SPP Hybrid Firm

(Solar + Energy Storage)

Blue Solar Co., Ltd.

Blue Solar

Overall topics

- Company Profile
- Thailand's SPP Hybrid Firm and Blue Solar's participation
- Our work after passing the selection
- Financial model
- Wrap up for current progress
- Recommendations and lessons learned

Blue Solar

Company Profile

Company Profile

Blue Solar Farm 1
Location: Ladlumkaeo, Pathum Thani, Thailand
Installation capacity: 5 MW

Blue Solar

Company Profile

Blue Solar Farm 3
Location: Samut Sakhon, Thailand
Installation capacity: 5 MW

Blue Solar

Company Profile

Blue Solar Roof

Location: Nonthaburi and Pathum Thani, Thailand

Total Installation capacity: 0.46 MW

Blue Solar

Thailand’s SPP Hybrid Firm and Blue Solar’s participation

Thailand's SPP Hybrid Firm and Blue Solar's participation

- Policy
- Competitive bidding and TOR details
- Candidates
- Blue Solar's concept for this bidding
- Auction result

Blue Solar

Policy

- Renewable energy
  - Clean
  - May be unreliable
- Previous auction of biomass power plant in southern provinces
  - Resulted in cheap electricity price
  - By the way, there are still questions whether the winners would really develop those projects successfully?
- That previous auction final price became the reference price (3.66 THB) for this auction.

Blue Solar

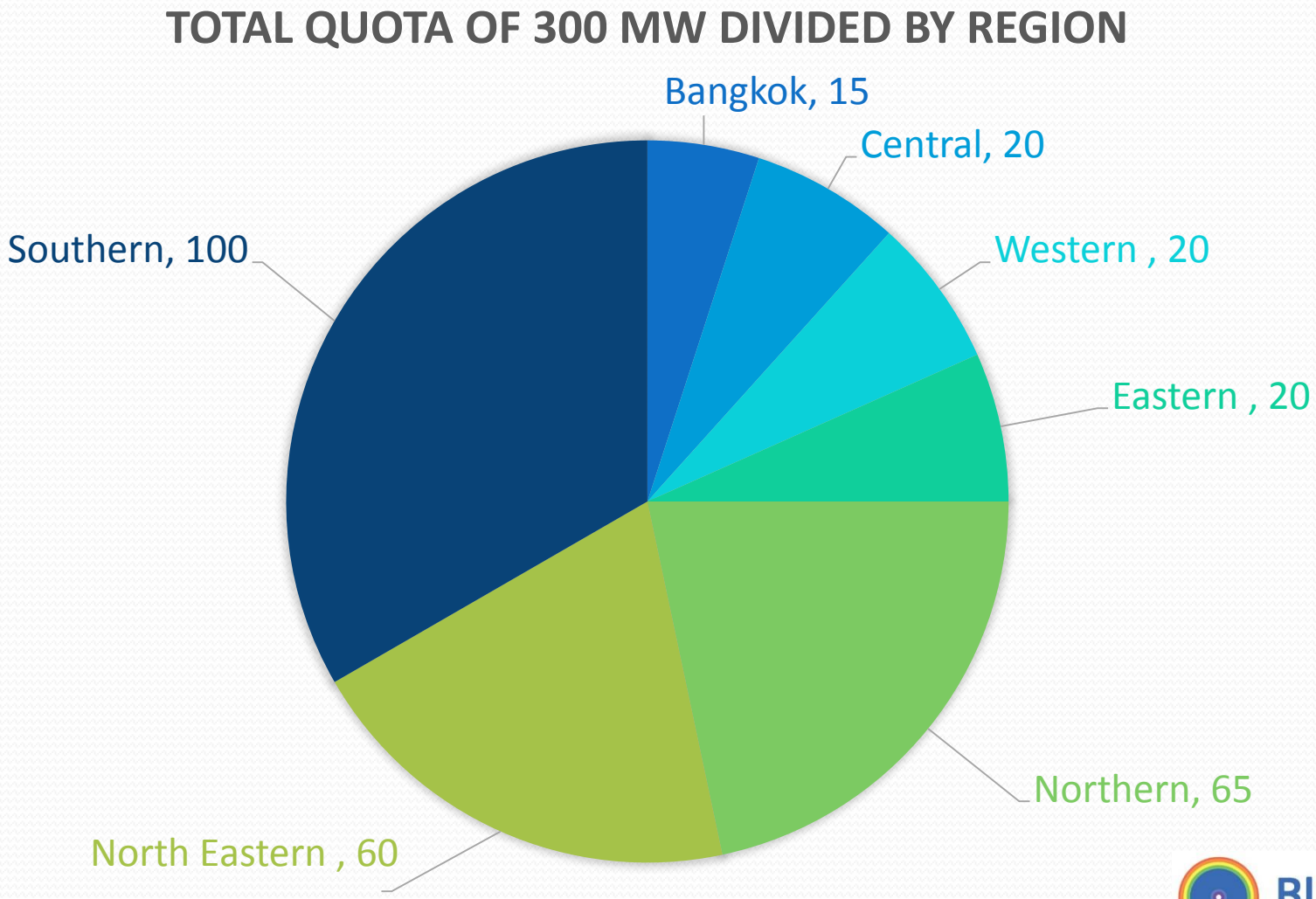
Competitive bidding and TOR details

- Power plant size of 10 - 50 MW
  (for both generation and exporting)

- Type of fuels
  - Biomass
  - Biogas (waste water/solid waste)
  - Biogas (energy crop)
  - Mini hydro
  - Wind
  - Solar
- Can use Energy Storage System

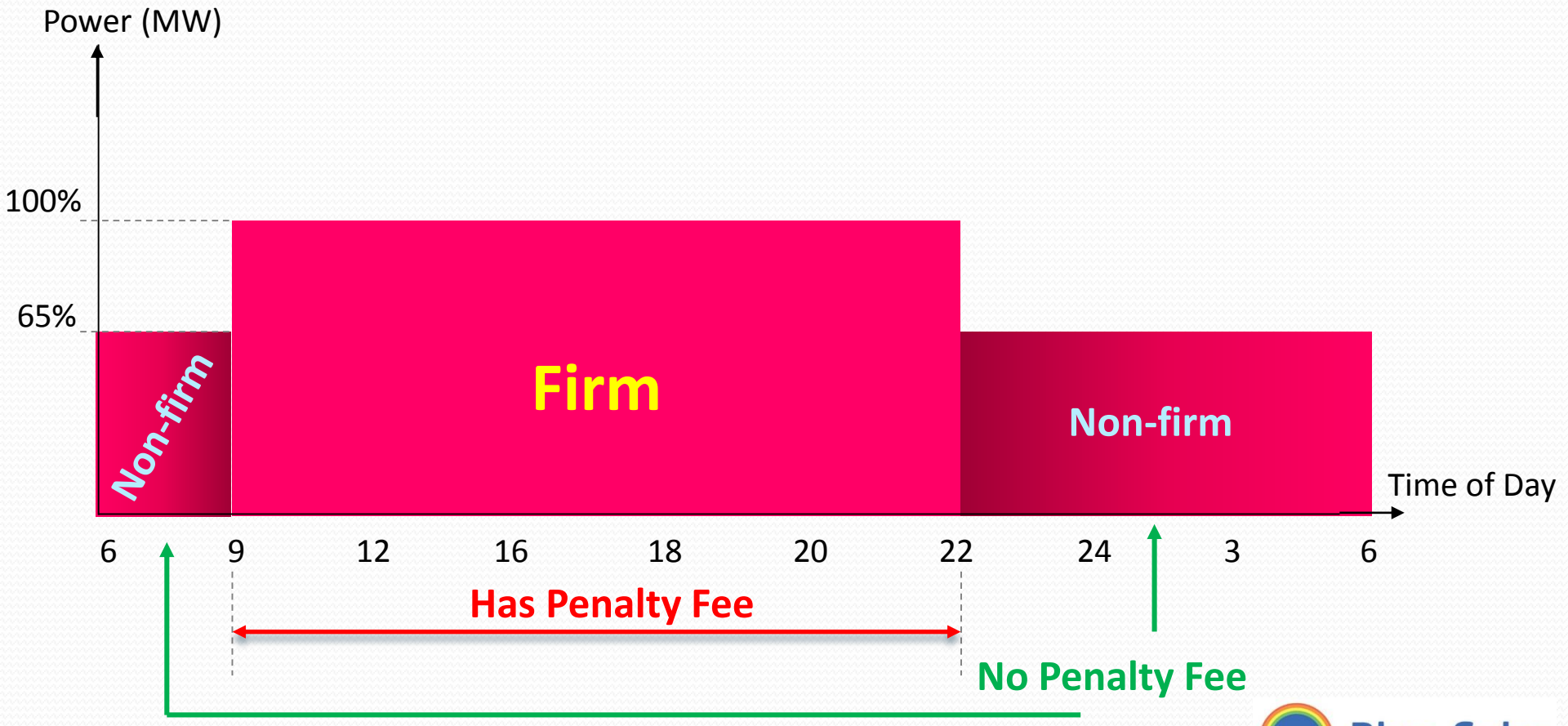
Blue Solar

Competitive bidding and TOR details



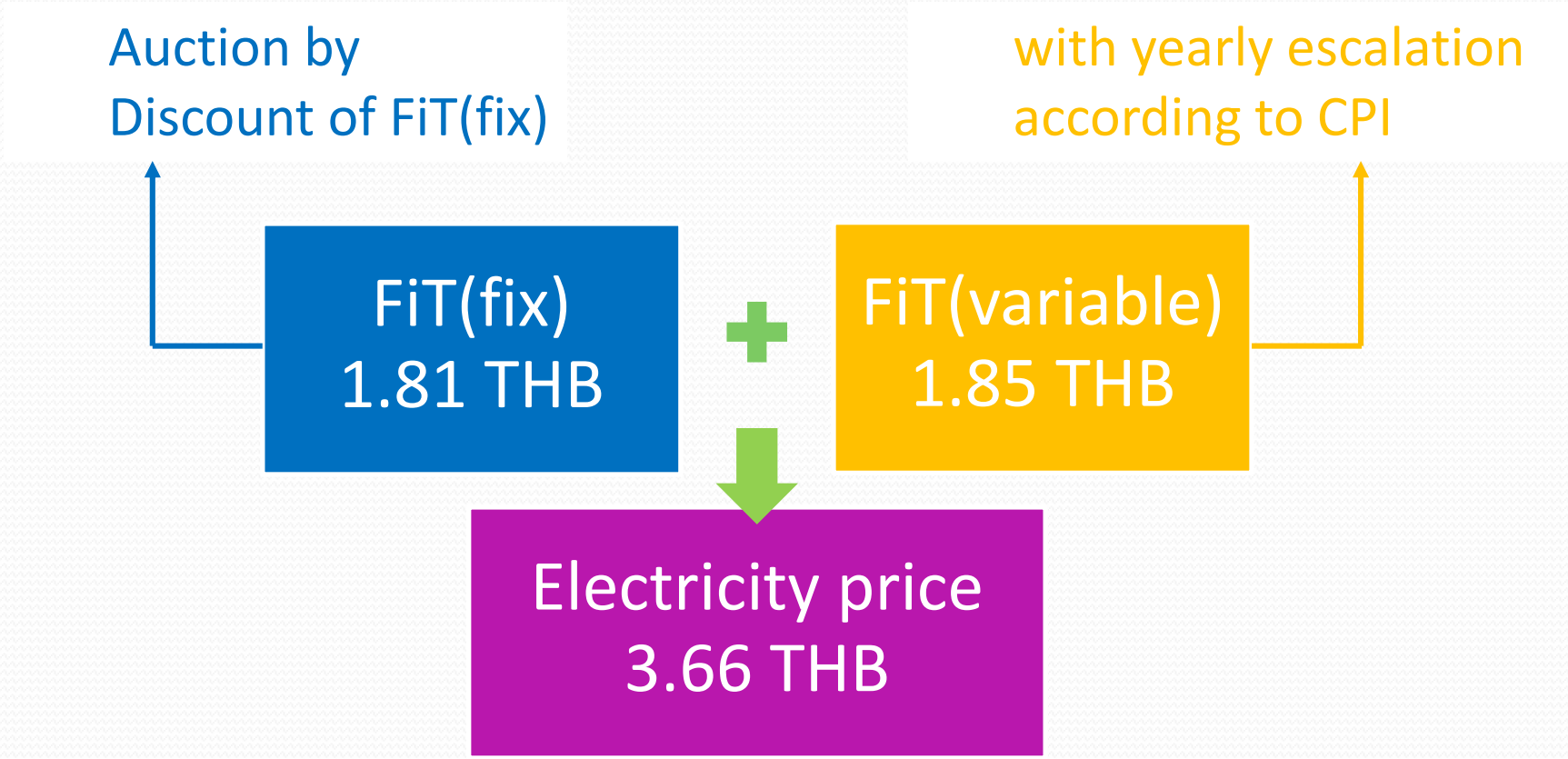
Blue Solar

Competitive bidding and TOR details



Blue Solar

Competitive bidding and TOR details



Blue Solar

Competitive bidding and TOR details

Blue Solar

Candidates

- Most of the participants submitted biomass projects for this auction as biomass plant is well recognized for its reliability of power generation, if it has no problem of raw material supply.
- Among all biomass players, sugar factories had the best competitive advantages as they would have sugar cane bagasse (by product from sugar production process) to be raw material for their biomass power plant free of charge.
- Solar and wind is not reliable, unless they have to be integrated with ESS.
- ESS was not economically feasible in 2017.

Blue Solar

Blue Solar's concept for this bidding

- Positive carbon emission power plant (reliable)
  - Coal (high reliability)
  - Natural gas (high reliability)
- Neutral carbon emission power plant
  - Biomass (high reliability)
  - Biogas (high reliability)
- Negative carbon emission power plant
  - Solar (low reliability)
  - Wind (low reliability)

High reliability

Low reliability

Blue Solar

Blue Solar's concept for this bidding

- Negative carbon emission power plant

- Expensive → inexpensive
- Low reliability → high reliability

- One of the best solutions for Climate Change

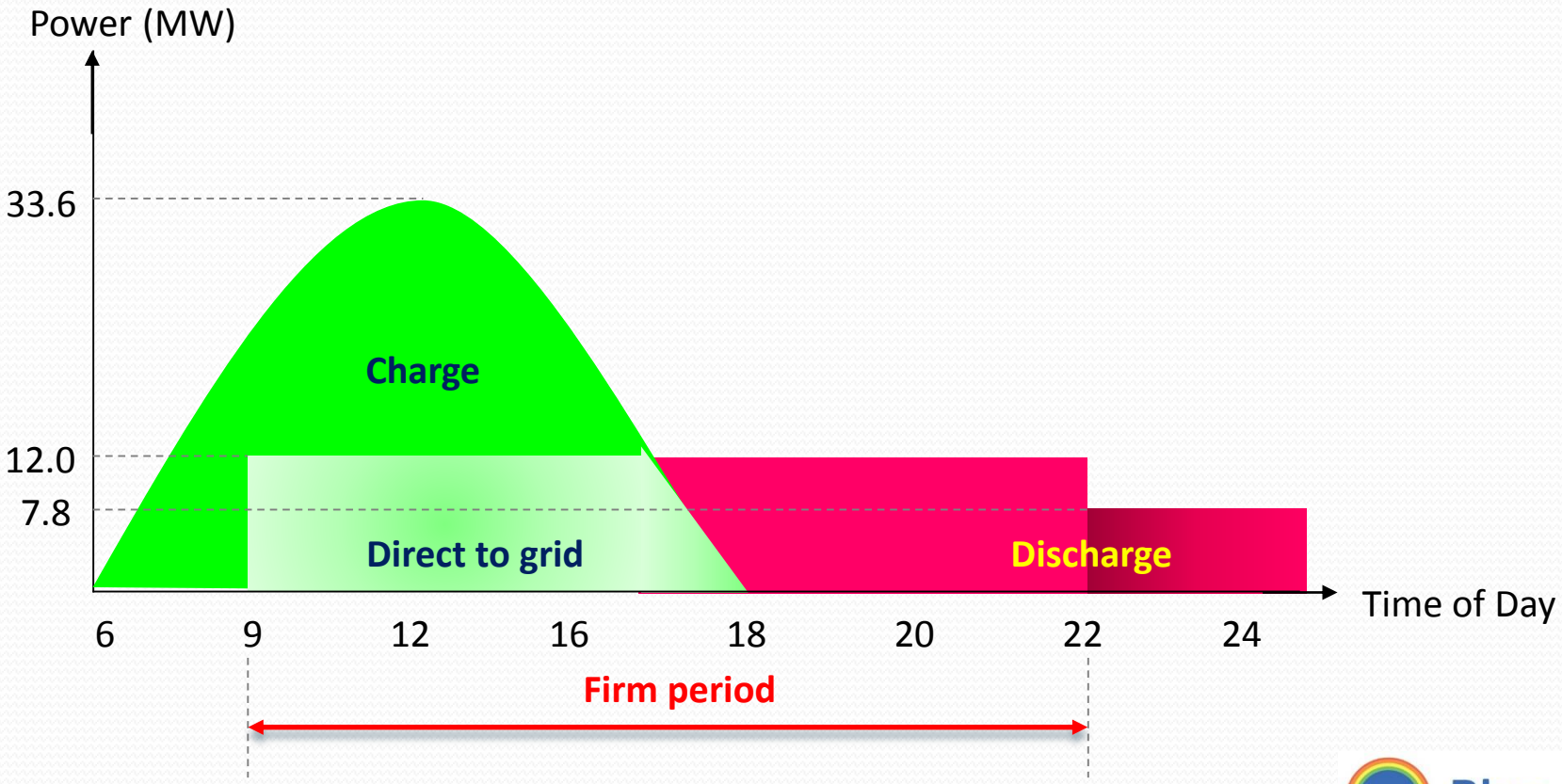
Blue Solar

Blue Solar's concept for this bidding

- Sell electricity at 12 MW AC to the grid
  - Firm period: 12 MW
  - Non firm period: 7.8 MW
- Install 42 MW DC Solar PV
- Install 12MW, 54 MWh ESS (Energy Storage System)

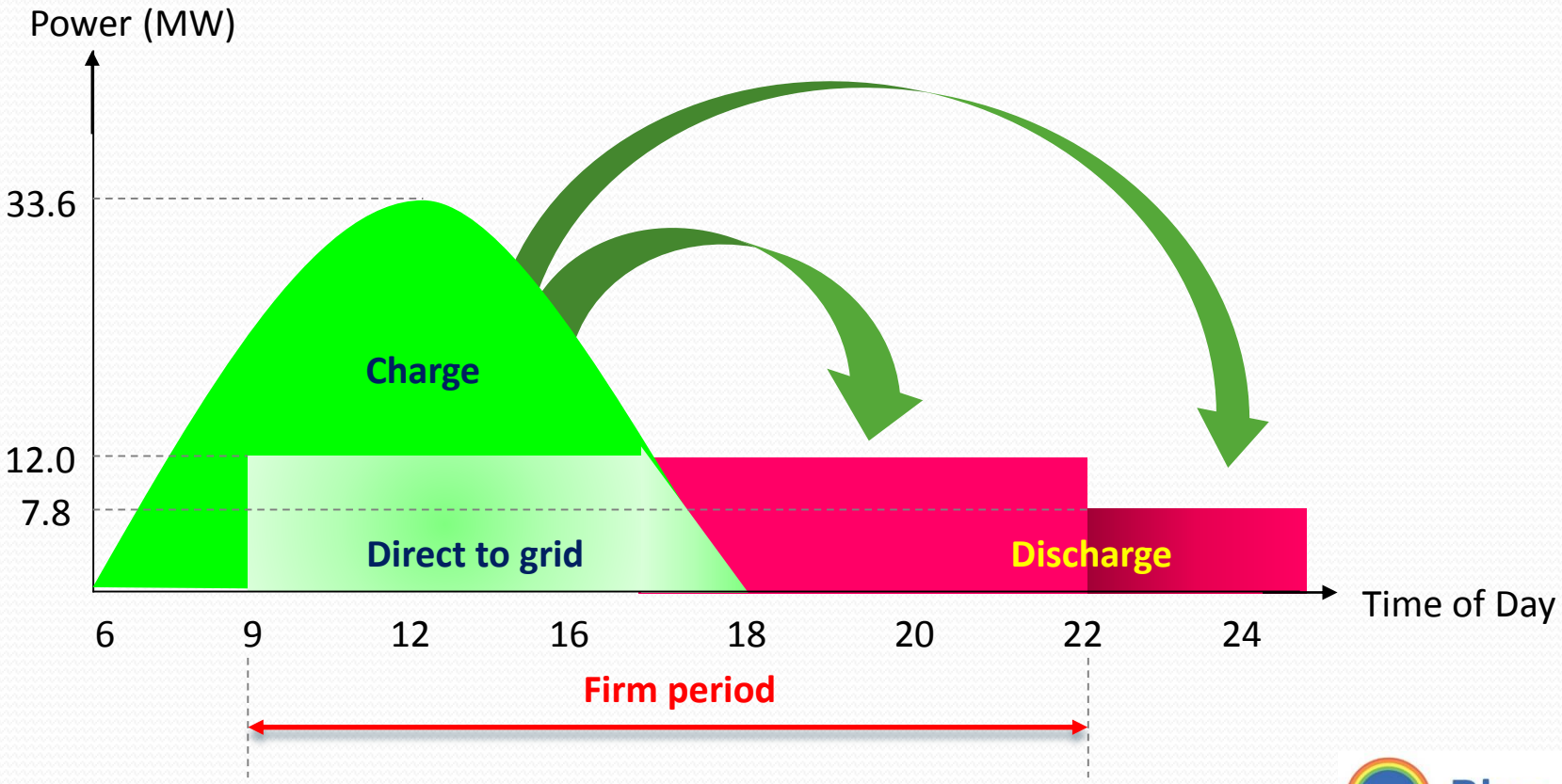
Blue Solar

Blue Solar's concept for this bidding



Blue Solar

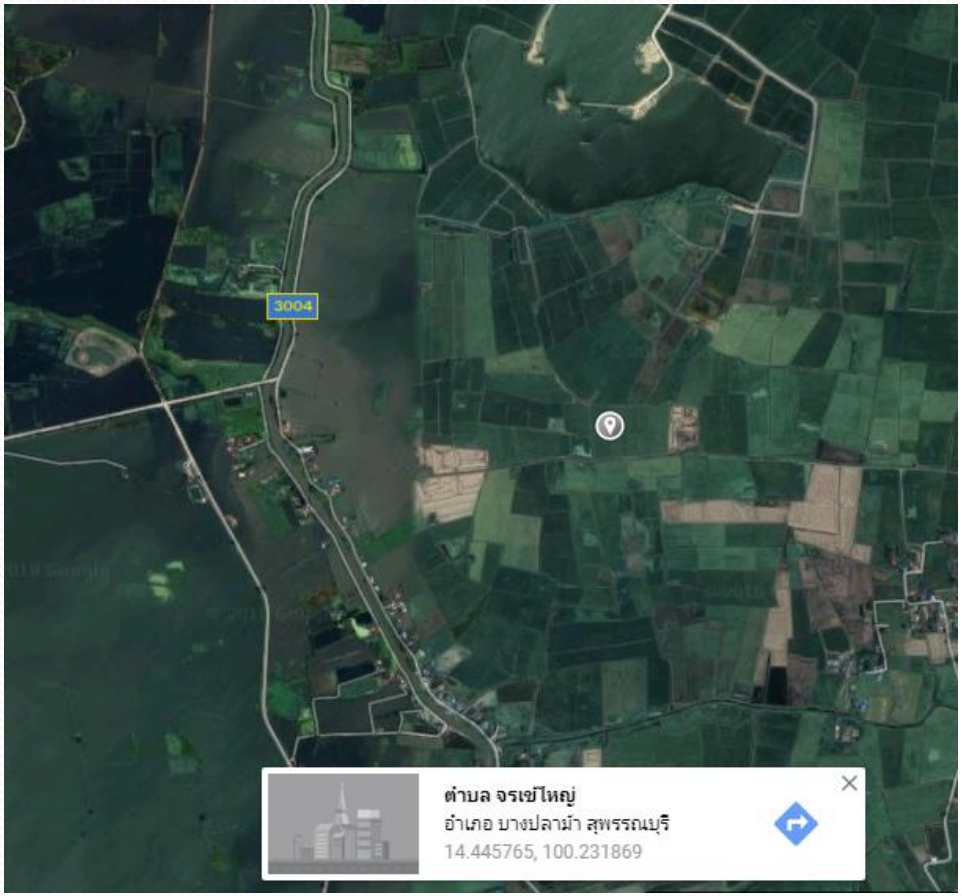
Blue Solar's concept for this bidding

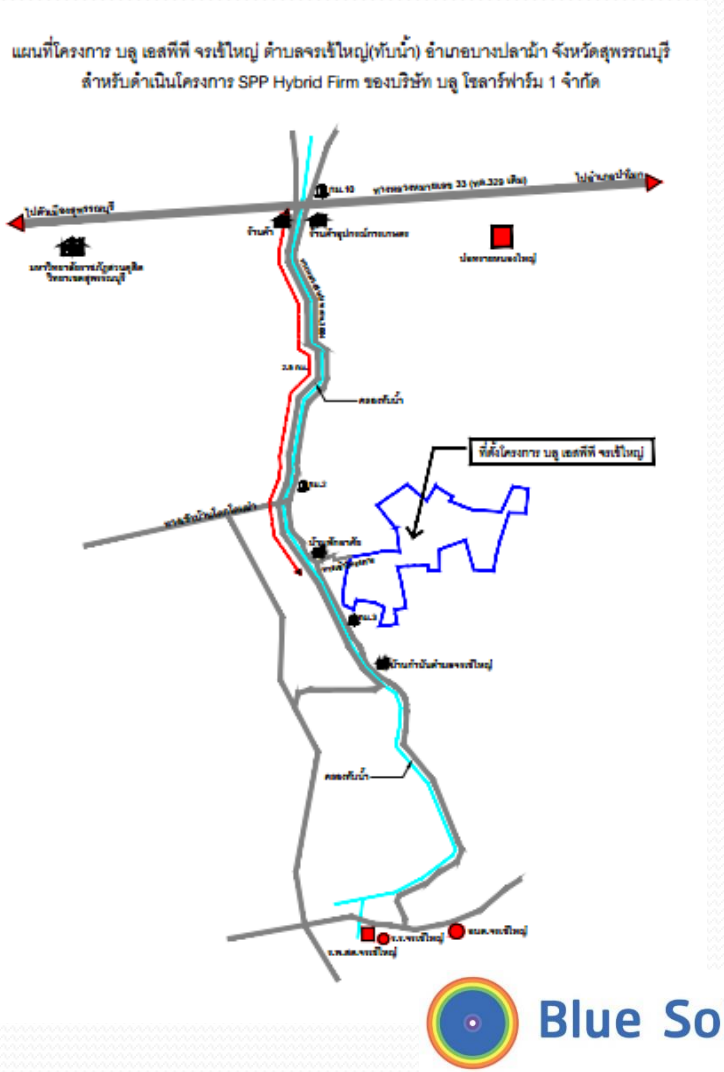


Blue Solar

Blue Solar's concept for this bidding:

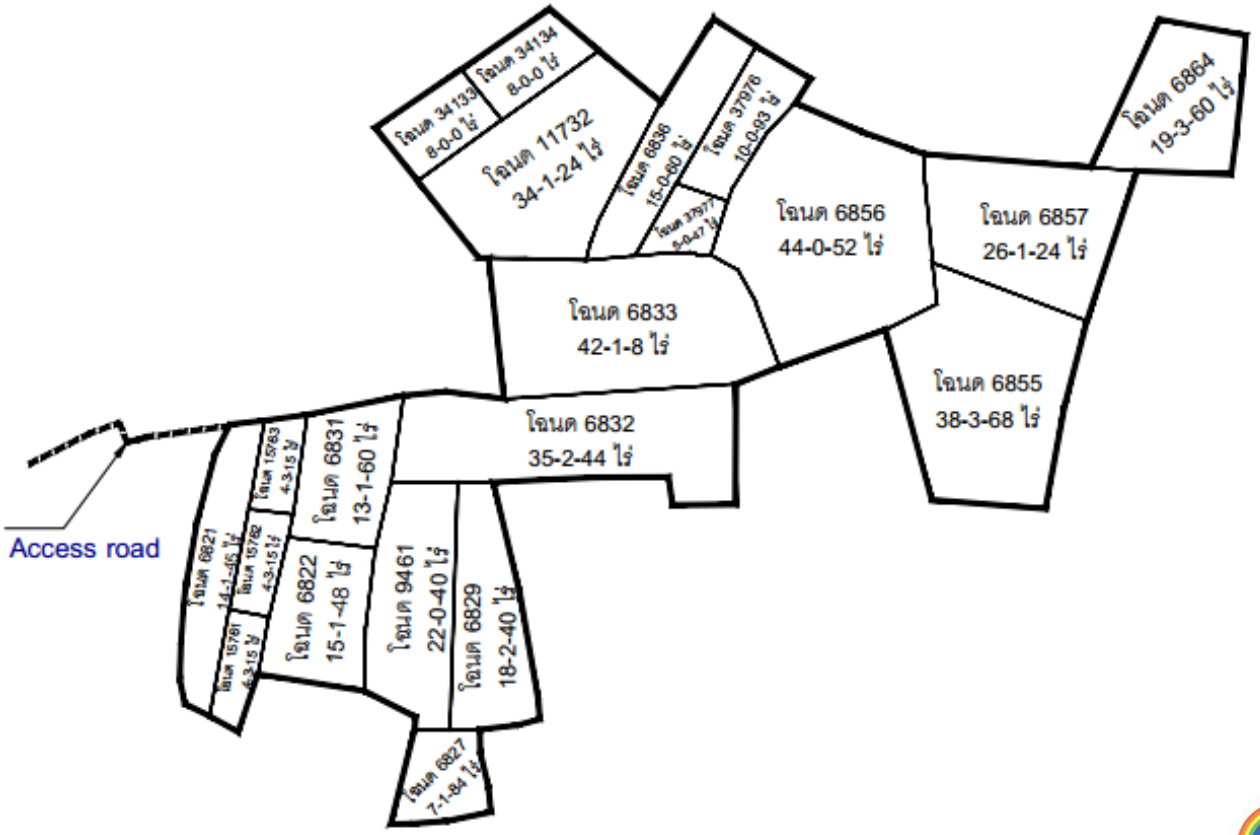
Project land





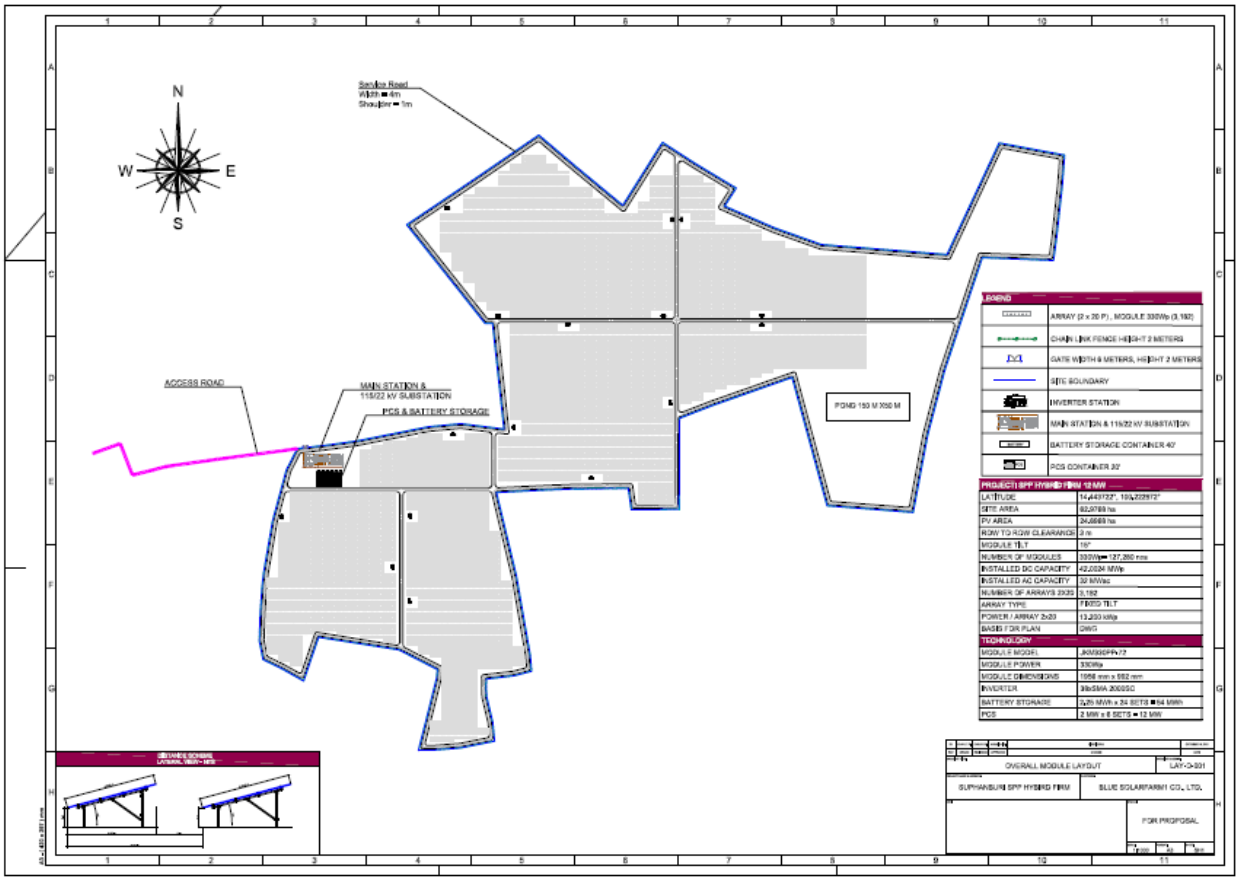
Blue Solar

Blue Solar's concept for this bidding: Project land



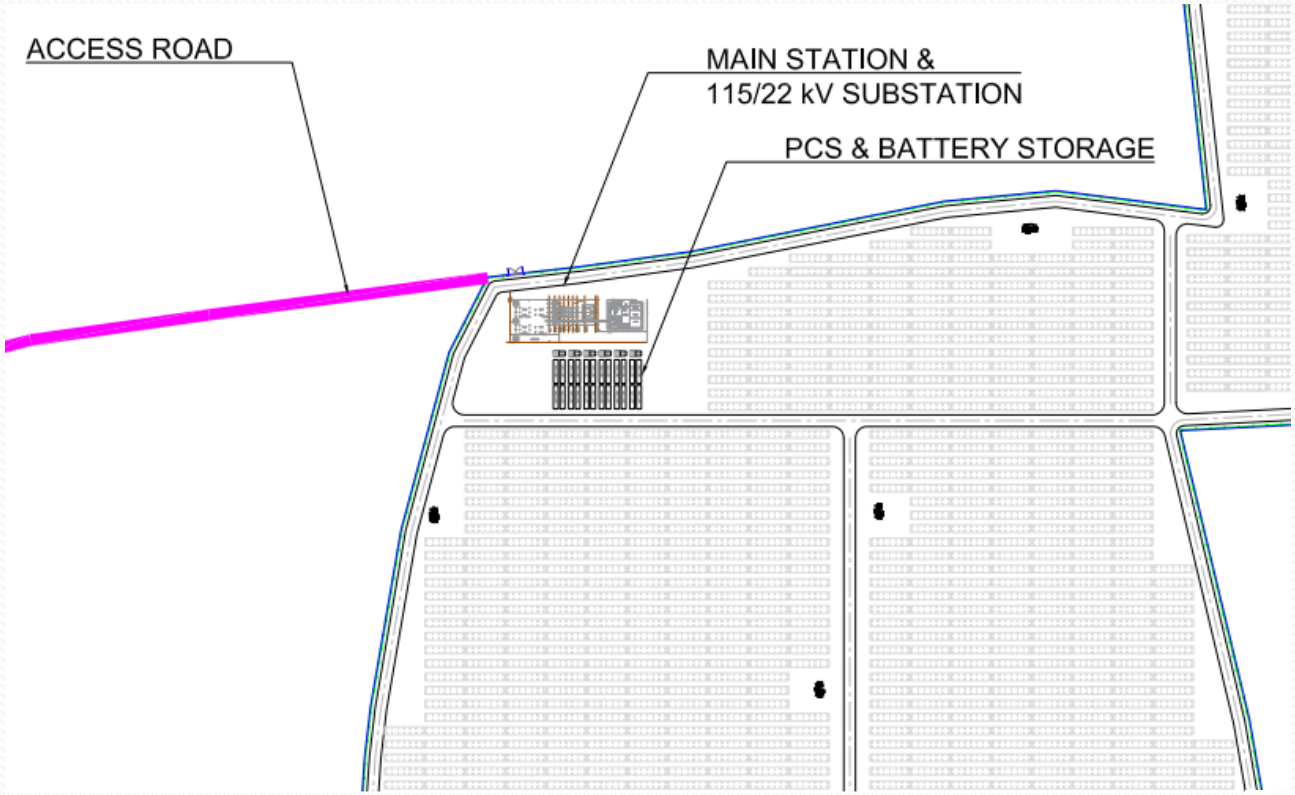
Blue Solar

Blue Solar's concept for this bidding: Project layout



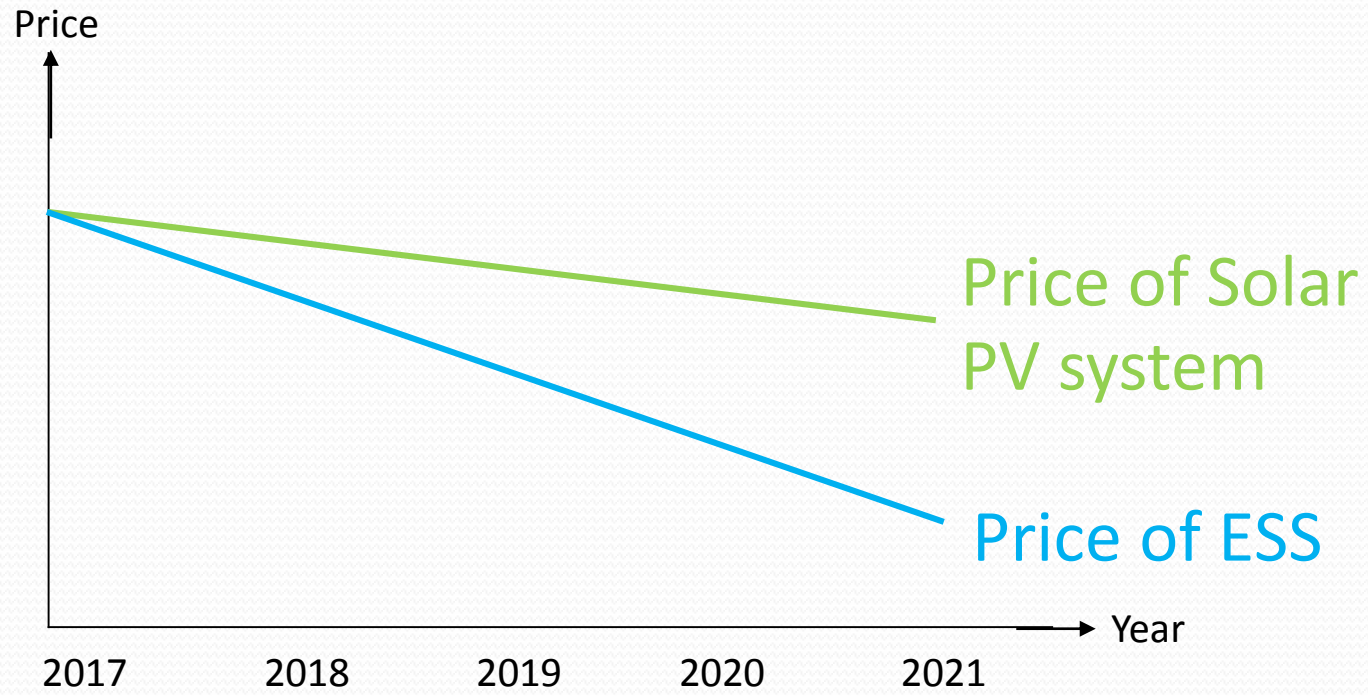
Blue Solar

Blue Solar's concept for this bidding: Project layout



Blue Solar

Blue Solar's concept for this bidding: Price of Solar PV system and ESS



Blue Solar

Blue Solar's concept for this bidding: Proposed price

- The project has to achieve commercial operation (COD) with in Dec 31st, 2021

- Electricity price
  - FiT(fix): 1.81 THB - 62% discount: 0.6878 THB
  - FiT(variable): 1.85 THB
  - Beginning FiT = 0.6878+1.85 = 2.5378 THB or 7.8 US¢

Blue Solar

Auction result

- 85 projects were submitted for the auction.
  - Totally 1,644MW – 5 times more than the quota of 300MW
- 42 projects passed technical round.
- 17 projects, including Blue Solar, passed the final (price) round.
- Average price was 2.44 THB.

Blue Solar

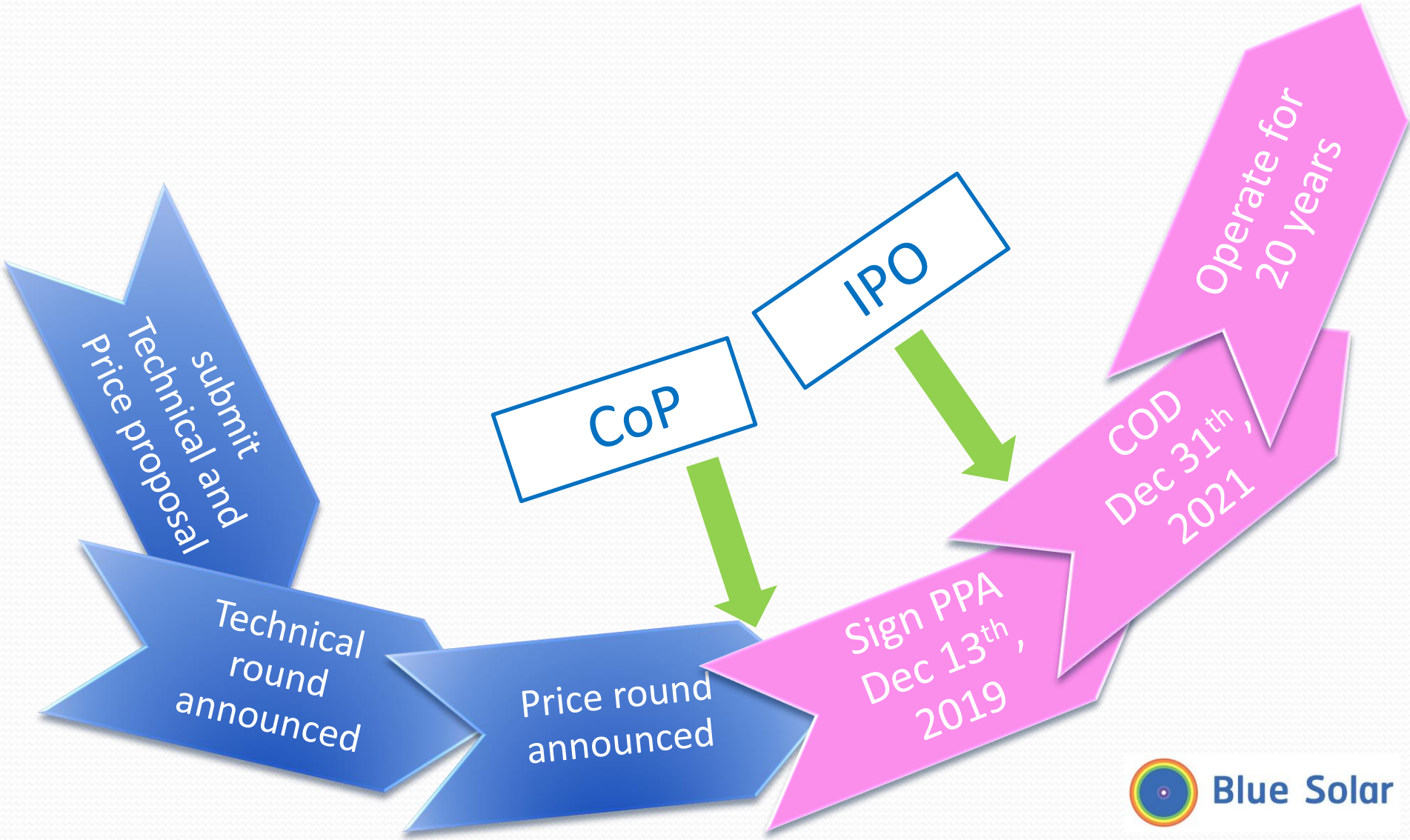
Our work after passing the selection

Our work after passing the selection

- Main timeline
- Trend of Solar + ESS and best practices from others
  - Information from BNEF
  - USA
  - Australia
- Researching to refine our study
  - Current cooperation with many parties
  - Better selection of technologies
  - Better developed algorithm
  - Pilot site experiment

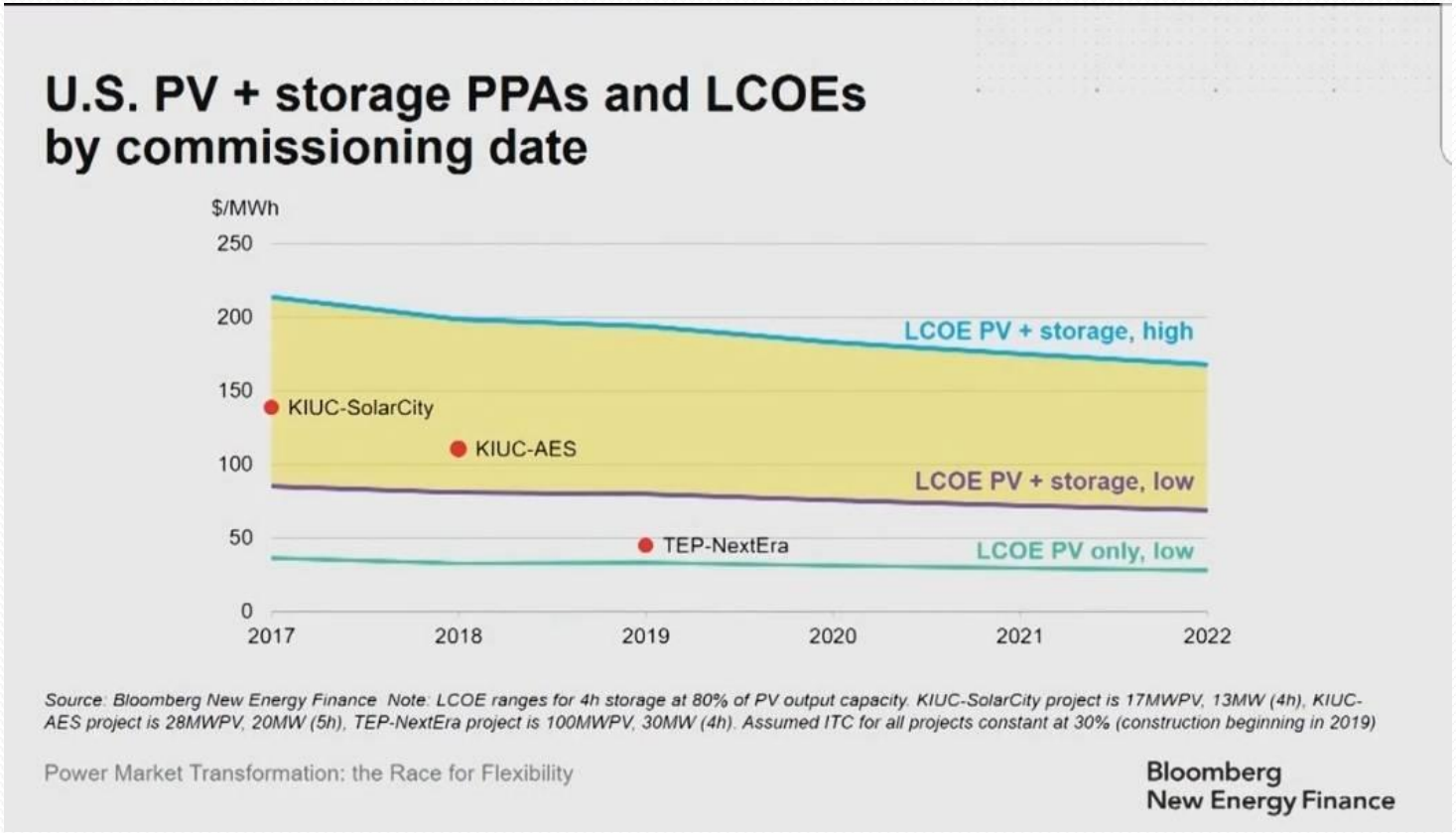
Blue Solar

Main timeline



Blue Solar

Trend of Solar + ESS and best practices from others



Blue Solar

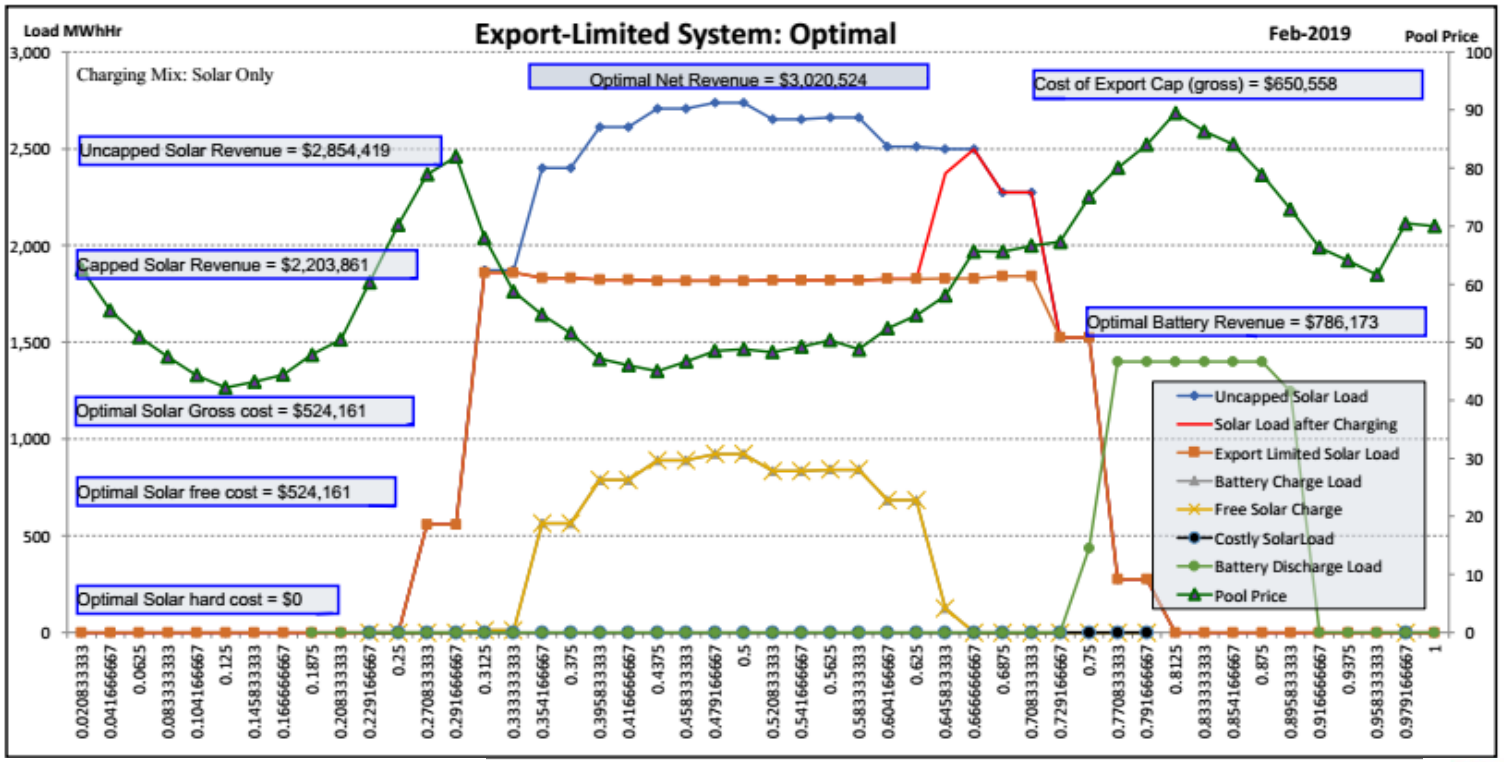
Trend of Solar + ESS and best practices from others

- TEP
  - Tucson Electric Power's (TEP) solar plus storage facility
  - Being built by NextEra Energy
  - 100 MW solar array and a 30 MW, 120 MWh energy storage system
  - The all-in cost for the solar-plus-storage project was "significantly less than 4.5¢/kWh over 20 years."
  - If the value of available subsidies is backed out, the pricing on the project is closer to 9¢/kWh.

Blue Solar

Trend of Solar + ESS and best practices from others

Revenue optimisation example



Blue Solar

Researching to refine our study:

Current cooperation

- Set up a research company located in Eastern Economic Corridor of innovation (EECi)
- National Science and Technology Development Agency (NSTDA)
- Suppliers
  - DELTA
  - ABB
  - Fuji Electric
  - Juwi
- Open for research cooperation with other parties: strategic partners, consultants, academic institutes, and etc.
- Plan to share research outcome to the public.

Technical & Financial

Blue Solar

Researching to refine our study:
Current cooperation

NSTDA

DELTA

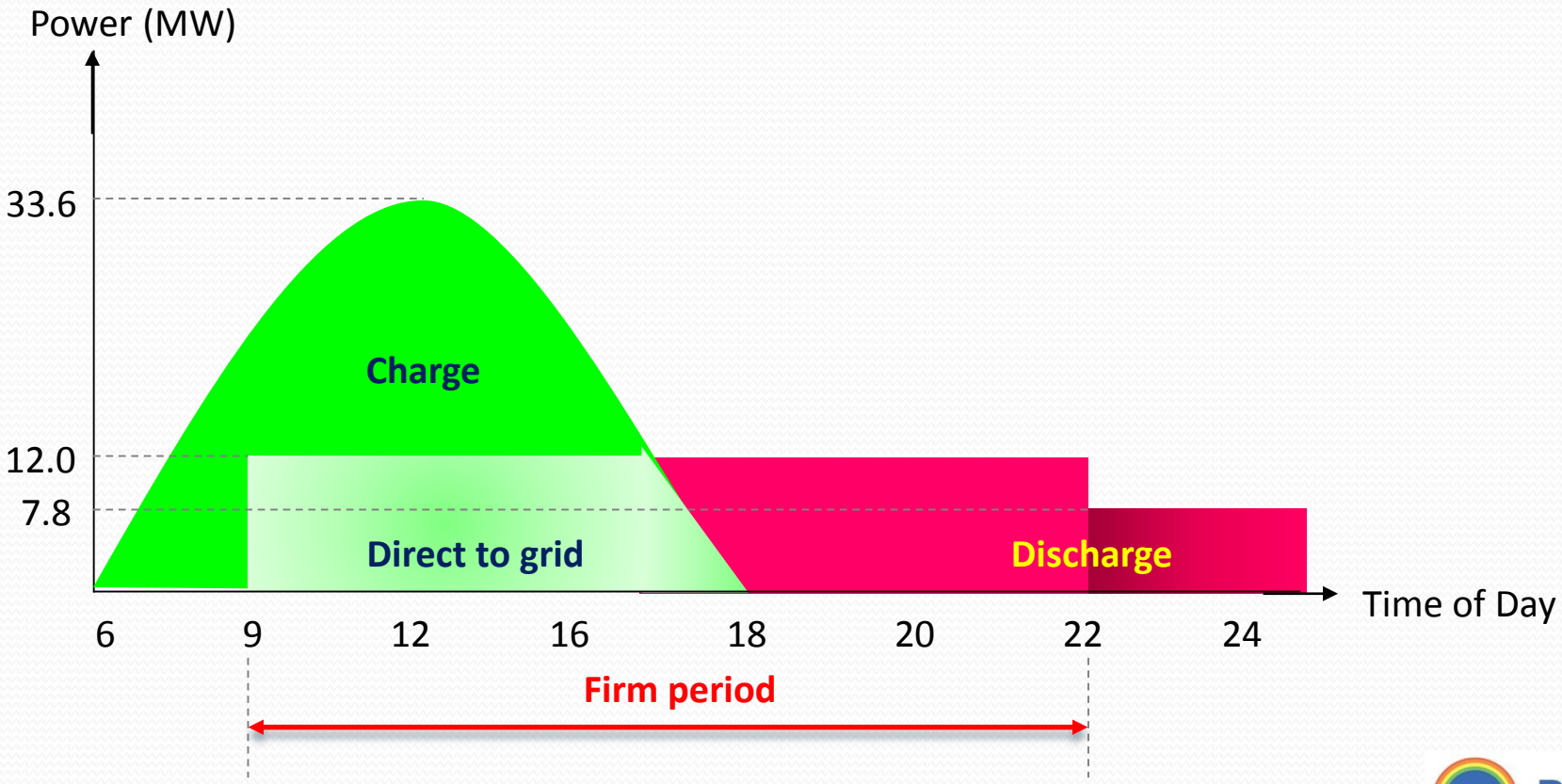
Blue Solar

Researching to refine our study: Better selection of technologies

- Solar: might increase energy output up to 20%
  - Tracker
  - Bifacial
- Battery: price and cycle time
  - Lithium-ion
  - Redox flow
  - Lead acid
- System equipment: lower investment and energy loss
  - Bidirectional inverter → DC direct coupling

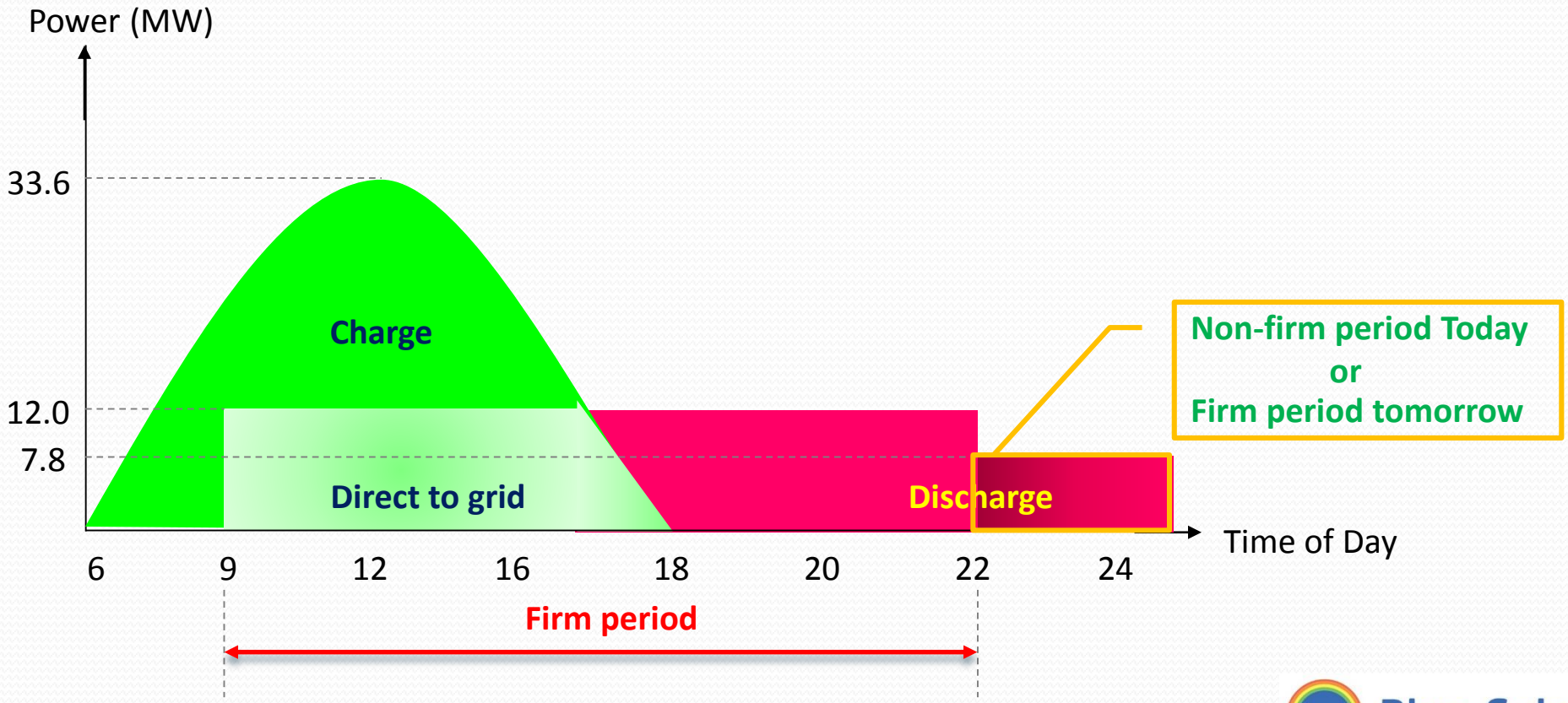
Blue Solar

Better developed algorithm



Blue Solar

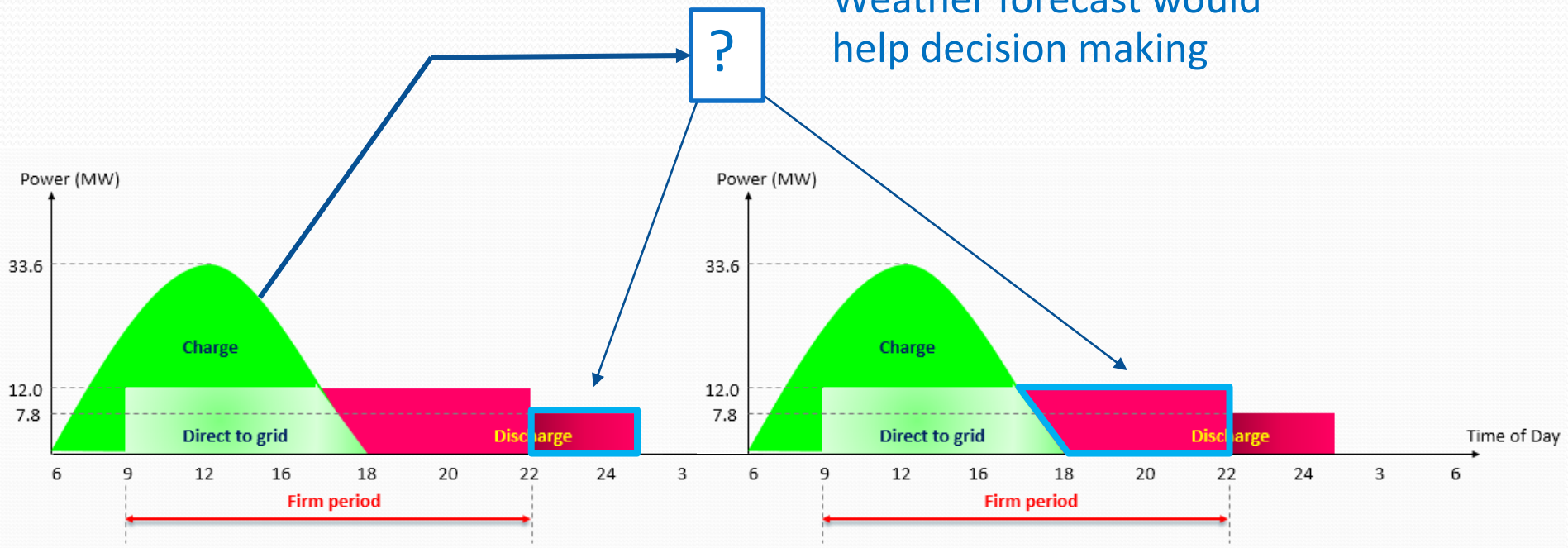
Better developed algorithm



Blue Solar

Better developed algorithm

Weather forecast would help decision making

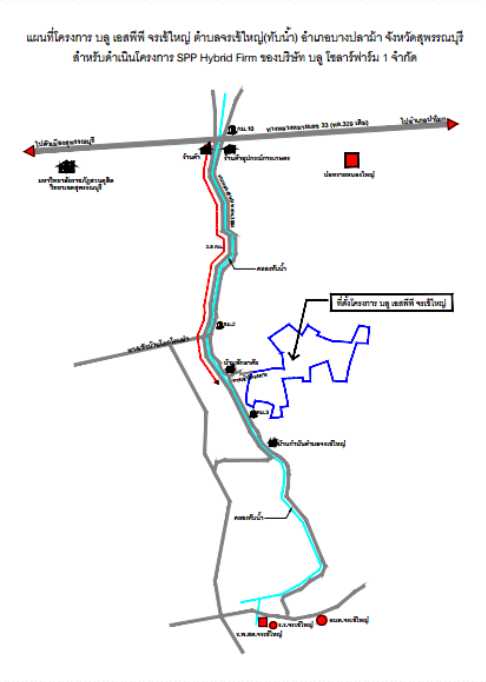


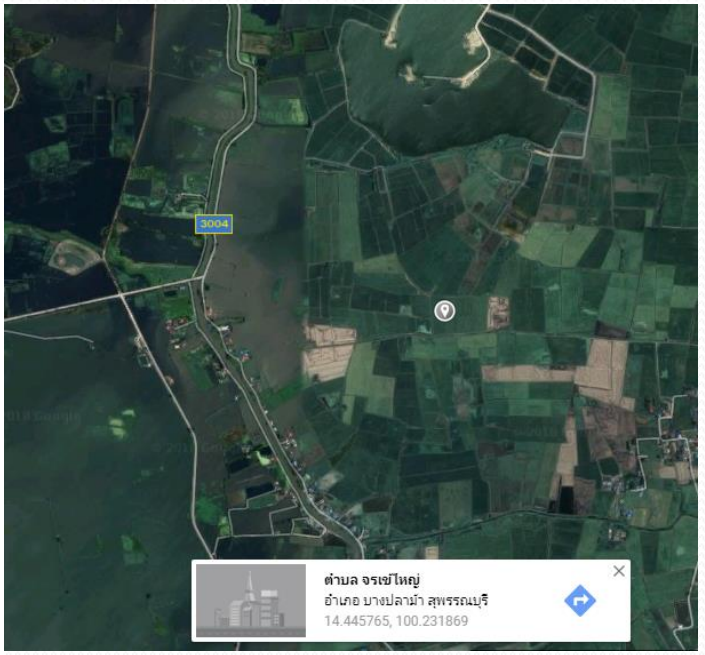
Today

Tomorrow

Pilot site experiment @14.443722 N, 100.222972 E

- Solar: 100 kW
  - Tracker
  - Bifacial
- Battery: 130 kWh
- Weather forecast
- Flood protection





Blue Solar

Financial model

Financial model

- Carbon credit and SolarCoin to compensate penalty fee
- Plan for IPO in 2020
  - Raise fund
  - Need attractive project return
- Funding
  - Low interest rate
  - Possible grants for project
  - Research support

Blue Solar

Financial model:
Current financial projection

- Assumption
  - Energy loss from ESS 10%
  - Battery DoD 90%
  - Solar system price 0.56 USD/W
  - ESS price 110.00 USD/kWh
  - Interest rate 4.00%

- Financial return
  - Project IRR 7.07%
  - Equity IRR 9.03%

Blue Solar

Wrap up for current progress

Wrap up for current progress

- R&D and optimization
- Risk evaluation
  - Equipment price risk
  - Delivery risk
  - Financial cost
  - Careful study for flood protection
  - Technology-friendly platform to support battery replacement in the future
- Visit best practice projects: TEP, LYON, etc.
- Learning center, organic agriculture and green tourism
- Other activities for local people: job creation, scholarship, etc.
- Graphic illustration

Blue Solar

Wrap up for current progress:

Learning center, organic agriculture and green tourism

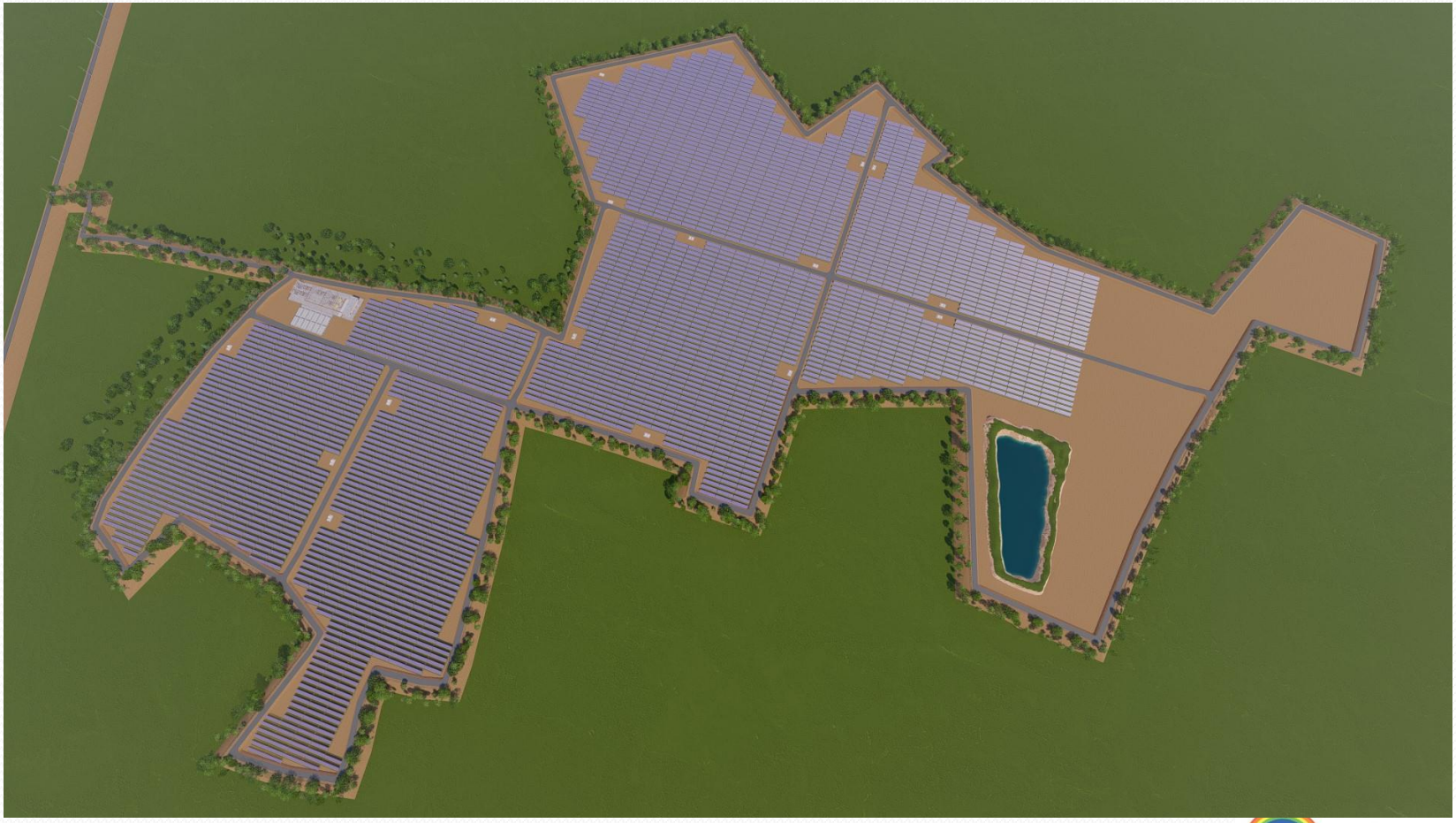
Blue Solar

Wrap up for current progress:

Other activities for local people: job creation, scholarship, etc.

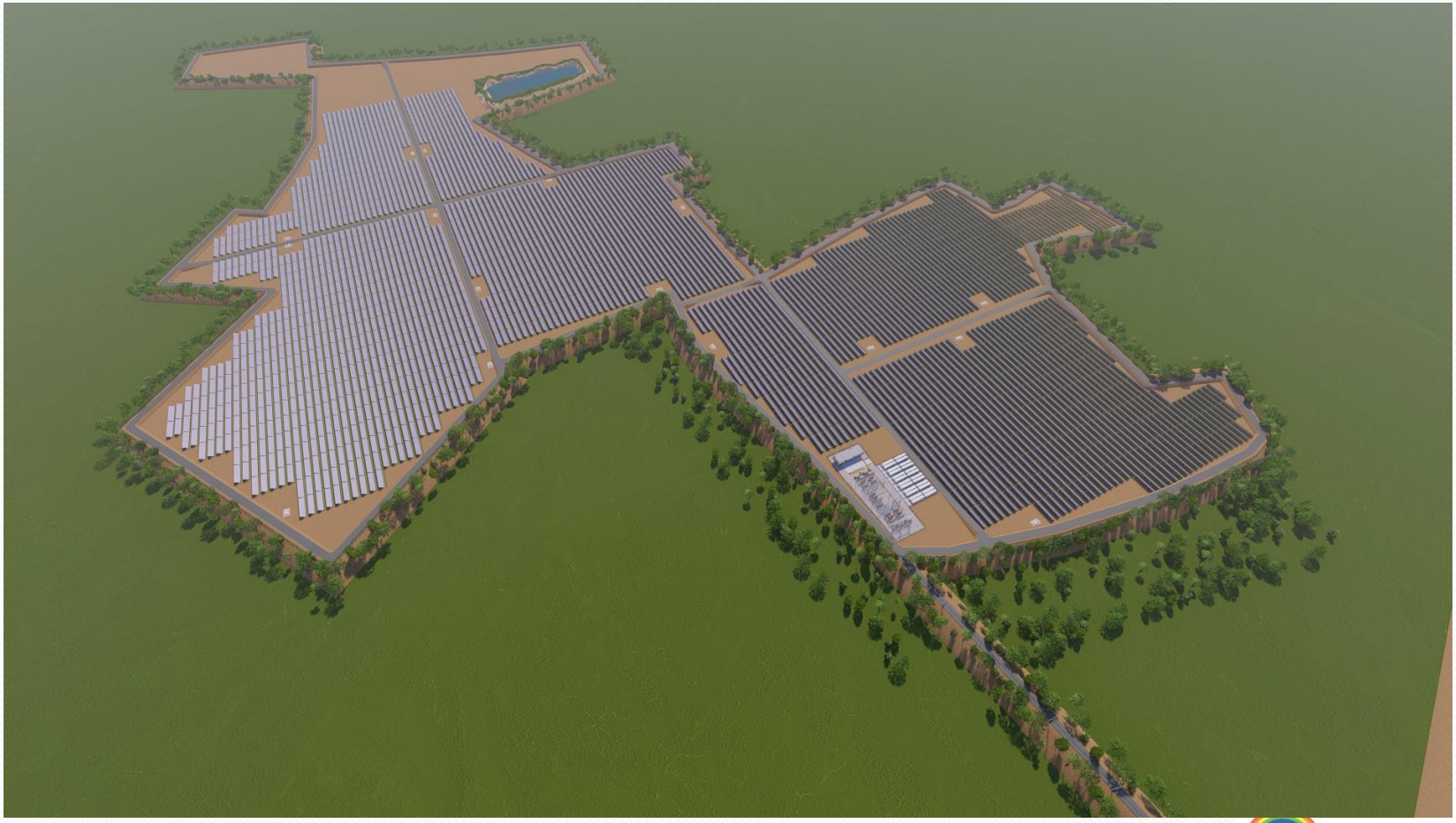
Blue Solar

Wrap up for current progress:
Graphic illustration



Blue Solar

Wrap up for current progress:
Graphic illustration

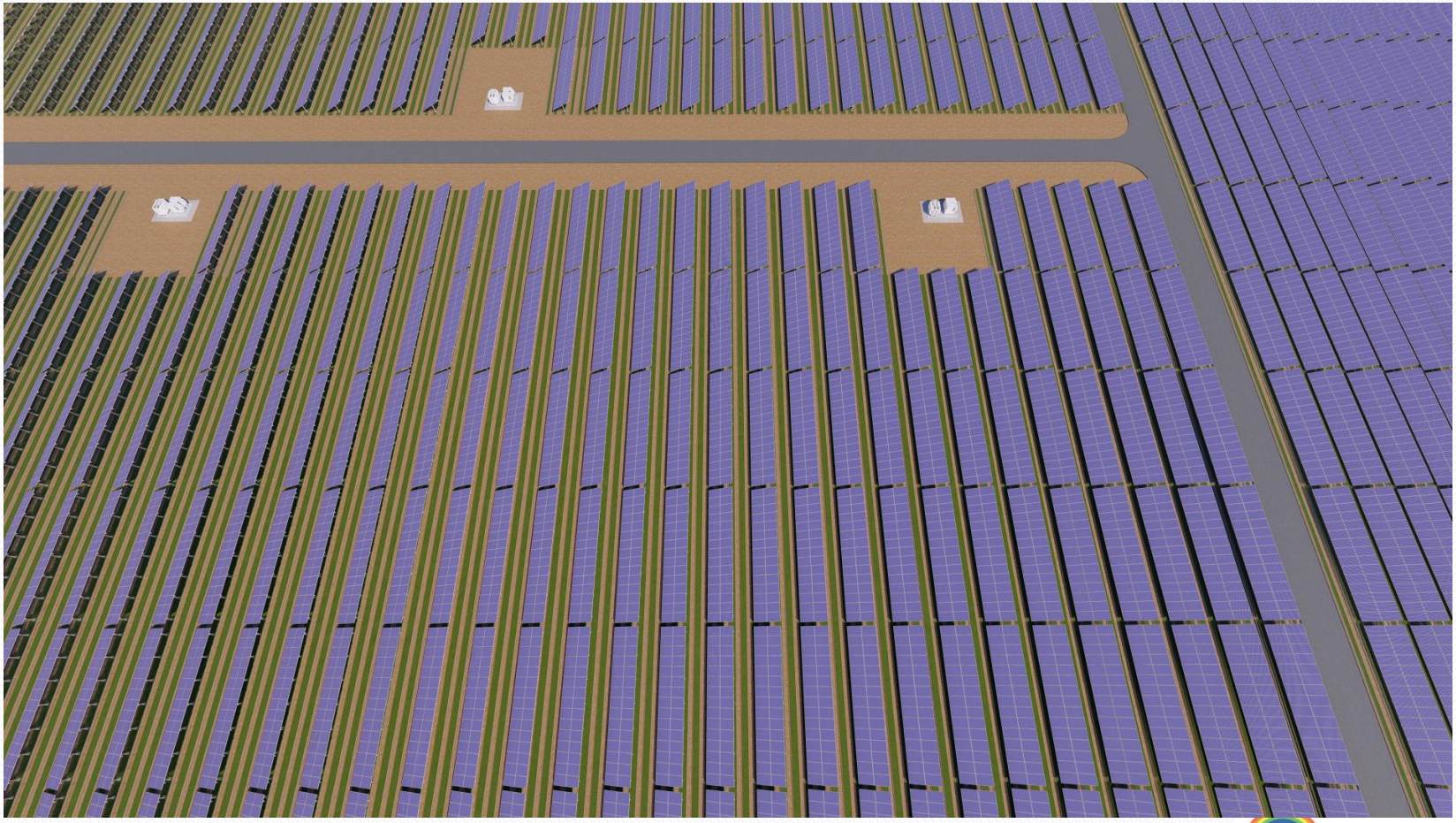


Blue Solar

Wrap up for current progress:
Graphic illustration

Blue Solar

Wrap up for current progress:
Graphic illustration



Blue Solar

Wrap up for current progress:
Graphic illustration

Blue Solar

Wrap up for current progress:
Graphic illustration

Blue Solar

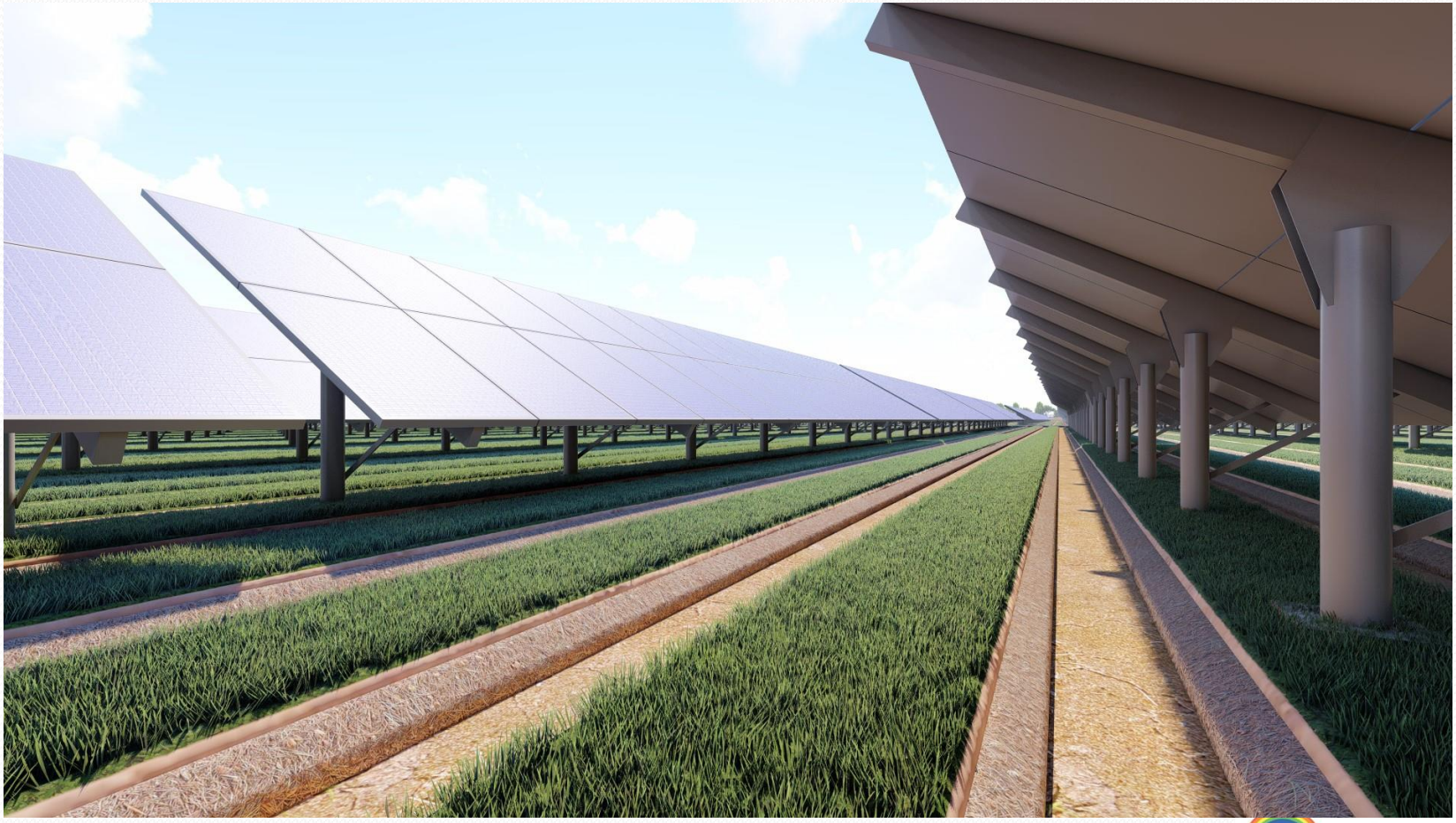
Wrap up for current progress:
Graphic illustration

Blue Solar

Wrap up for current progress:
Graphic illustration

Blue Solar

Wrap up for current progress:
Graphic illustration



Blue Solar

Wrap up for current progress:
Graphic illustration

Blue Solar

Wrap up for current progress:
Graphic illustration

Blue Solar

Wrap up for current progress:
Graphic illustration

Blue Solar

Wrap up for current progress:
Graphic illustration

Blue Solar

Wrap up for current progress:
Graphic illustration

Blue Solar

Wrap up for current progress:
Graphic illustration

Blue Solar

Recommendations and lessons learned

Recommendations and lessons learned

- Consumer VS industry perspectives
  - Consumer prefer the cheapest one.
  - Industry players need appropriate return to strengthen their business.

- Energy mix and diversification could be destroyed
  - Biogas is nearly impossible to compete with other fuels
  - It is beneficial for agriculture (fertilizer as by product) and organic waste treatment.

Blue Solar

Recommendations and lessons learned

- Should run auction for each type of fuel separately together with taking other beneficial factors into account.

- Renewable energy auctions would result in low power price.
- It could weaken the industry.

- The emerging country might begin with incentive scheme to grow up its strong RE industry.
- Auctions might be appropriate for the country with mature energy system.

Blue Solar

Thank you

Blue Solar