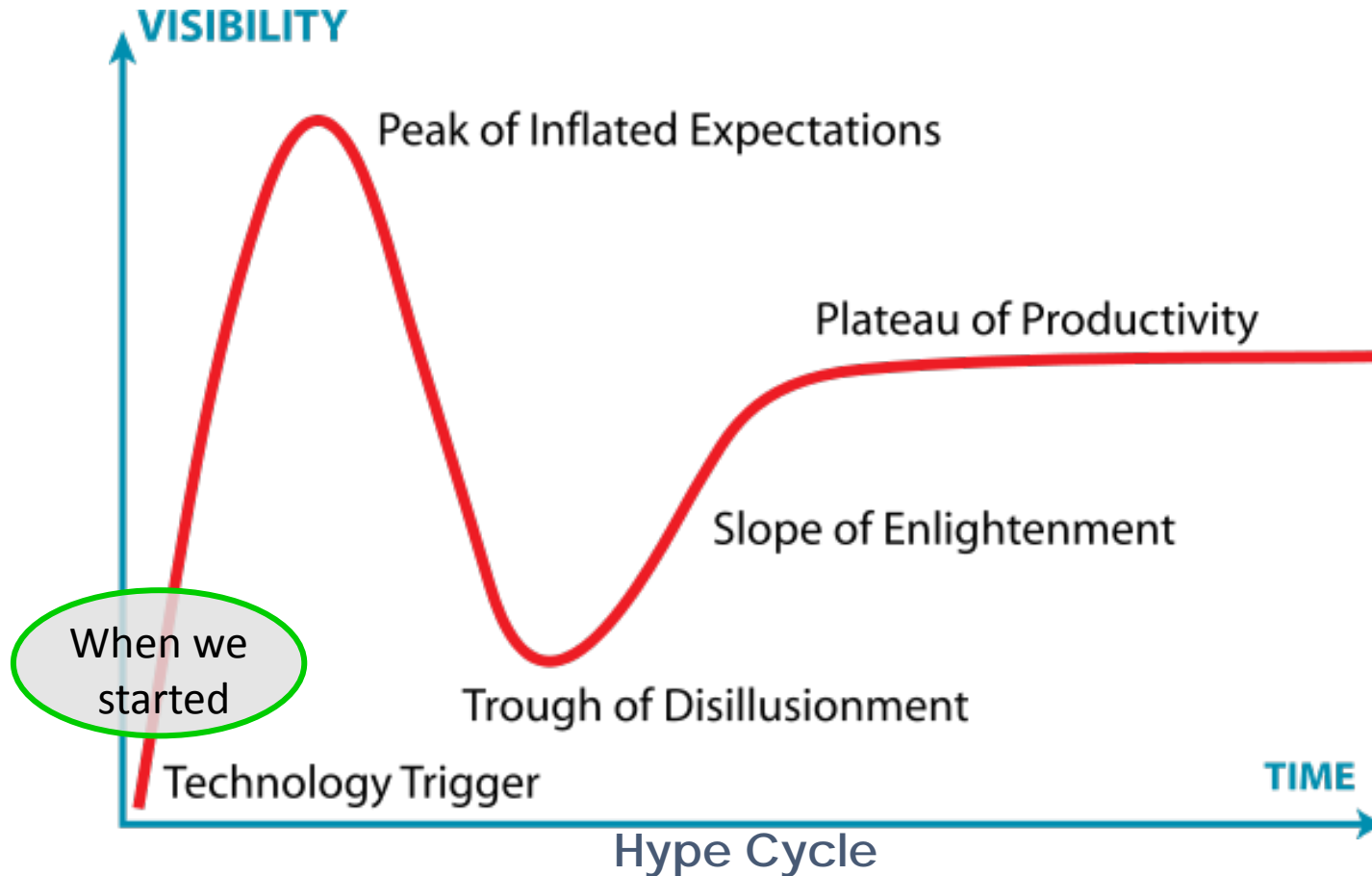


Smart contracts

# Blockchain Hype Cycle

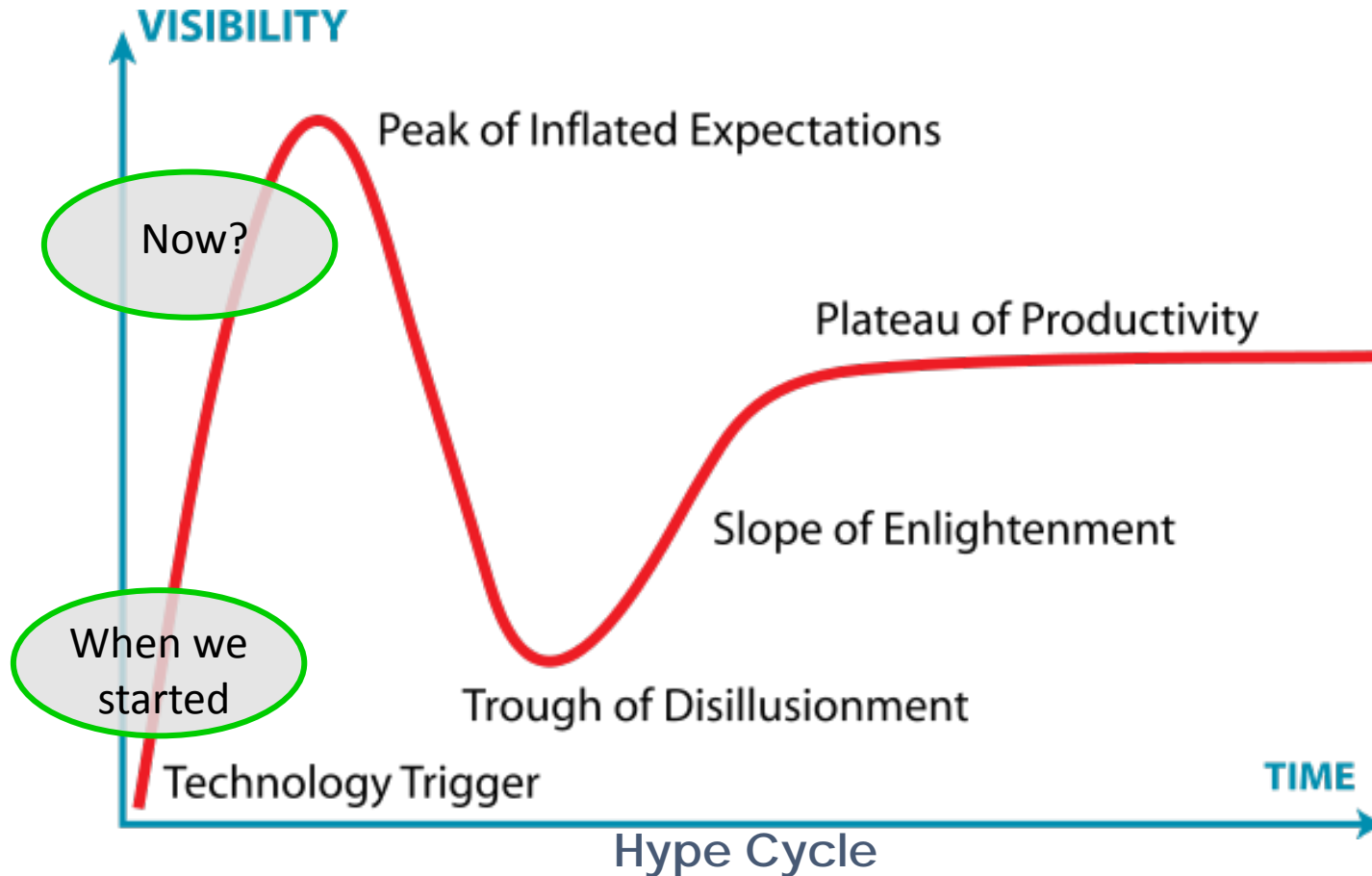


# Blockchain Hype Cycle

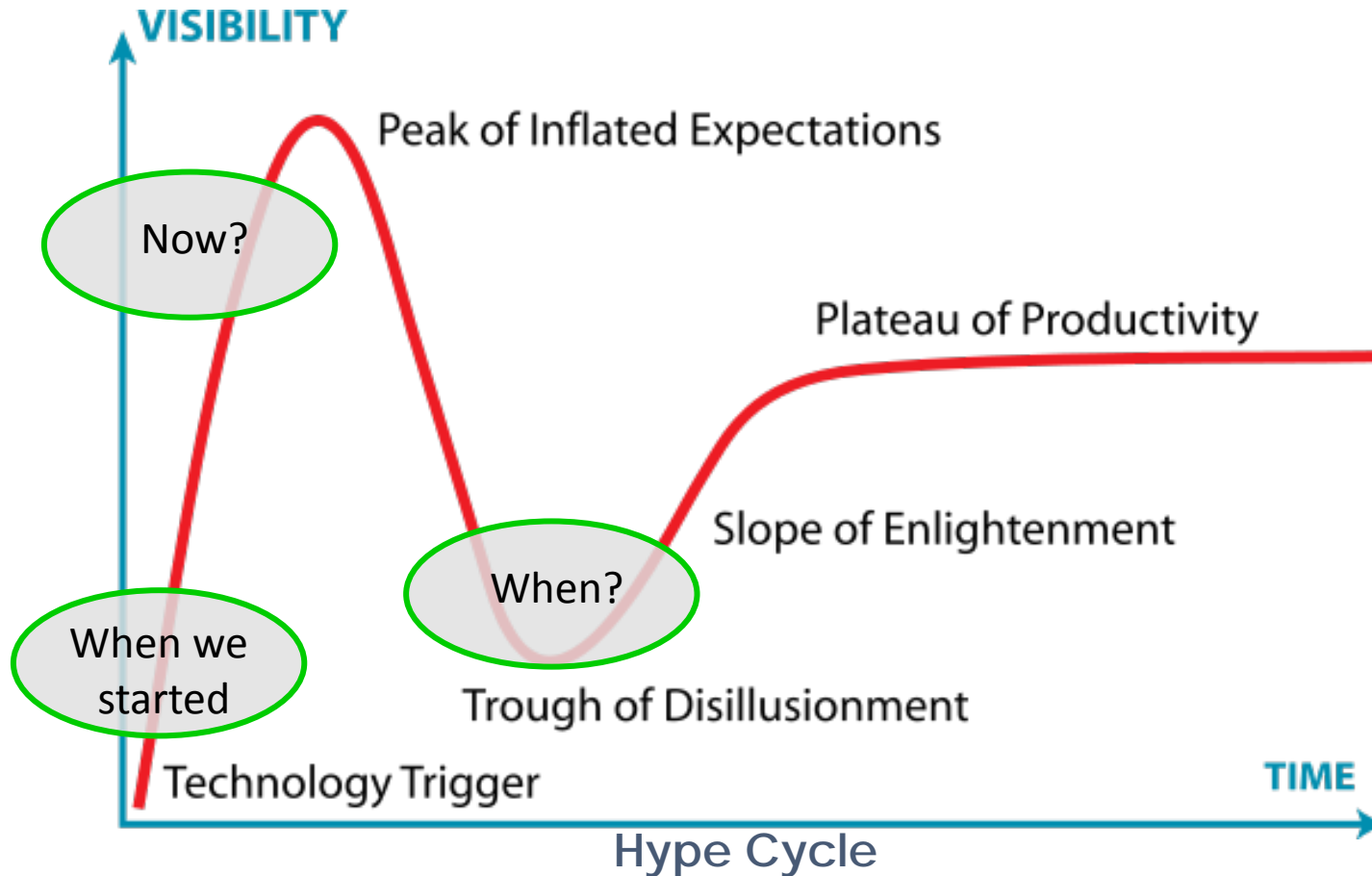




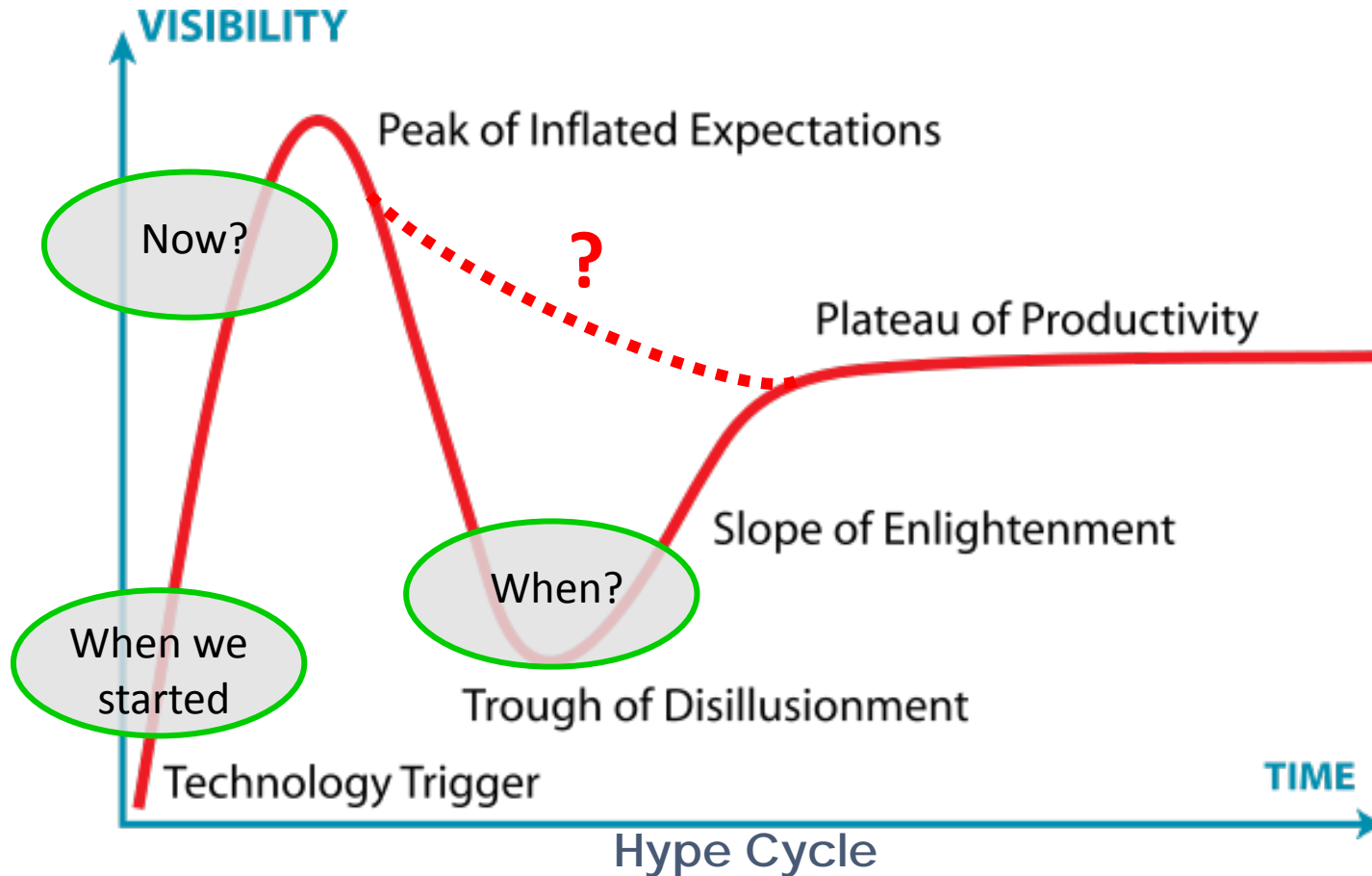
# Blockchain Hype Cycle



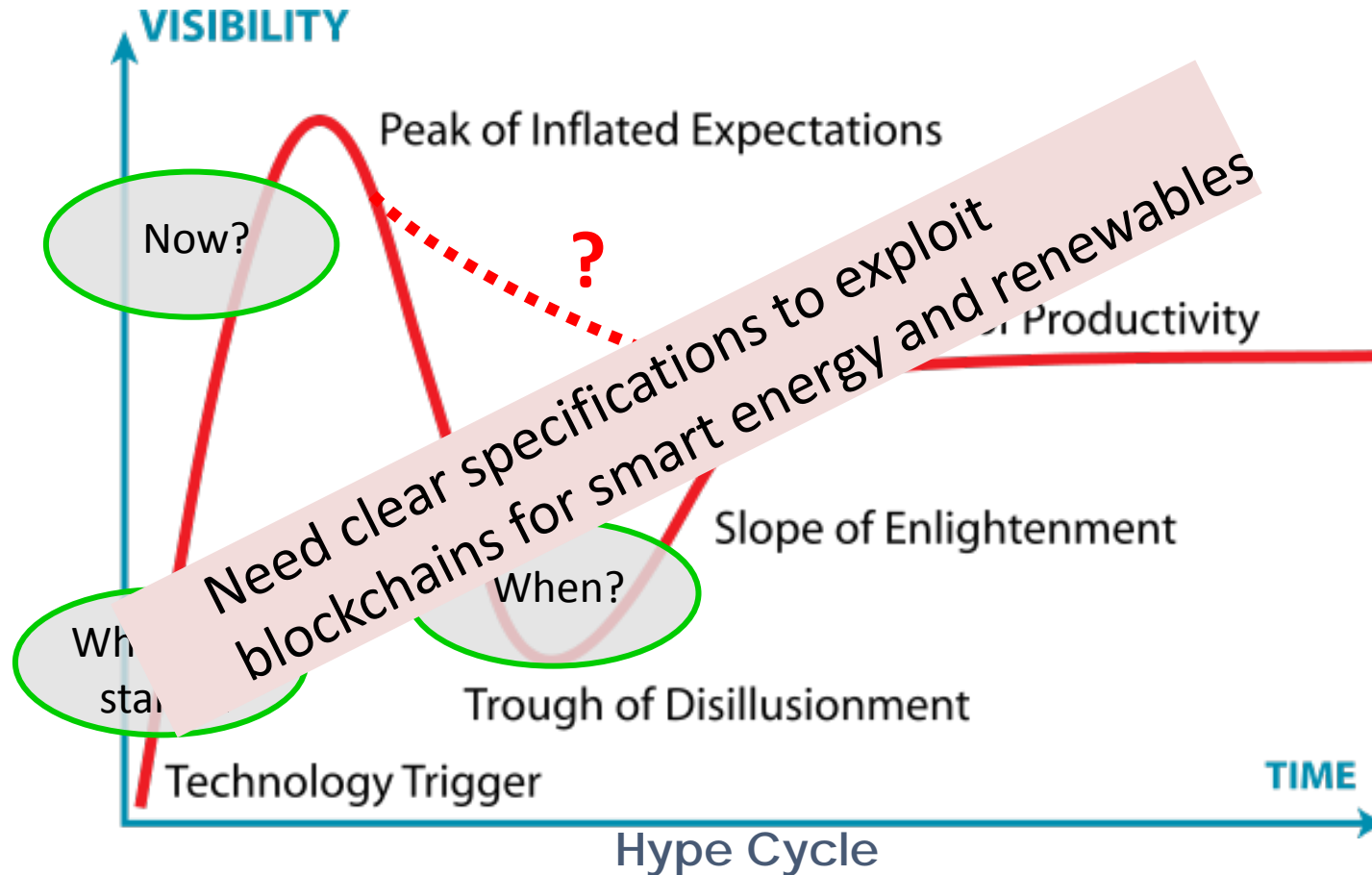
# Blockchain Hype Cycle



# Blockchain Hype Cycle



# How do we exploit blockchains?



# Agenda

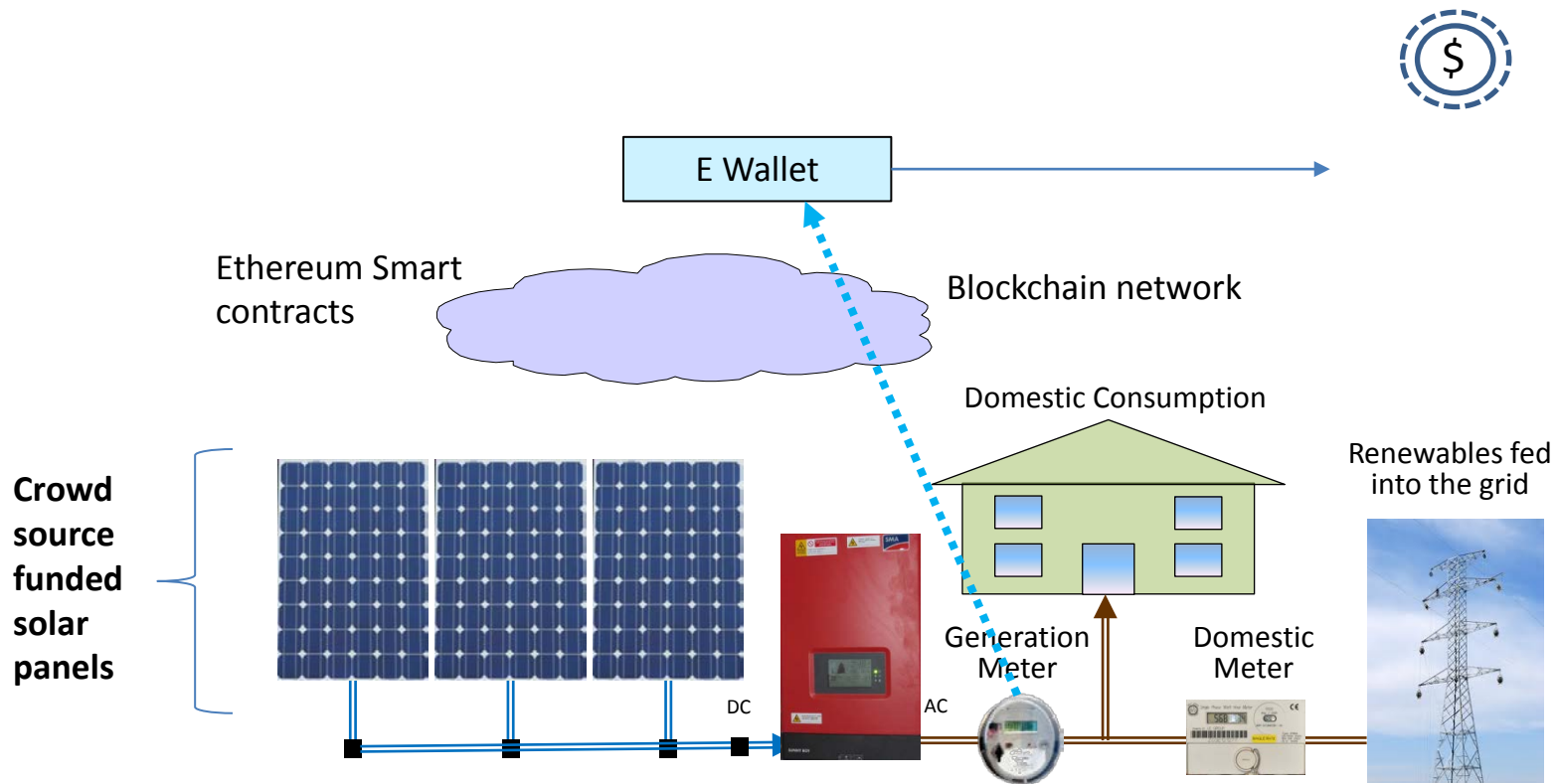
- Introduction
- Smart Solar Panels
- Testbed & Specifications
- Exploiting blockchains
- Solar gardens
- Conclusions

# Solar gardens

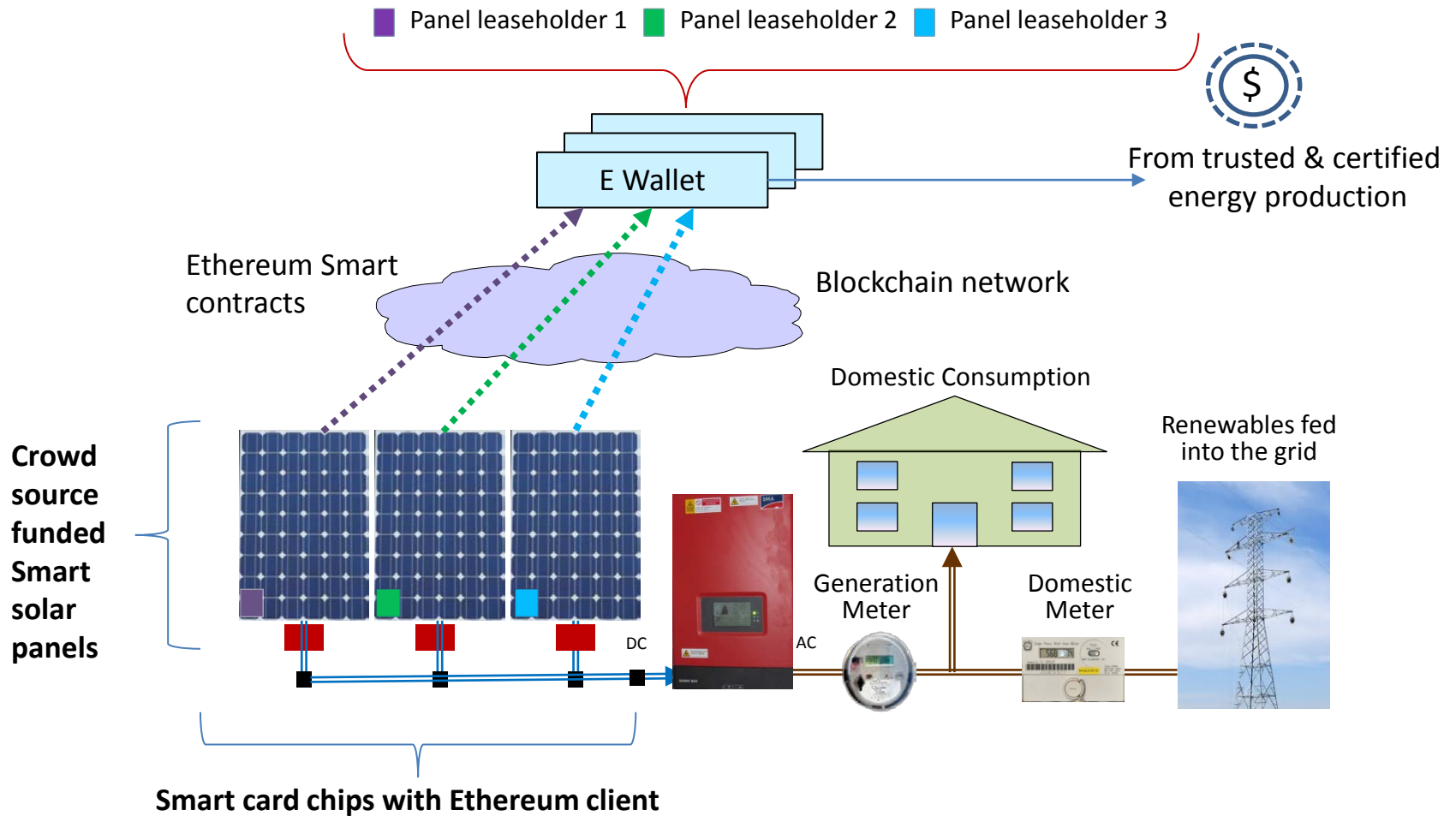
- Local renewables on community or agricultural buildings
- Crowdfunding
- Individual subscribers buy tradeable rights to be rewarded for renewable energy produced by “their” panels
- Grid parity means schemes are commercially viable without subsidies
- Smartcard chip certifies green energy production
  - Fill e-wallet with cryptocurrencies
- Ethereum supports smart contracts



# Solar gardens and blockchains

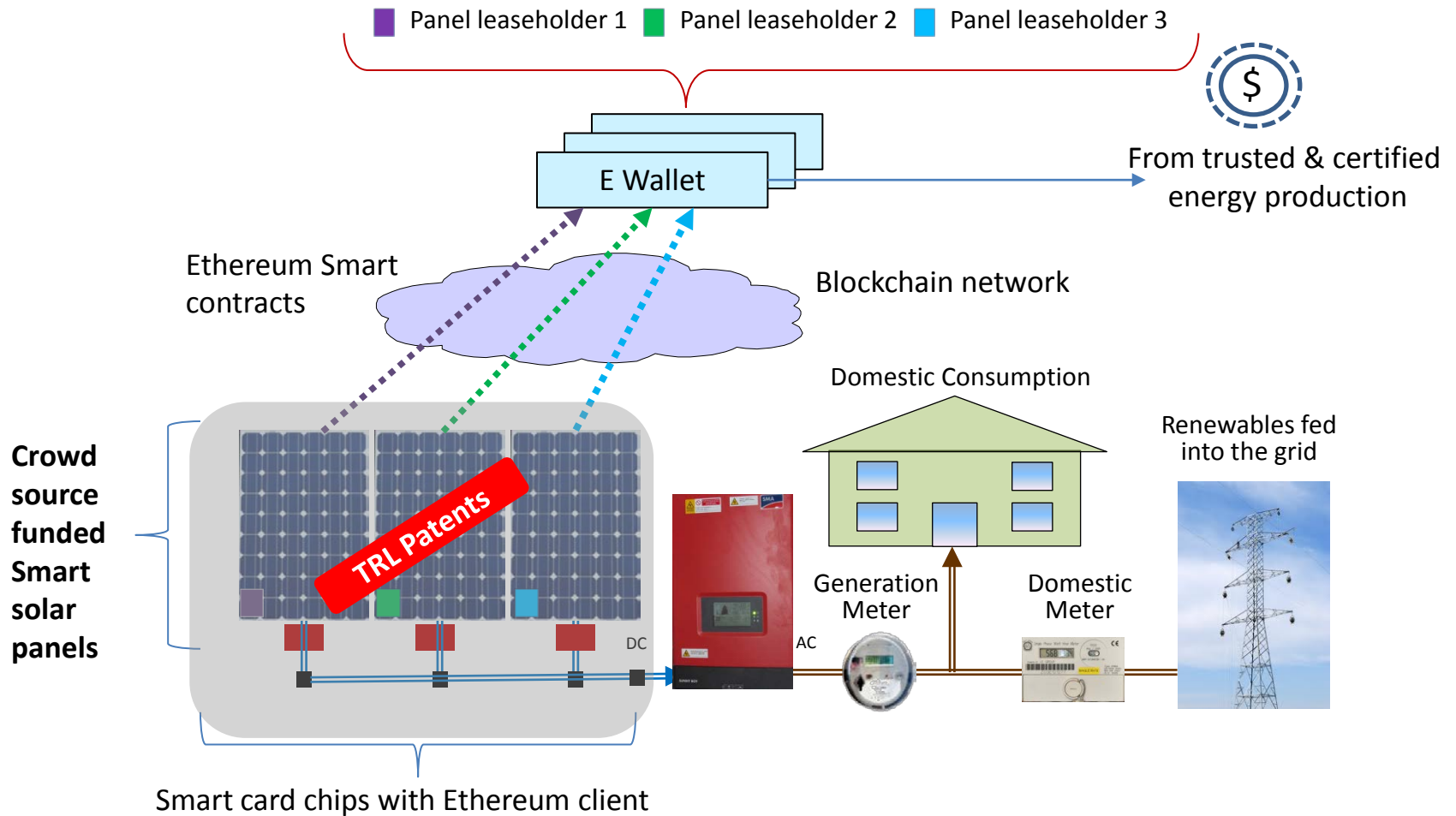


# Trusted Renewables Solar Gardens



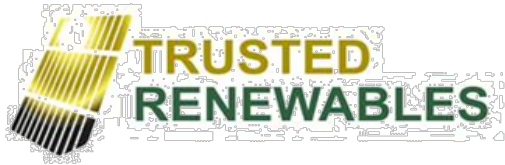


# Trusted Renewables Solar Gardens



# Agenda

- Introduction
- Smart Solar Panels
- Testbed & Specifications
- Exploiting blockchains
- Solar gardens
- Conclusions



# Great Project!





# PROJECT DAEDALUS

Thankyou