

Wells Fargo Innovation Incubator (IN²) Webinar Series

April 3, 2020



Agenda

Welcome from IN²

Trish Cozart, IN² Program Manager, NREL

Cleantech Macrotrends Briefing –

Todd Allmendinger and Anthony DeOrsey, Cleantech Group



About the Wells Fargo Innovation Incubator (IN²)

Launched in 2014 with an initial \$10 million commitment by the Wells Fargo Foundation, and expanded in 2017, the Wells Fargo Innovation Incubator (IN²) is now a **\$30 million program** supporting innovative technologies and innovators. The program is managed and run out of the National Renewable Energy Laboratory (NREL).

IN² provides technical assistance that leverages the capabilities, facilities, equipment and the deep expertise that exists at NREL and the Donald Danforth Plant Science Center to help companies **de-risk technologies and ease their path to market adoption and deployment.** IN² also fosters the cleantech ecosystem through our Channel Partner awards program.



Technology Incubator



Channel Partner Awards Program



Cleantech Group Award for 2020 Technology Briefing Series

- Define the value chains, business activities and relate the trends to stakeholders and portfolio companies
- Geographic focus in North America
- Focused on the technology sectors of IN²



IN² Focus Areas



• Water

Founded by: Wells Fargo | NREL | 5

Briefings Schedule

April	Macro Trends & Overviews
Мау	Commercial Buildings
June	Sustainable Agriculture
Sept.	Housing





Briefing

Macro Trends for 2020



WELLS FARGO | CINREL

3 April 2020

Cleantech Group: Introduction

Our research, consulting and events catalyze opportunities for sustainable growth powered by innovation.







2020 CLEANTECH PORUM 20 CLEANTECH FOBUN ELIBORY SAN FRANCISCO

INTER CLEARCHED (NORLIN ALL)



HERT THE COMPANIES CATING OUR INCOME. BATTLES



twist Problem like "Freddy Bolder,"



Research

Markets change. Companies evolve. Our research delivers the insight you need to stay ahead of the trends. For deep dives into the market, our expert analysts publish Sector Insights, Investment Insights and provide customized briefings.

Events

Engage with industry leaders and innovators from across the breadth of the global sustainable innovation ecosystem. Find capital, advisors, partners and coinvestors at our international events.

Consulting

Build strategies to engage external innovation and thrive as your industry transforms. We'll help you set priorities and determine where and how to find the partners and investment opportunities that take your business forward.



Our Industry Sectors Lens





Our research methodology

We help corporate strategy teams, investors and innovators identify, evaluate and connect with the best of global innovation



Contents

Process

Macro trend

Circular Economy

Decarbonization & Electrification

Cities & Urbanization

Digitalization, Decentralization, Automation

Resilience

Discussion



Briefings Plan 2020





Today: Discussing the Macro Trends

?

5 Macro Trends How should we think about it?

> **Drivers** What is driving the trend?

Challenges
 What are the challenges to the trend?

Examples of innovation Illustrative examples in each sector

• Discussion by each Sector

Business activities to explore in Sector Deep Dives

Future Briefings: Sector Deep Dives

Landscape



Group innovators by similar "business activities" along a value chain



PERETRY	🖉 sunfire	James Lange
Were proposition (Protogor departments) excitation excitating for total states for contrast galaxy distance for the state of the state of the state protogory and an end water.	New properties limited of lange sectors schedules: schedule out with for set, and recently schedule (all listers vite rate accepted)	Note properties, much of runing on based in Impye When her hearts in Amount proceedings of the sector pro-
Allocation CON Instrumed and image Research II Schwartz (SCH Instrumed and Instrument Technique Laurenteen) Sector Allocation Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 Research 2019 R	Vision - Appl (11) Approach with integriter force to food a minimum analysis, and to entry effort typical modelship, and typical and an effort integrate for modelship, and typical and and the food states of the food states of the food states and the food and the food states of the food states and the food and the food states of the food states and the food and the food states of the food states and the food and the food states of the food states and the food and the food states of the food states and the food and the food states of the food states and the food and the food states of the food states and the food and the food states of the food states and the food states and the food states of the food states and the food states and the food states of the food states and the food states and the food states of the food states and the food states and the food states of the food states and the food states and the food states of the food states and the food states and the food states of the food states and the	Electronic Control of Mill Other and Source of March 2010 Tamer of Mill Other and source of March 2017 March 2017 Albert and source of Mill Other and the source of the the source
A second	 Versional Versional and the theory of these technics of the technic states in the technical technic states in the technical states are a technical states and the technical states and the technical states and technical technical states and technical technical states 	Protect Public Public Public protection of the second second second protection of the second second second second protection Public of the second second second second protection Public of the second second second second public of the second second second second second public of the second se
Papeled 322 million Internet (N2) Consta transment, Bastillionagh Internet National Parliate transment and the Ingree National Solida Lancers, Flatform 8 (10)	Explore Vision where because Vision were carden where the series for the series of the first survey to the series to the series of the forethese	English (19.45km) Reserved Sciences (Sciences Sciences) County and architectural
Counters.	Names of Long. (10)	Barthart Cares Bypt, 170





METRON	ENERGIENCY	Section of Credition
Advantagement of the strength of the second s	When programming the formulae of any tree tog tree and tree of any analytic half. As induced manufactures	Non-presentation in subject of the ball of the second seco
Ministered - And Otto Associal Di Lincolare Scienciff Discourse revenue, Statistical revenue, Brit Debies and Science - Ande - March 2017 Associal Andre Science - Andreas - Million 1 and Andreas Discourse - Andreas - Million Coursel, Andreas - Andreas - Million and Science - Andreas - Andreas - Andreas - Andreas - Million Coursel, Andreas	Homostania Handling and the station for examination of the secondarial stations transmitted stations transmitted stations transmitted by the station of the stations part of a particular of the stations transmitted stations of the stations transmitted stations transmit	When you wanted to a charter or means that 1 are 20th Assess to a charter or means, that 2 are 20th Assess to a charter of the three the same of a mean mean state. 1 and the same transmission 1 and the same
Fundamental Fundamental characterizary served way loop tool to fundamental characterizary provide and statemental to capital characterizary control and strategic research of physical strategic to increase for each fundamental served of the strategic served to capital characterizary served to capital cha	 Bit is a series to basis inside a series of and infl bit is a series of the bit of the series of a series of a series of the bit of the series of the series of the series of the series of the series of the bit of the series of the series of the series bits of the series of the series of the series bits of the series of the series of the set bits of the series. 	 Levels, weiters of crash-called, includes (see Call De Weiters), financial registry and editorialistic furthers density and end-optimization and endoting schemes (see and end-optimization registry) (see an addressing weiter to get control of transferring (see Section 2016).
Capital STLD rolline	- Brash rights having institutes TE Proving	Capital 212 college
Research MT Science (Striker, Solic & Striker, MT Techa, Solid Sada Solite Tech Frails M Data Materials Central Vision Vision (2014; Co-Taxado	Earth UT color- beater III (and before the entropy sharing) and probability for the star	mention (14 project, all server light), had being stream and for Default. Lighted Steps Manager, of Sections

Current innovation activities and trends

Contents

Process

Macro trends

Circular Economy

Decarbonization & Electrification

Cities & Urbanization

Digitalization, Decentralization, Automation

Resilience

Discussion



Five Macro Trends





Contents

Process

Macro trends

Circular Economy

Decarbonization & Electrification

Cities & Urbanization

Digitalization, Decentralization, Automation

Resilience

Discussion



Circular economy: Moving beyond waste management



Source: WRI Center of Expertise on Resources

REFUSE: Prevent the use of resources REDUSE: Decrease the use of resources RE-USE: Find new product use REPAIR: Maintain and repair REFURBISH: Improve product REMANUFACTURE: Create new product from second hand RE-PURPOSE: Re-use product for different purpose RECYCLE: Re-use raw materials of product RECOVER: Recover energy from waste

Design For the Future

Incorporate Digital Technology

Rethink the Business Model

Team Up to Create Joint Value

Source: Circularity Gap Report 2020,

Trend is driven by reducing dependence on primary input and more "circular" process to regenerate natural capital



Challenges: overcoming inertia of the linear take, process, and dispose model

Design for Disposal

Traditional Business Models

Infrastructure

Supply chains





Commercial Buildings: Current Focus of Circular Economy Innovation

Relevant Business Activities	Example companies	Impact
Energy recovery	SHARC ENERGY SYSTEMS Thermomechanical heat recovery	Thermal energy from wastewater \rightarrow heating and conditioning
Smart Materials	VIEW Electrochromic smart glass	23% Peak Cooling Load Reduction (CAPEX)

Circular Concrete



CO2 is never released during production



Housing: Current Focus of Circular Economy Innovation



Greywater Reuse



Greywater capture, disinfection, reuse

35% reduction in water use

Sustainable Agriculture: Current Focus of Circular Economy Innovation

Relevant Business Activities	Example companies	Impact
Regenerative Agriculture	Regenerative poultry supply chain	Carbon emission reversal
Phosphorous Recovery	Phosphorous recapture & reuse	Phosphorous converted to controlled-release fertilizer

Food Waste



Per-store demand forecasting

Demand forecast / production optimization



Contents

Process

Macro trends

Circular Economy

Decarbonization & Electrification

Cities & Urbanization

Digitalization, Decentralization, Automation

Resilience

Discussion



Decarbonization: Efficiency, Electrification, Economics

Top greenhouse gas emitters



Demand-side Measures

Energy Efficiency

Electrification

Carbon Capture

Alternative Fuels

SOURCE: UN Environment Programme. Excluding land-use change emissions due to lack of reliable country-level data.



CO2 emissions are influencing investment decisions

Number of climate-related shareholders' proposals vs. % vote in favour

Efficiency Advances 40% 90 # climate related shareholders' proposals osals 80 35% 5 70 30% favour 60 **Fossil Fuel Divestment** 25% 50 shareholders' 20% 40 vote 15% 30 10% 20 **Targets- Cities & Corporates** 5% 10 0 0% 1H 2019 annualized 2013 2015 2016 2012 2014 2017 2018 2011 **Affordable Alternatives** North America Asia Pacific % vote in favour Europe

Source: ProxyInsight, Data compiled by Goldman Sachs Global Investment Research



Challenges: The highest emitting sectors cost the most to decarbonize



Source: Goldman Sachs Global Investment Research



Commercial Buildings: Current Focus of Decarbonization Innovation

Relevant Business Activities	Example companies	Impact
Sustainable Cement	Al-driven production process	30-40% reduction in GHG emissions
Energy Efficiency	75F HVAC, lighting, equipment controls	50% energy efficiency improvement
Distributed Energy	onswitch	100% renewable energy

Commercial-scale solar design to deployment

100% renewable energy deployed to buildings

Housing: Current Focus of Decarbonization Innovation

Relevant Business Activities	Example companies	Impact
Residential Solar	BUGGES Remote siting for residential solar	Residential solar without soft costs

Virtual Power Plants



Homes contribute back to grid

Home Energy Management Systems (HEMS)

🟚 sense

Home energy monitor

Device-level savings



Sustainable Agriculture: Current Focus of Decarbonization Innovation

Relevant Business Activities	Example companies	Impact
Electrification	Electric wheel / transmission retrofit	30% fuel consumption reduction
Algae Livestock Feeds	BLUE OCEAN BARNS Seaweed cattle feeds	Dramatic enteric fermentation reduction
Lab-grown Proteins	Finites Foods Finites Foods	"Localization effect"



Contents

Process

Macro trends

Circular Economy

Decarbonization & Electrification

Cities & Urbanization

Digitalization, Decentralization, Automation

Resilience

Discussion



Along with population growth cities are growing larger, faster

Adding 100 mn people to the population of the US by 2060, with >85% living in cities , will require ...





36 Chicago's or 1 every 14 months



Increase in Density of Cities

Expansion of Urban Land Mass

Pressure on already stressed infrastructure

Sustainability: help / hinder

Source: U Penn McHarg Center 2100 Project Atlas Green new Deal



A .0

Economic opportunities are driving urbanization



US Commuter mega-regions

Economic Stability

Economic Mobility

Access to Services

Access to Community

Source: Garrett Dash Nelson and Alasdair Rae



Challenges: Our infrastructure is already in poor condition

Overcrowding

Pollution

Infrastructure

Climate Hazards





Commercial Buildings: Current Focus of Urbanization Innovation

Example companies Relevant Business Activities Impact **↓** Density **Occupancy Sensing** Fully anonymous real-time occupancy analysis Power-over-ethernet infrared people counter **Parking Tracking & Analytics** Garage optimization spaceti Per-spot parking sensors Indoor Environmental Per-room environmental Monitoring spaceti improvements Humidity, CO2, sensors



Housing: Current Focus of Urbanization Innovation

Relevant Business Activities

Example companies

Impact

Residential Property Management

bellman. Building management automation

Real-time problem communication & response

In-room Environmental Management



Occupancy, temperature, humidity, light sensor

Automated HVAC & lighting control

Indoor Air Quality



Hazard identification & response



Sustainable Agriculture: Current Focus of Urbanization Innovation

Relevant Business Activities	Example companies	Impact
Vertical Farming	VertiCrop Indoor farming with 20x yield	50' x 75' indoor space = 16 acre farm food production
In-store Farming	inform	95% water use reduction, 90% transportation reduction
	Cloud-connected controlled ecosystems	solo dansportation reduction

Food Safety



Instant quality inspection

Portable spectroscopy food analyzer



Contents

Process

Macro trends

Circular Economy

Decarbonization & Electrification

Cities & Urbanization

Digitalization, Decentralization, Automation

Resilience

Discussion



Digitalization and automation enable decentralization





Industry 4.0: Cyber physical systems



On-Site Data Collection

Real-time Analytics

Machine-to-Machine Communication

Autonomy

Source: Kemp Technologies

Challenges: integrating decentralized participants – physically and economically

New Participants

Existing infrastructure

Interoperability

Cyber security





Commercial Buildings: Current Focus of Digitalization Innovation



AI + actively managed energy service

Housing: Current Focus of Digitalization Innovation

Relevant Business Activities	Example companies	Impact
Non-intrusive Load Monitoring	Voltaware Credit card-sized home load monitor	Appliance-level energy usage monitoring
Home Automation	VECV Smart plug for appliance automation	"Dumb" appliances become smart

Data-driven Services

luko Smart devices for insurance data Insurance policies tailored to individual homeowner



Sustainable Agriculture: Current Focus of Digitalization Innovation

Relevant Business Activities	Example companies	Impact
Livestock Management	AgriWebb Digitized operations map + grazing management	Individual animal-level management
Remote Irrigation Control	SCADAfarm Remote monitoring + control of irrigation system	Mobile phone irrigation control

Greenhouse Optimization



Al-enabled greenhouse automation

3x yield prediction accuracy



Contents

Process

Macro trends

Circular Economy

Decarbonization & Electrification

Cities & Urbanization

Digitalization, Decentralization, Automation

Resilience

Discussion



Resilience is no longer a plan B strategy



Extreme Weather Preparation

Infrastructure Adaptation

Operational Flexibility

Predictive Safety

Pivoting from susceptibility to strategy





Scale and speed of weather risks outpaces resources

Debt at risk due to climate change (\$BN)





Source: Moody's

Commercial Buildings: Current Focus of Resilience Innovation

Relevant Business Activities	Example companies	Impact
Geospatial Risk Analytics	JUPITER Flood, fire, heat, drought, cold, wind risk analysis	1 hour to 50-year asset-level weather risk predictions
Microgrids	SCALE On-site storage for microgrids	Remove power outage risks and reduce emissions by 20-40%

Biomaterials



Water / wind damage selfrepaired



Housing: Current Focus of Resilience Innovation

Relevant Business Activities	Example companies	Impact
Digital Twinning	3D digital twin of residential properties	Model damage before it occurs
Microgrids	GRIDMARKET Quoting to installation of DERs	Backup generation / reduced downtime
Insurance & Reinsurance	\Xi FloodFlash	Rapid payouts for flood damage

Flood data -> insurance IoT device

Sustainable Agriculture: Current Focus of Resilience Innovation

elevant Business Activities	Example companies	Impact
Crop Adaptation	Iavie bio Biostimulants and biopesticides	Yield improvement under droughts & infestations
Weather-based Irrigation	ARABLE Thermal and acoustic sensors	Hourly water stress and daily leaf water potential readings

Crop Insurance

METEO**PROTECT** Climate risk insurance for farms Automatic payouts



Contents

Process

Macro trends

Circular Economy

Decarbonization & Electrification

Cities & Urbanization

Digitalization, Decentralization, Automation

Resilience

Discussion: Business Activities for Deep Dives



Commercial Buildings

Business activities for deep dives





Housing Business activities for deep dives





Sustainable Agriculture

Business activities for deep dives





Briefings Schedule

April	Macro Trends & Overviews
May	Commercial Buildings
June	Sustainable Agriculture
Sept.	Housing





WELLS FARGO | CINREL

IN2@nrel.gov

Thank You!

Championing Sustainable Innovation, Catalyzing Business Opportunities

Cleantech Group's research, consulting and events catalyze opportunities for sustainable growth powered by innovation.

