# Recent Trends in Solar Cell Materials



Dr. C. Gopinathan Associate Professor and Head Department of Solar Energy School of Energy Sciences Madurai Kamaraj University Madurai-21

# **Electrical Energy or Electricity**

#### Electrical Energy is measured in Kilowatt –hour 1 W.H = 3600 Joules = 860 Calorie

#### India

**Electrical Production** 

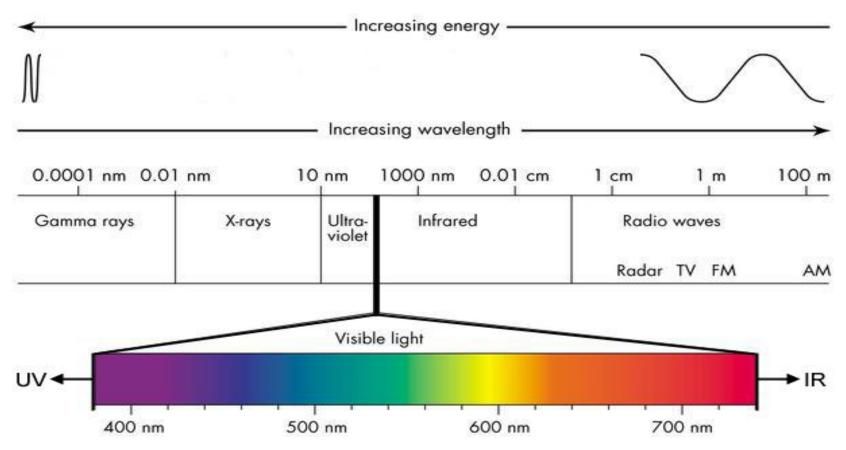
<u>1947 - 1350 M W</u> 850 M.W (Coal, Diesel) 500 M.W (Hydro power) 2015 - 3,00,000 M W

2,15,000 M W – (Coal, Diesel) 85,000 M W – (Renewable) Renewable (Solar) India - 5,000 M W Tamilnadu - 500 M W <sup>2</sup>

# Energy Spectrum

Wave length (µm)	0 - 0.38	0.38 – 0.78	0.78 – 4.0
Approximate energy (W/m <sup>2</sup> )	95	640	
Approximate percentage of total energy	7%	47.3%	<b>45.7%</b>

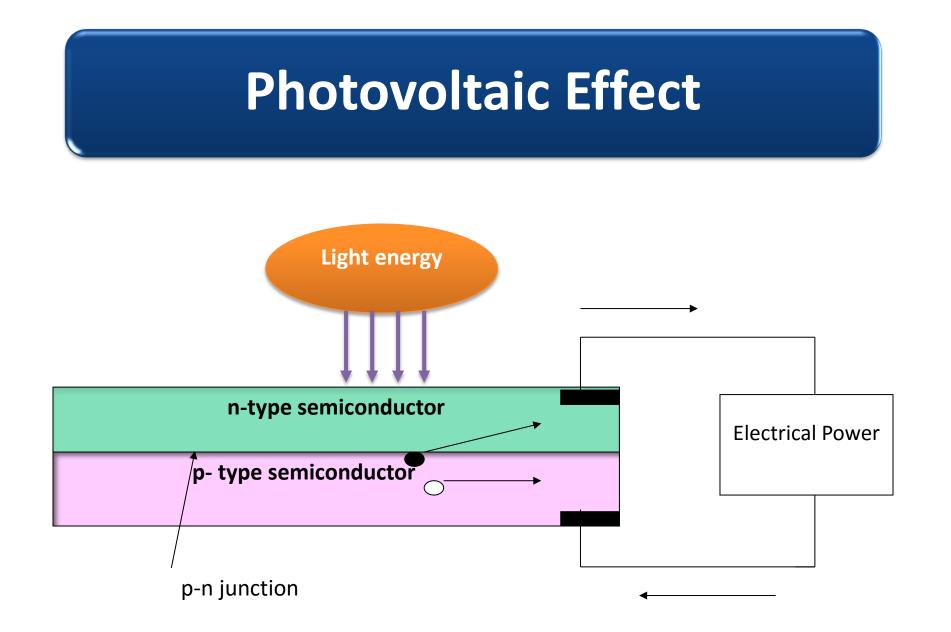
## A Little Background on Light



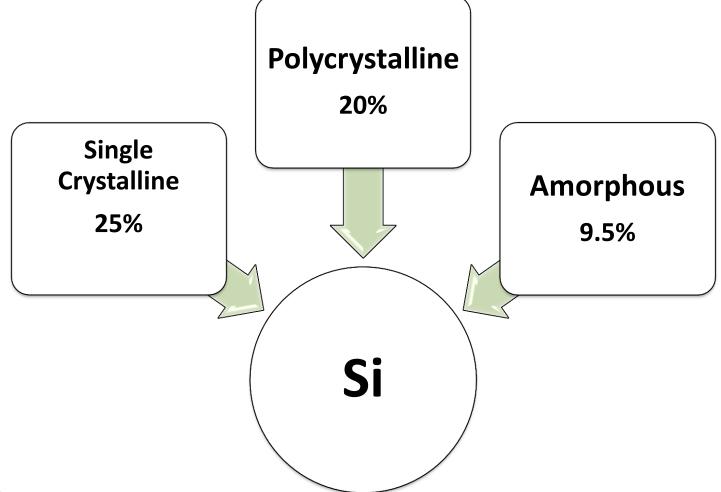
# Solar Cell

A promising technology for addressing energy needs of India and world.

Substantial progress have been made in the development of primary and applied aspects of Solar Cells especially in light weight materials and low-cost electrode materials for the improvement of power generation devices.



### Silicon Solar Cell



# III,V, VI, VII Solar Cell

GaAs (Thin film)	27%				
GaAs (multicrystalline)	19%				
InP (Crystalline)	23%				
Thin film Chalcogenide					
CIGS	20%				
CdTe	17%				
Multi Junction Device					
GaInP/GaAs/Ge	33%				
Galn/GaAs	30%				
GaAs/CIS	26%				

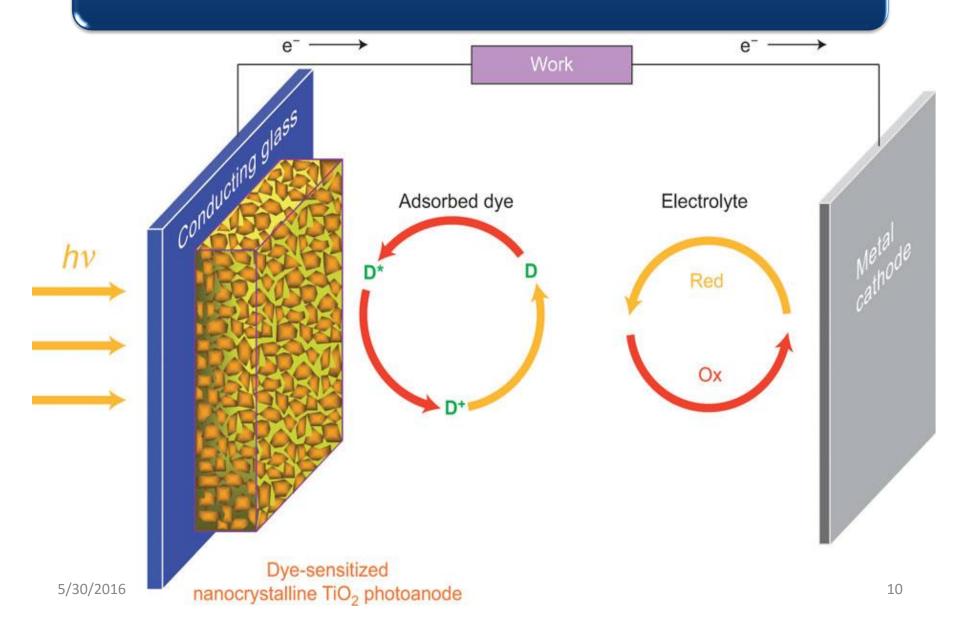
#### Hybrid Solar Cell (Organic-Inorganic)

Conventional Solar Cells are no longer considered for Solar Cell fabrication due to expensive materials of High Purity and intensive process techniques.

The efficiency of conventional Solar Cells made from inorganic materials reaches up to 24%.

Various new strategies, methods and innovative approaches are implemented in Organic, bulk-hetero-junction, Polymer and Dye-sensitized Solar Cell applications to increase the overall power conversion efficiencies

## Dye Sensitized Solar Cell

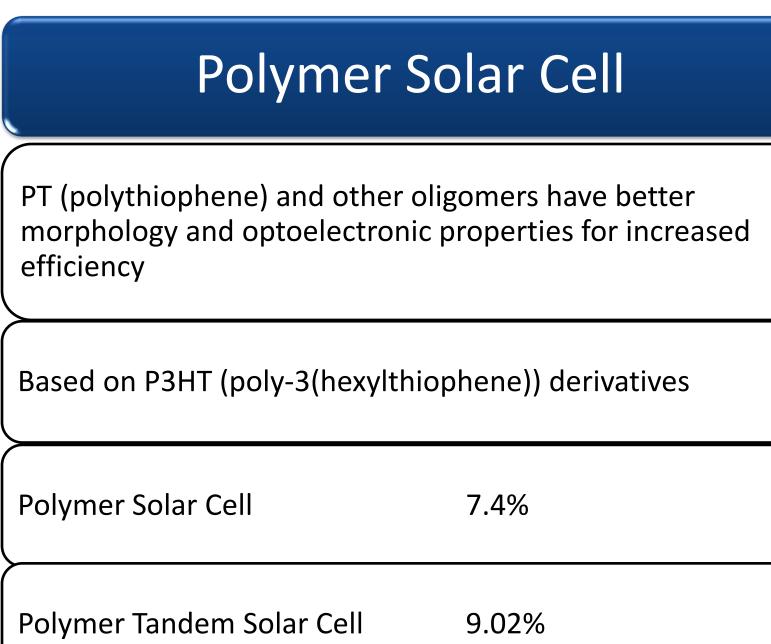


## Dye Sensitized Solar Cell

Nano	Thick	Paste/Photo	Dyes	η%
structure	ness	centre		
	(µm)			
NRs	0.7	TiO <sub>2</sub>	Di-tetrabutylammonium cis-bis(isothiocyanato)bis(2,2'-	1.13
	2.3		bipyridyl-4,4'-dicarboxylato)ruthenium(II)	4.87
NPs	12-15	TiO <sub>2</sub>	Ruthenizer 535-bis TBA	4.2
NPs	10	TiO <sub>2</sub>	cis-Bis(isothiocyanato) bis(2,2'-bipyridyl-4,4'-	5.2
			dicarboxylato ruthenium(II)	
NT/NP	8-9	TiO <sub>2</sub>	Di-tetrabutylammonium cis-bis(isothiocyanato)bis(2,2'-	3.12
<b>N</b> 30/201	6 11.88		bipyridyl-4,4'-dicarboxylato)ruthenium(II)	<b>2</b> 169
		1		1

# Cont...

NP	-	TiO <sub>2</sub> /Al <sub>2</sub> O <sub>3</sub> TiO <sub>2</sub> /Bi <sub>2</sub> O <sub>3</sub>	Di-tetrabutylammonium cis-bis(isothiocyanato)bis(2,2'- bipyridyl-4,4'-dicarboxylato)ruthenium(II) Di-tetrabutylammonium cis-bis(isothiocyanato)bis(2,2'- bipyridyl-4,4'-dicarboxylato)ruthenium(II)	1.73
NP	10	TiO <sub>2</sub> -SiO <sub>2</sub>	Di-tetrabutylammonium cis-bis(isothiocyanato)bis(2,2'- bipyridyl-4,4'-dicarboxylato)ruthenium(II)	5.9
NW/NP		TNW/TNP TiO <sub>2</sub> /SrO	Di-tetrabutylammonium cis-bis(isothiocyanato)bis(2,2'- bipyridyl-4,4'-dicarboxylato)ruthenium(II) Di-tetrabutylammonium cis-bis(isothiocyanato)bis(2,2'- bipyridyl-4,4'-dicarboxylato)ruthenium(II)	6.91



5/30/2016

## **Applications of Solar Cells**

Toys, Watches, Calculators

Electric fences

Remote lighting systems

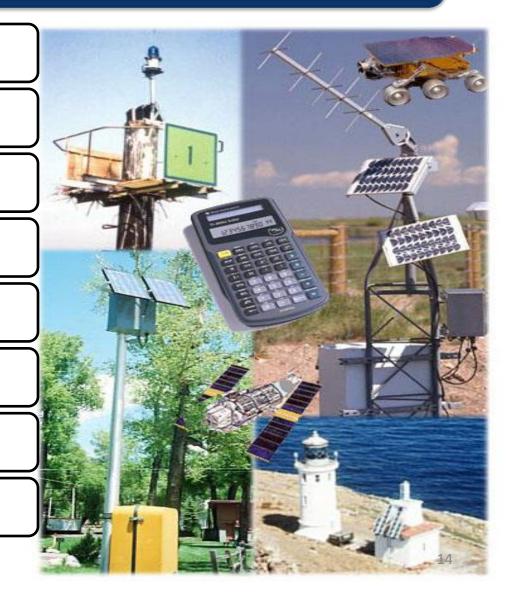
Water pumping

Water treatment

**Emergency power** 

Portable power supplies

Satellites



# Off-grid application

 Water

 Pumping



Space





# Grid Connected applications



Commercial Building Systems (50 kW)





# **Future Applications**

#### Nano Solar Cells



#### **Tetrapod Nanocrystals**

- Tiny rods are embedded in a semi-conducting plastic layer sandwiched between two electrodes
- Rods act like wires, absorbing light to create an electric current
- May double the efficiency of plastic solar cells
- Made of cadmium, tellurium

5/30/2016

# Advantages

- 1. It is clean and non-polluting
- 2. It is a renewable energy
- 3. Solar cells do not produce noise and they are totally silent.
- 4. They require very little maintenance
- They are long lasting sources of energy which can be used almost anywhere
- 6. They have long life time
- 7. There are no fuel costs or fuel supply problems

### Reference

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   Available: http://www.bp.com/en/global/corporate/about-bp/statistical-review of worldenergy 2013/energy-outlook-2030.htm (2013).
- Exxon: The outlook for energy: a view to 2040.
   Available: http://www.exxonmobil.com.sg/Corporate/energy\_outlook\_view. aspx. (2013).
- Jonathan Wood (2005) "Meeting the challenge of solar energy" Materials today October, pp. 16.
- Bharvi Dutt and Khaiser Nikam (2013) "Solar cell research in India: A scientometric profile"
   Annals of Library and Information Studies, Vol. 60, pp. 115-127.
- R. Ramachandran et.al., (2015) "Recent Progress in Electrode Fabrication Materials and Various Insight in Solar cells: Review" International Journal of Electrochemical Science, Vol. 10, pp. 3301-3318.

# Thank you

### To see the future of energy.....



#### Peripherals of a solar rooftop system Design of a Monitoring system

Gowrishankar Ramanan May 30, 2016



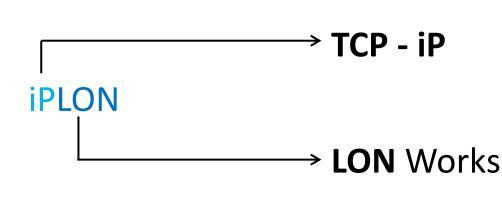


KFW DEG



#### About the Founder

- Founded by Victor Thamburaj
- Alumnus of IIT-M
- Electrical Engineer
- 40+ years of experience in Germany





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# **TCP-iP**: Communication protocol **LON Works**: Decentral applications



#### About iPLON

- We believe in Renewable energy and Post Carbon Economy
- HQ in Germany (Schwaebisch hall)
- Experience of over 1000 MWp, >5000 installations
- Started Indian operations in 2012 (Chennai)
- Focused on M&C and O&M of solar farms
- Completed over 750 MW and 20 rooftop installations in India
- Asia's largest (151 MWp) project in MP



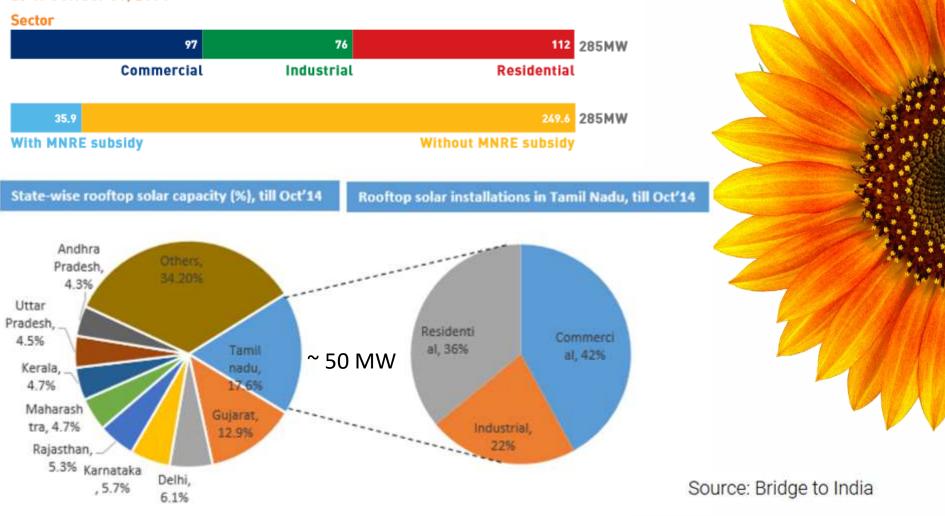




#### Tamil Nadu's solar market

#### Total installed capacity: 285 MW

as of October 31, 2014



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#### India's Tamil Nadu Could Become a Renewable Energy Powerhouse

by Deepak Sriram Krishnan - February 27, 2015

#### This blog post originally appeared on *Insights*.

Tamil Nadu, India's sixth-most populous state, has emerged as a major hub for renewable energy over the last decade. More than one-third of its installed capacity—about 8,000 megawatts—now comes from renewable energy sources like wind and solar.

Still, the state's clean energy markets can go further—research shows that

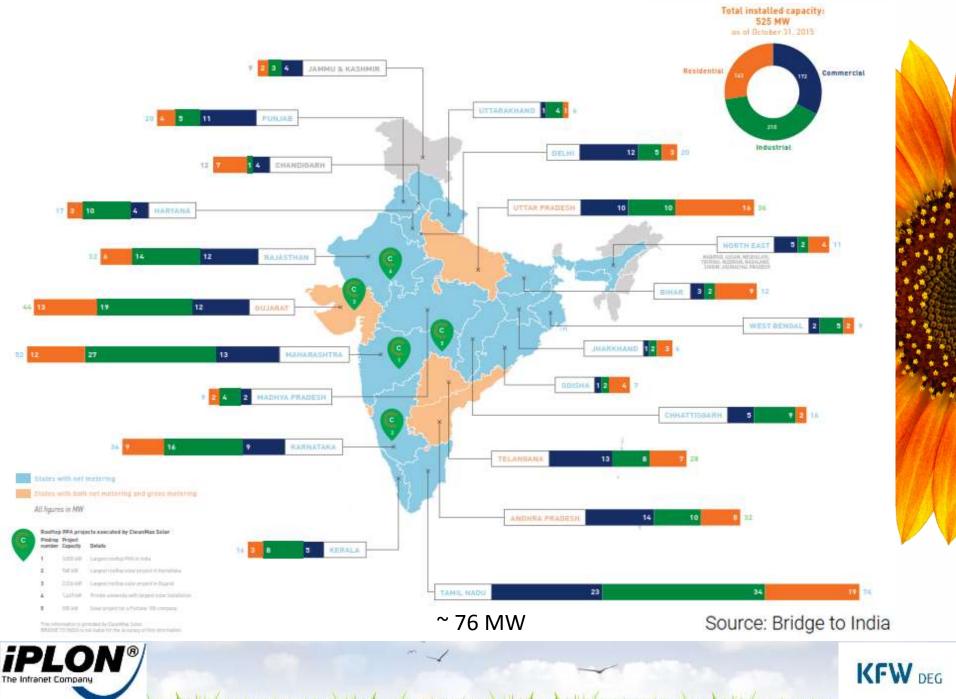


Solar empowers residential, commercial, and industrial consumers to lock in power prices below grid averages. Photo by Intel Free Press/Flickr.

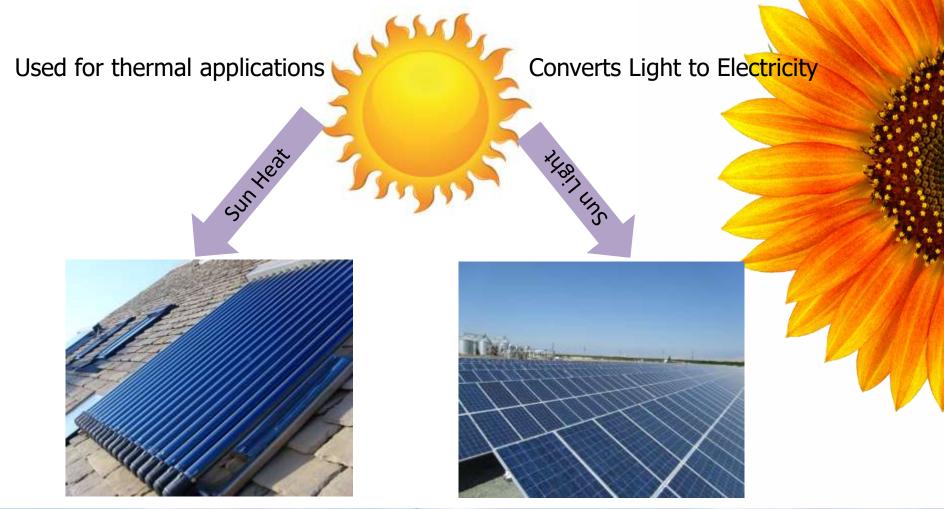
Tamil Nadu's renewable energy potential is close to 680 gigawatts (GW), 85 times its current installed capacity and comparable with the U.S. fossil fuel power plant capacity (781 GW) in 2012. Harnessing local renewable energy resources could yield important economic development benefits for the state; but government, industry and the utility will first need to work together to address some key challenges.





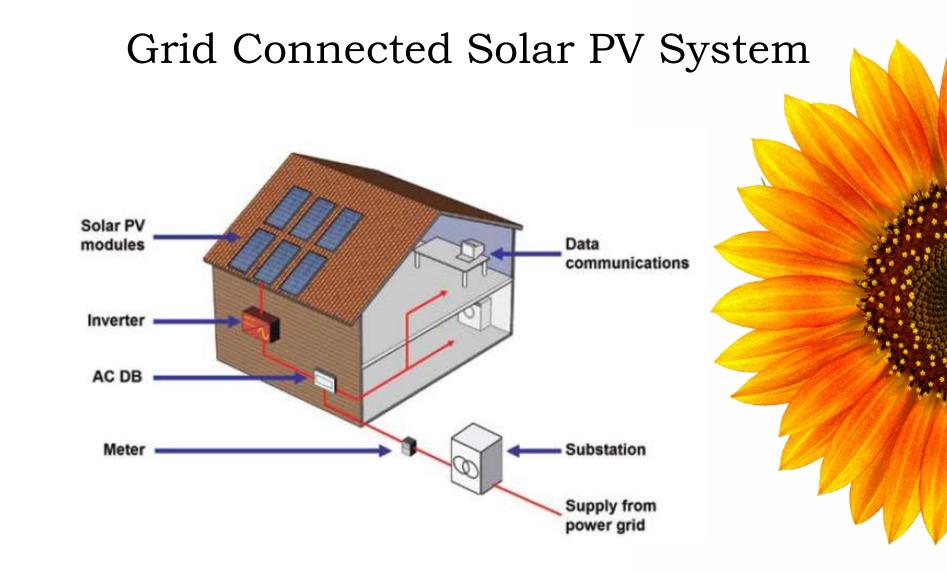


## Sun: Source of Energy



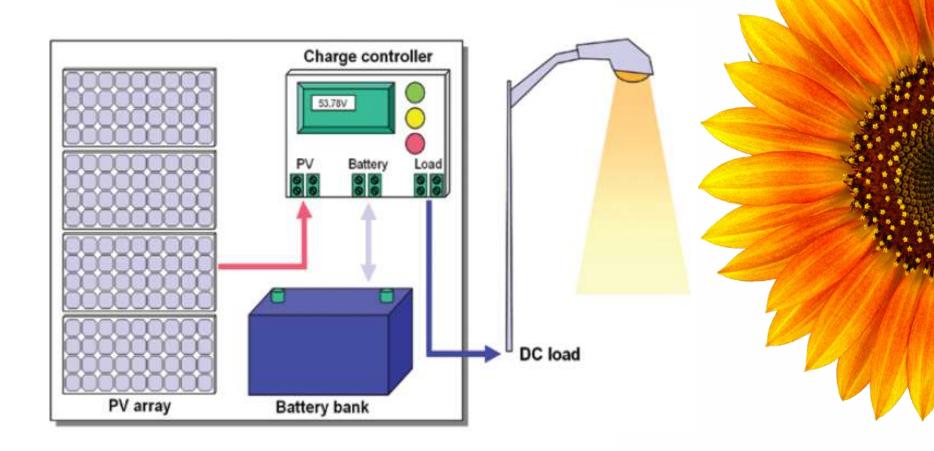








#### Off Grid Solar PV System





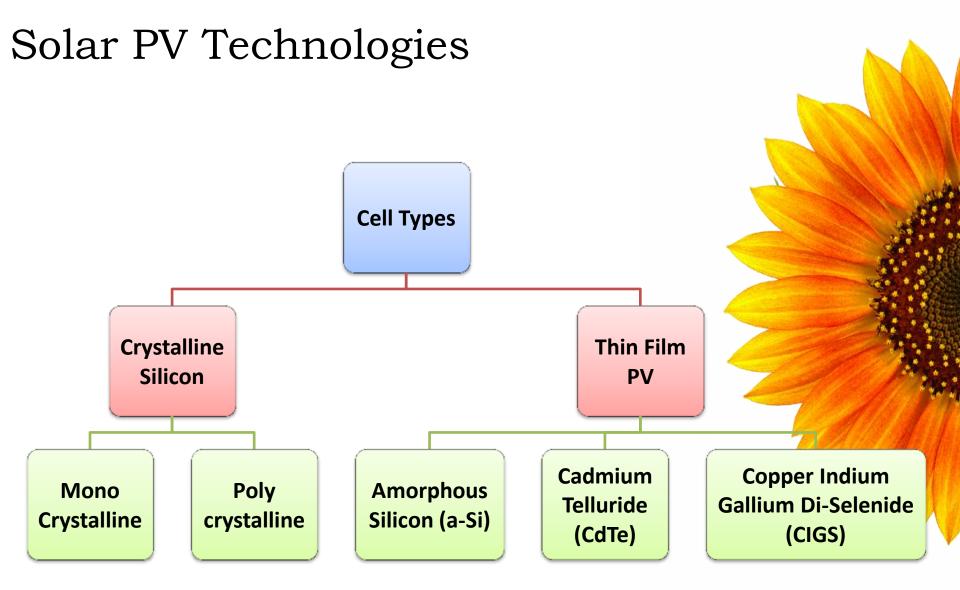
#### Balance of Systems (BoS)

- Power Electronics Inverters, SMU
- Mounting structures
  - Racking: Fixed tilt
  - Tracking systems: Single/Dual Axis
- Cables and connectors
- Performance monitoring systems
  - Weather Stations
  - Local Monitoring (SCADA PC based)
  - Remote Monitoring (Web based)
- Installation
  - $\circ$  Engineering and Design
  - $\circ$  Construction
  - Project Management





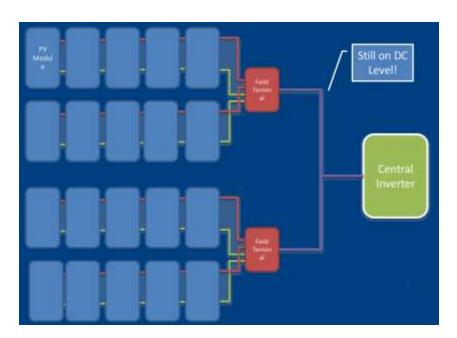
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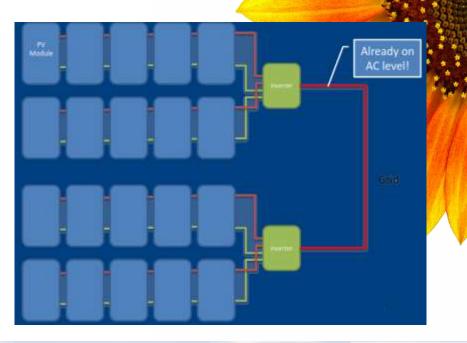


- Types of Inverters
  - Central Inverter

     Dominant in emerging markets
  - String Inverter
    - Preferred in European markets
  - Micro-inverter







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- Mounting structures
- Modules' long-lasting companion
  - Supports the modules
  - Aluminium, Galvanised Iron
  - Should be "Corrosion Resistant"
  - Choose wisely Soil, wind, weather conditions!
  - Majority Fixed tilt
  - Rare: Trackers



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#### Performance Monitoring System

- Weather Stations
- Local Monitoring (SCADA)
- Remote Monitoring

#### Why Remote Monitoring?

Gain insights into:

- String current
- String voltage
- Inverter performance
- Energy Generated
- Error-messages
- Weather conditions
- Performance of the plant
- Benchmarking multiple projects





#### Offering solutions for Solar Rooftop Plants

- Typical enquiry: '1-liner'
- Non-precise offer: "Price budget"
- iPLON questionnaire
- Customer project details
- Official offer
- Customer Purchase Order
- Engineering, Production, Delivery and Commissioning Workflow







Typical enquiry

Hi Gowrishankar,

Thanks for reverting.

To start off with we require your solutions for a 200 kWp rooftop installation.

Please advise detailed technical and commercial solution for the same.



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### Design of a Monitoring System

#### Device details

- Inverters
- Energy Meter
- String Monitoring Unit
- Weather Sensors

#### Plant details

- Plant Layout
- Internet Connection
- Site Location
- MNRE Certificate
- Delivery time





### Why do we ask for the device details?

- Mode of communication
- Communication Protocol
- Output Signal type
- Engineering & configuration efforts = No. of field inputs and their properties





### Why do we ask for the plant details?

- Understanding nature of the site:
  - Single roof
  - Distributed roofs
  - Distance between the devices
- Which GPRS network works well
- Location of the plant
- Customs Duty exemption possibility = Offering the best competitive solution that fits both





#### A Practical example

Device Details:

- 1. Inverters: Make and quantity- SMA (STP 60 x 3 nos.)
- 2. Energy Meter: Make and quantity (1 no. ?) (Schneider; 01)
- 3. String Combiner Monitoring Boxes (if applicable): Make and quantity (Make yet to be decided; Qty- 03 nos.)
- 4. Weather Sensors :- Shall iPLON also offer this. For rooftops we have M&T Ingenieurburo make sensors (Irradiation, module temp, ambient temp and wind speed) with an RS485 output. If you are procuring sensors separately then please mention make and type (output signal) (Please quote for your sensors)

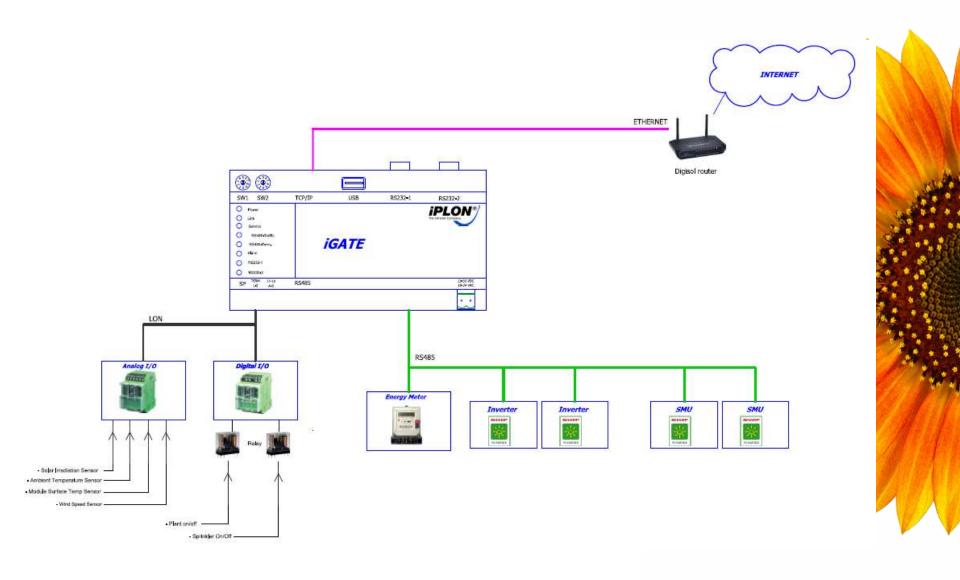
Other details:

- 1. Plant layout: So that we can check if all devices are nearby (cable length RS485) (Max. distance between devices shall be of 25 mtrs.)
- 2. Internet connection: Do you have a DSL connection on-site or should we supply a GPRS router (DSL connection available)
- 3. Site location: nearest railway station (Gurgaon, Haryana)
- 4. Do you also have a MNRE certificate for customs duty exemption ? (Yes)
- 5. When is the Delivery time? (Mid- April)

We shall be able to make a good offer with these details. Looking forward to the same.

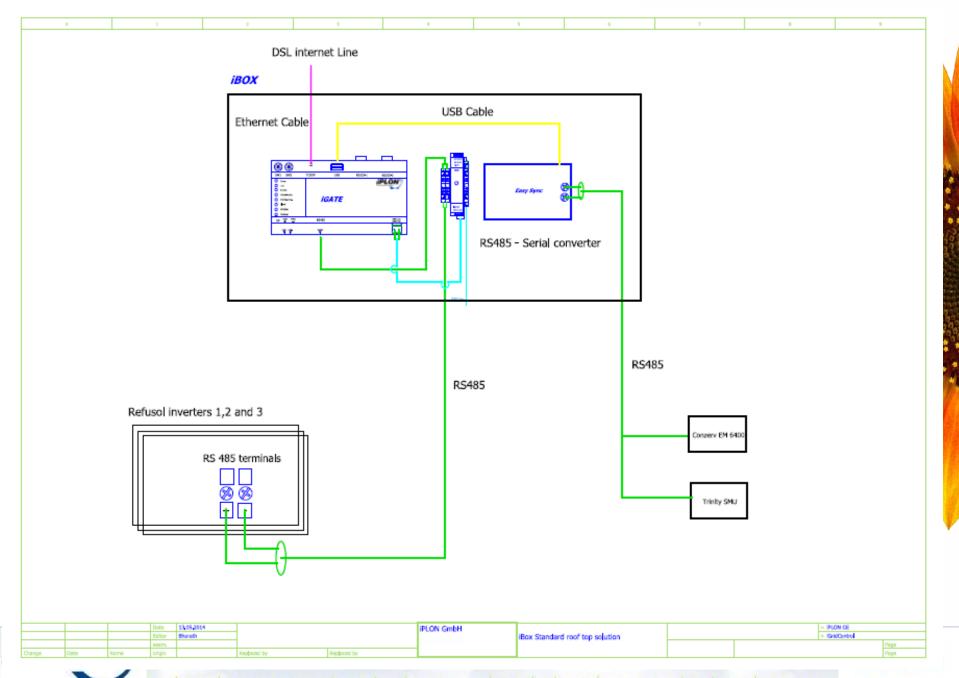
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#### Our Offer

5<sup>th</sup> Street, Mylapore, Chennai, Tamil Nadu, India 600 004. Mobile: +91 98849 70611 email: info@jplon.de Web: <u>www.iplon.in</u>

From: Gowrishankar Ramanan



Direct No.:	+91 7338910852

To:

Date :

Tel Nr:

Number of Pages: 3

Offer Number: Rooftop offer. V1.0 Grid tied Rooftop PV plant monitoring system

Dear Mr.

In response to your enquiry on 2<sup>nd</sup> February 2016 and subsequent discussions over the phone, we would like to make an offer for your requirements which includes our delivery and payment conditions.

System size – Location – Segment – Commercial Rooftop

Description	Price
Monitoring system iBOX Premium for       rooftop         - iBox with Datalogger       -         - 24V Power supply       -         - RS485 Modbus communication with Delta Inverters (3 in daisy chain)         - RS485 Modbus communication with 1 Energy meter (Make:xx)         - EasySync - 1 no. (2 RS485 to 1 USB converter)         - Build in a IP 55 Hensel Box: ready with all terminals.         - Engineering	र .
<ul> <li>Weather Sensors</li> <li>Irradiation Sensor (M&amp;T Ingenieurburo) with in-built Module Surface temp</li> <li>Ambient Temperature sensor (M&amp;T Ingenieurburo)</li> </ul>	₹.







5<sup>th</sup> Street, Mylapore, Chennai, Tamil Nadu, India 600 004. Mobile: +91 98849 70611 email: info@iplon.de Web: <u>www.iplon.in</u>



Web-portal rental & maintenance charges after 1st year	
- Charges applicable from 2nd year 'Per year' price quoted	₹
On-site commissioning charges - Plant located in Chennai - Termination of all cables at iBOX end (Power supply, RS485, TCP) - iPLON Engineer will visit at site and get all devices online - Configuration and testing of web-portal: - Handover and training	
	₹
(Prices are exclusive of taxes. Will be charged as per actuals)	

\* The total length of this Modbus RS485 bus should not be more than 200 meters

#### Scope of Customer:

- 1. Mounting and Installation of iPLON Cabinet & weather sensors
- 2. All cable procurement
- 3. Power Supply, RS485 and sensor cabling
- 4. All terminations on device end (Inverters, Energy meter etc)
- 5. Internet connection for iGate (for commissioning purposes too)
- 6. iPLON will support with termination and connection drawings and cable guidelines

#### Frame conditions:

- DSL/GPRS costs to be taken up by customer
- · Access to Internet portal for 1 year
- iPLON payment and delivery conditions
- 5 years cooperation contract (delivery of hardware and software and services)
- A mutual and confidential cooperation
- · Additional engineering and services will be charged separately
- Customer to provide device communication protocol mapping details to iPLON for free of charge in case iPLON already does not have them
- · The prices quoted are applicable only for this project in Chennai
- All issues, problems which occur due to mistakes not done by iPLON will be charged to the customer separately
- Taxes, shipping, handling, insurance, VAT, Customs Duty and other charges, if occurring, will be charged separately





5<sup>th</sup> Street, Mylapore, Chennai, Tamil Nadu, India 600 004. Mobile: +91 98849 70611 email: info@iplon.de Web: www.iplon.in



Offer validity:	14 days
Delivery:	Approx. 4-5 weeks (after Order confirmation). Delivery on receipt of agreed prepayment
Payment :	50 % :Prepayment 50% :Delivery of iBox on-site Wired Transfer.

This offer is based on the frame conditions mentioned above and valid for 14 days from issue. According to the timescale mentioned above, the order has to be placed in sufficient time, to ensure on time delivery.

The charging of additional services will be done immediately as the services occur. The payment period is 7 days net.

Installation to begin as per project status feedback from Customer (please note that if the customer gives us a wrong feedback, the extra charges will be forwarded to the customer) Commissioning to begin as per project status and the feedback from Customer

This offer is for all the parts named above. Individual purchase of single parts is not possible.

More efforts and work which are needed due to incomplete or wrong data and information will be charged additionally. For the unlikely event of changes in the supply chain of iPLON, iPLON will address these issues openly to the customer.

This electronic offer, including all attachments, is directed in confidence solely to the person(s) to whom it is addressed, or an authorized recipient, and may not otherwise be distributed, copied or disclosed. The contents of this transmission may also be subject to intellectual property rights and such rights are expressed, claimed and are not waived.

Please feel free to get in touch with us if more clarification or additional services are needed.

Best Regards,

iPLON India Pvt. Ltd.

Victor Thamburaj Managing Director







#### **Smart Control Functions**

- Zero Evacuation
- Fuel Save system (Solar-Diesel Hybrid)
- Smart Storage System
- Supply side management
- SMART METERING::SMART GRID::SMART CITY!!!









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## IPLON iBox Solution Rooftops



Mr. Carlos Valencia, Senior Systems Manager, iPLON Date : 30<sup>th</sup> May 2016



# Agenda

Rooftop ProjectsProductsService





#### Rooftops Germnany



About 1.5 million photovoltaic systems
 From this 1 million are rooftops





#### Maritim, Hamburg, 972,7 kWp







#### Carport,





#### **PV roof installation in Germany**

**100 kWp roof top:** 450 x ITS module 220Wp 4 x 10kW Kostal inverter 1 x 65kW MW Inverter 4 x string box with 4 MPP trackers each

100 kWp roof top: 550 x Sovello module 190Wp 2 x 65kW MW Inverter 5 x string box with 4 MPP trackers each





# Combination with Greenhouse and PV System



Building up of Greenhouse combination have to be done with the knowledge of a lager Greenhouse builder and the Information about the goods who will be produced inside!





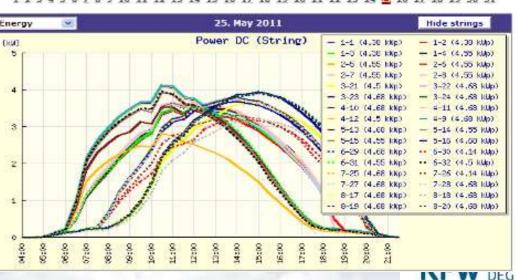


#### Single String Monitoring with different Orientation!



With a single MPP tracking You will see at the diagram the different single MPP point of the different module strings!

iPLON<sup>®</sup>/

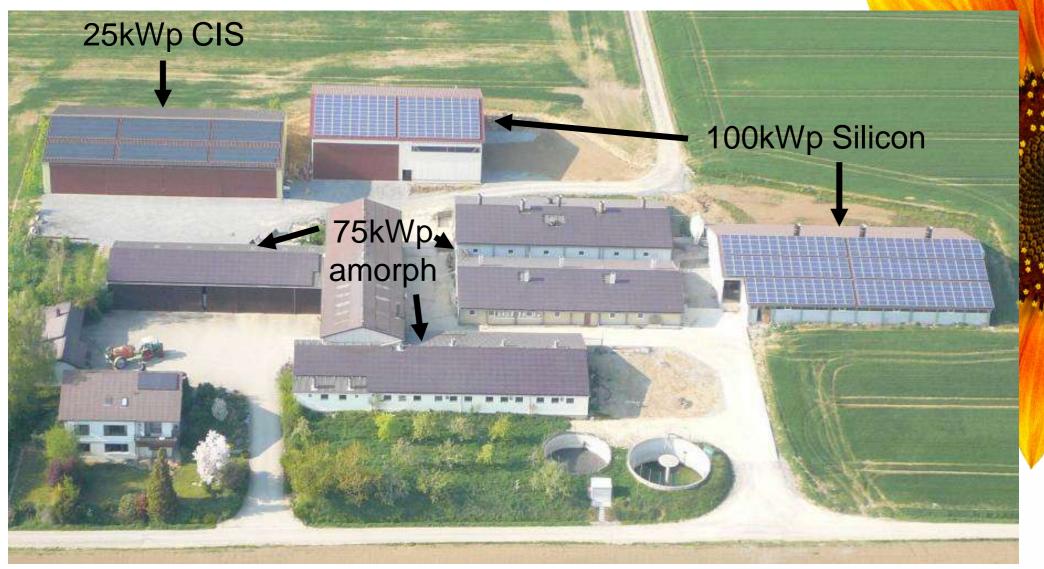


#### **Special Solution Grid Inverter parallel to a Diesel Engine**



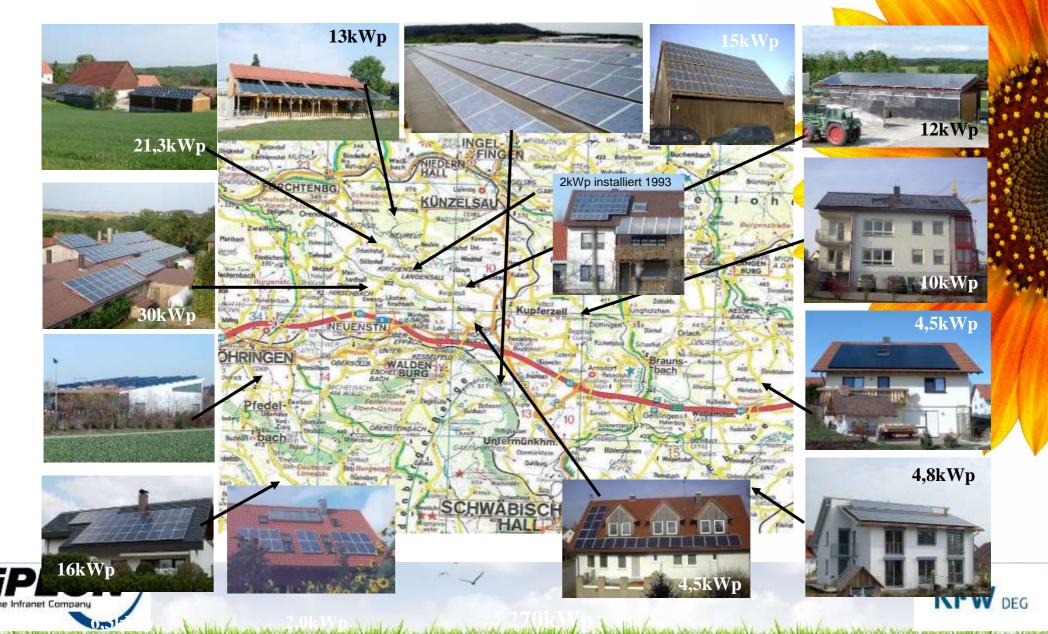


#### 200kWp with different module technologies



IPLOTALATION: 2001: 25kWp CIGS 2003: 75kWp amorph Silicon 2010: 100kWp EFG silicon 2011: 30kWp Silicon KFW DEG

# **Old References**



#### 140kWp Pergola in the Netherland







KFW DEG

#### **1 MWp PV Projekt Stadion Dortmund**



**Technical Details:** 

7.800 CIGS modules 168 x single MPP Tracker 6 x 140kW Inverter

DC switch for fire security!

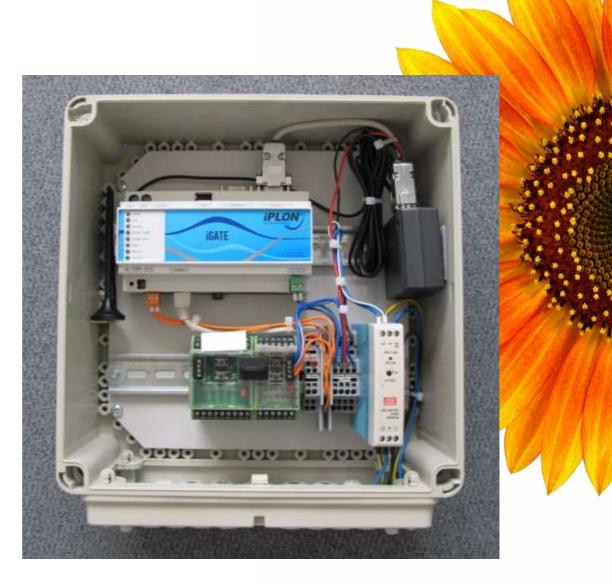
iPLON<sup>®</sup>/





#### iRooftop-Box 18710

- Inverters Interface
- •Energy meter Interface
- Weatherstation Interface







#### iGridControl-Box 18510 (Value)

Grid stability system

Power reduction
100 %, 60%, 30%, 0%
1 min reaction time

iP

 Powerfactor correction
 Cosphi 1,00, 0,99, 0,98, 0,97, 0,96







# **Thank You!**

<u>www.iplon.de</u> <u>www.youtube.com/user/iPLONChannel</u>





# Weather Stations and Environmental Sensors for Rooftop Projects

30th May 2016

Mr. Sreenath C

**Business Development Team** 

iPLON(India)



# Overview

- Relevance of Weather Monitoring station
- Introduction to various Measuring techniques
- Digital Silicon Irradiance Sensor
- External Temperature Sensor
- Wind speed Sensor

## **Relevance of Weather Monitoring Stations**

- Energy output is directly related to ambient conditions like
  - Amount of sunlight (Irradiation)
  - PV Module temperature
  - Ambient temperature



### Parameters needed to be measured

#### **Irradiation sensor**

#### **External Temperature**

sensor





#### Wind Sensors







# **Irradiation Sensor**

- Make: IngenIeurbüro
- Principle: short-circuit current is proportional to irradiance
- Build out of a mono-crystalline solar cell connected to a shunt
- Calculated values of irradiance and temperature are given on to a RS485 port



### Operating range of $-20^{\circ}$ C to $70^{\circ}$ C

IP 65 protection

Power supply: 12 to 28 V DC

Accuracy  $: \pm 5\%$ 



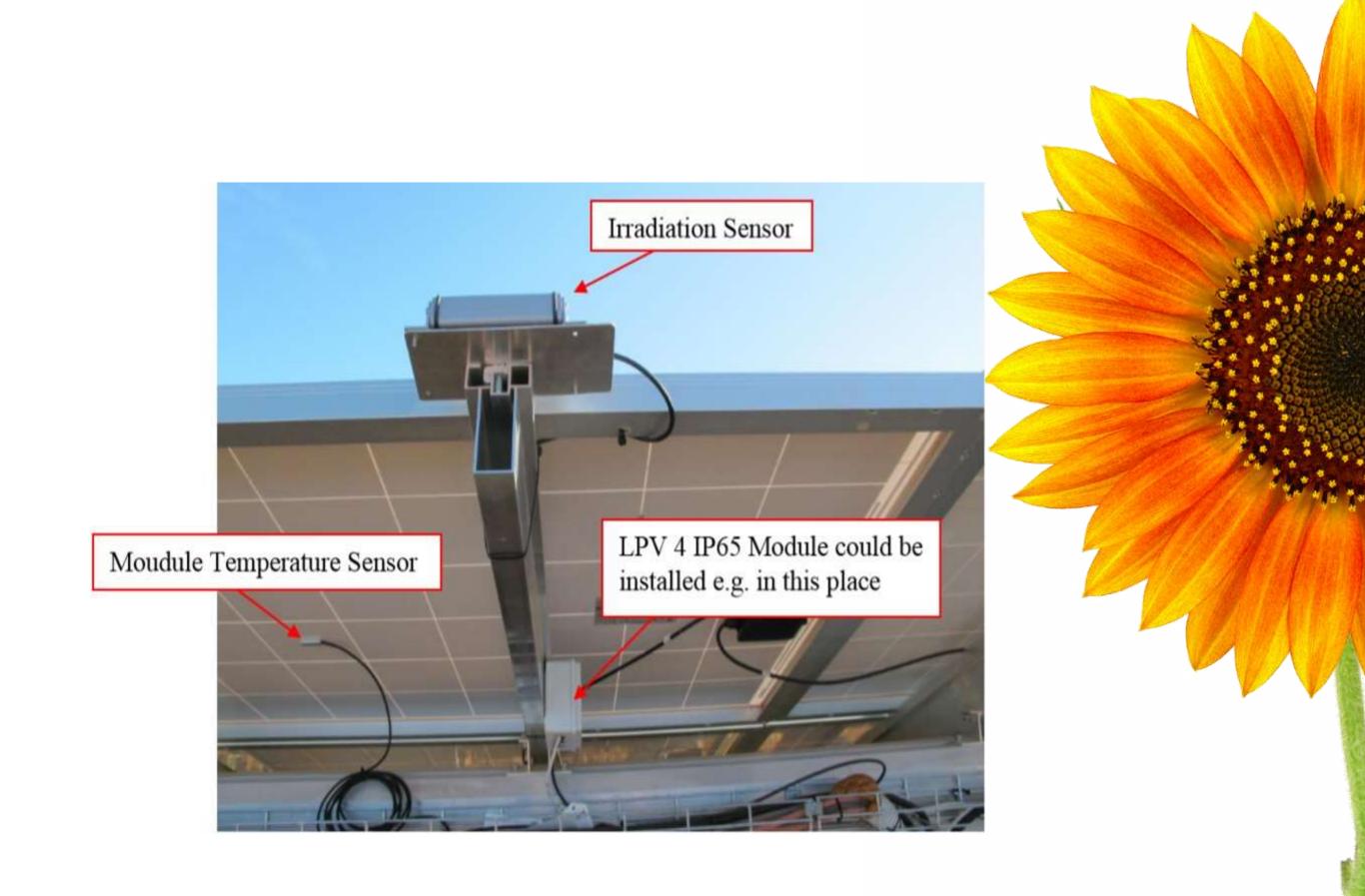


# Installation











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# **External Temperature Sensor**

- Make: Ingenieurbüro
- Sensor type: Pt1000 1/3 class B
- Temperature range: -40 to  $+85^{\circ}$  C
- Protection: IP67

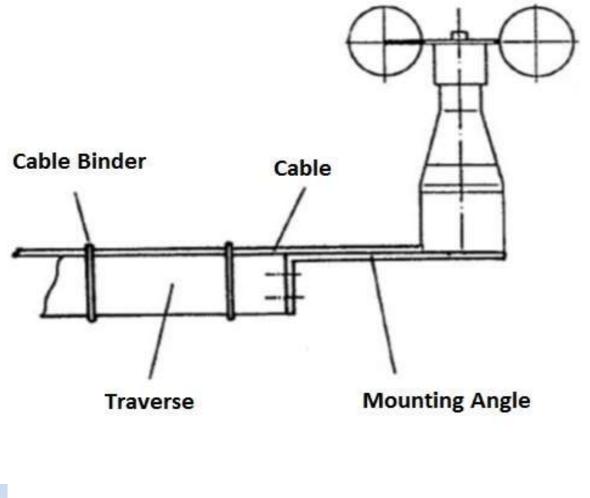


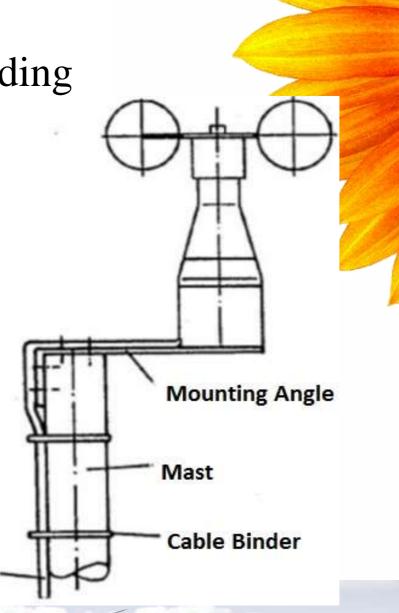
# Wind Speed Sensor

- Cup star anemometer
- Range: 0 40 m/s
- Signal: 2.3 Hz/(m/s)
- Accuracy: 0.5 m/s or 5% of reading

Cable

and the second second







# Lufft WS504 PV Monitoring Sensor

- Global radiation: Thermopile pyranometer
- Temperature: Thermistor (NTC) in a ventilated radiation shield according to WMO standard)
- Wind: Ultrasonic
- Precipitation: Doppler-Radar
- Humidity, air pressure: Capacitive sensors



#### Weather Station Value line 15010

 For calculation of the PR (Performance Ratio) the Irradiation (W/m<sup>2</sup>), the ambient temperature and the Module surface temperature are needed

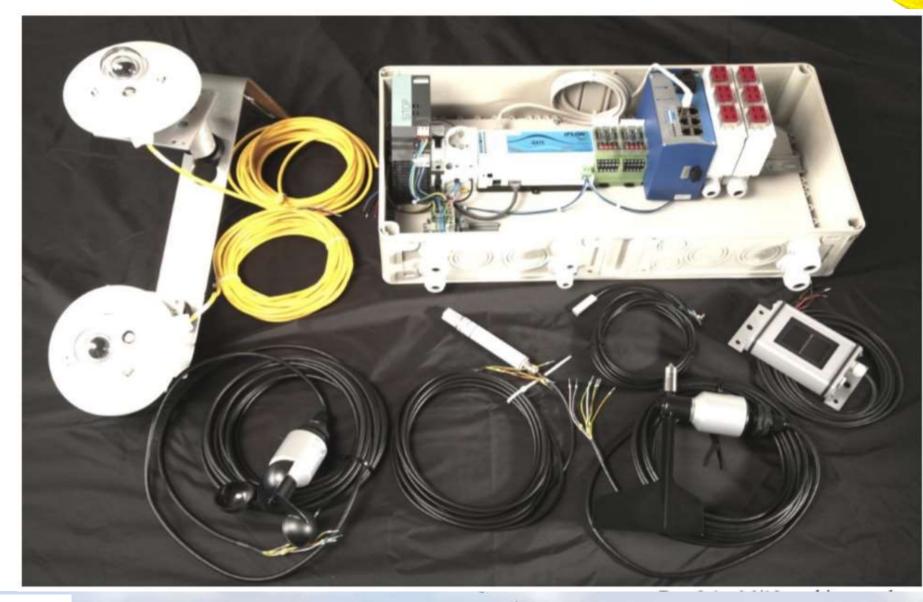


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# Weather Station Extended 15013

 Extended version of sensors and for stations, which are very far from the control room





# Thank You!

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www.youtube.com/user/iPLONChannel

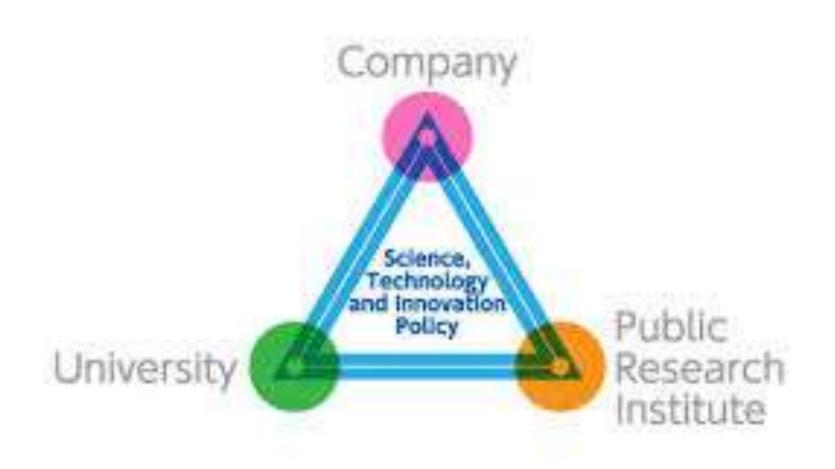


# Importance of Industry-University Collaboration

V.Kirubakaran Coordinator Rural Energy Centre Gandhigram Rural Institute - Deemed University (MHRD, Gol) kirbakaran@yahoo.com

# BRIDGING THE GAP Between Academia and Industry

#### **Existing Structure**



#### Need

### Academia

Leading Researchers

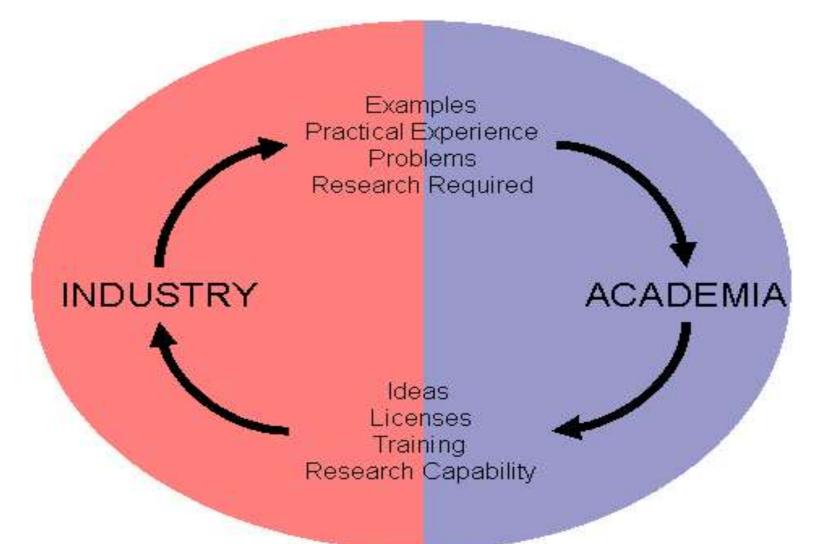
#### **Students**

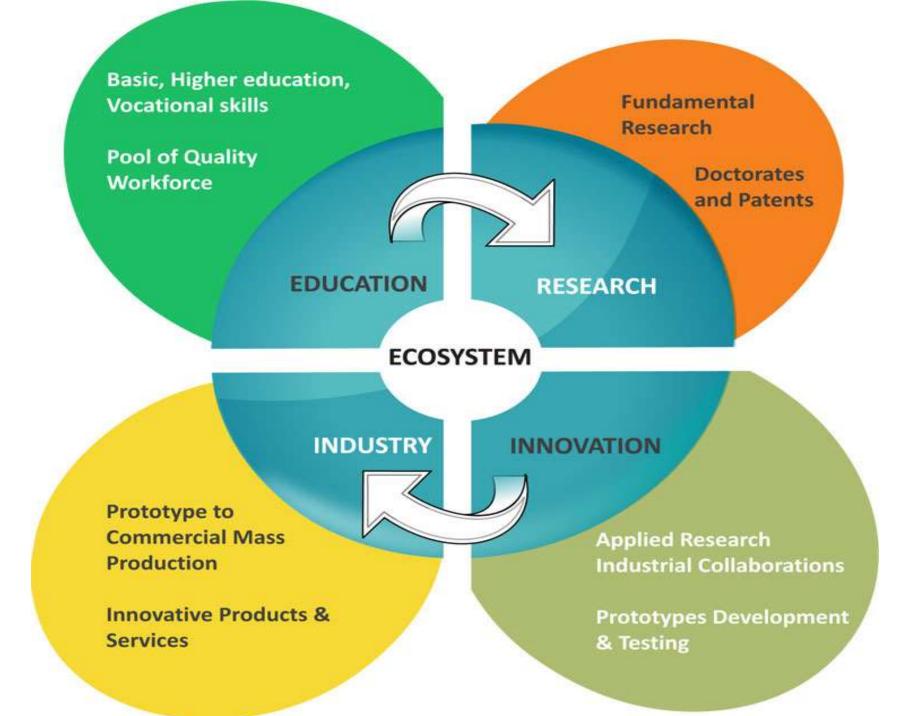
Talented future Data Scientists

#### Industry

Domain Expertise, Business Cases

#### Collobration



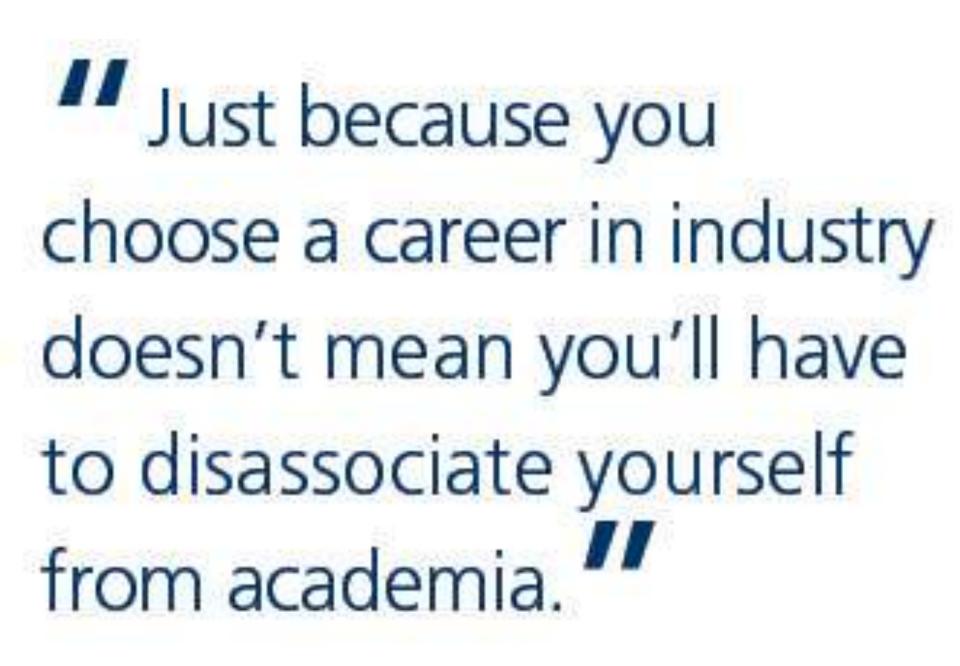


# Objectives

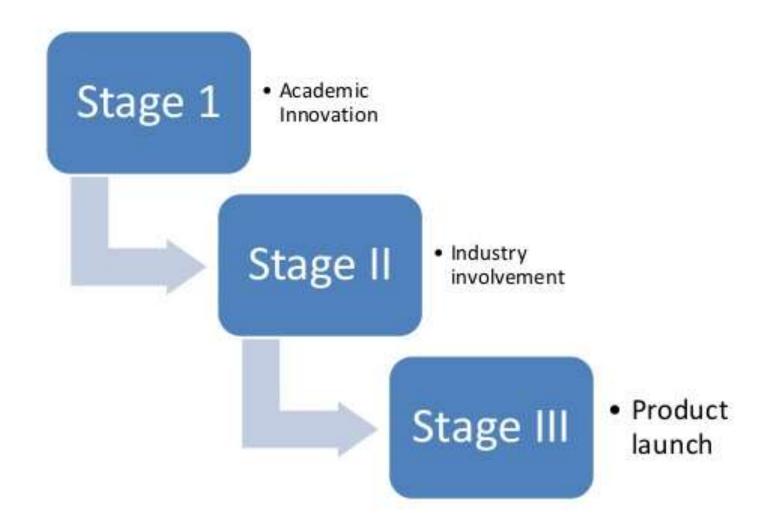
- To synchronize the quality of education to meet the trend of industry.
- To produce employable students i.e. "Industryready students."
- To conduct other value added programs based on industry requirements.
- To integrate industrial training and other inputs to develop students.
- To offer research, development, consultancy and testing services to solve industrial problems.

# Objectives

- To improve curricula, faculty, infrastructure, pedagogy in line with the industry's requirements.
- To develop good work culture in students.
- To organize lectures by experts from industry.



# Harvard/MIT Model





# **Bridging Gap**

- Establishing III Cell
- Organizing Joint Workshops / Seminars
- Industrial Expert to visit Institution
- Industrial involvement in Curriculum Development
- Joint Degree Programme
- Student Staff Visits to industries

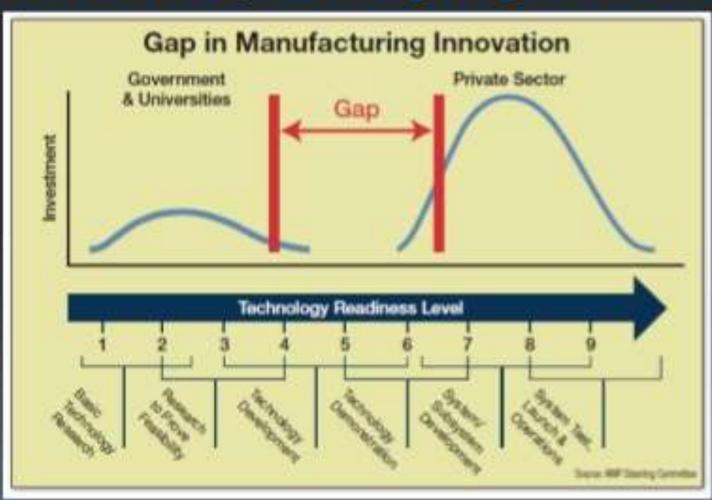
- Professional consultancy by the faculty to the industries
- Industrial testing / measurements by the faculty & student
- Joint Research Programme
- Visit by the faculty to the industry to deliver a lecture on specific topics
- MoU

- Short Term Technical Assignment for the faculty in the industry
- Visiting Professors by the Industrial experts
- Industry Chair Professor to the Institute
- R&D Lab sponsored by the industry
- Student fellowship / internship

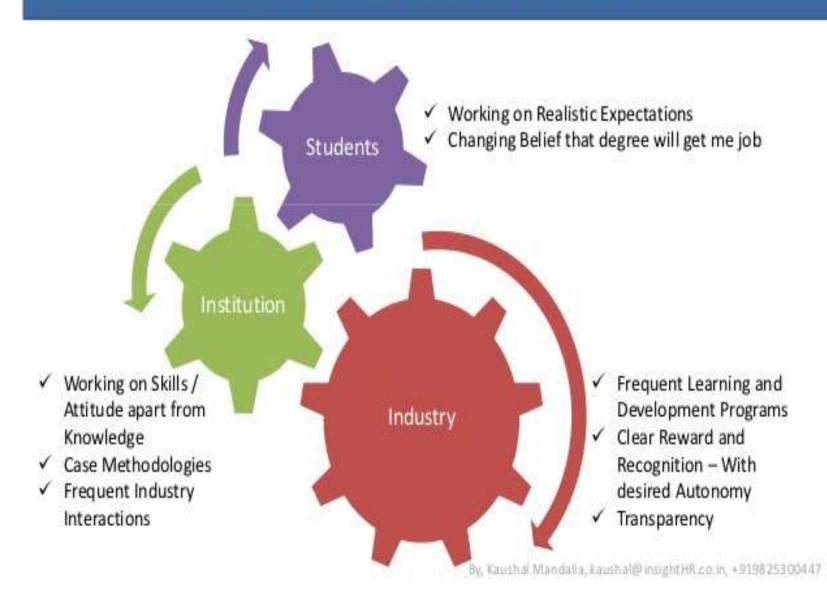
# Threats

- No coordination in III Cell
- Rigid Curriculum
- Mismatch in Academic Aspiration and Industrial requirement

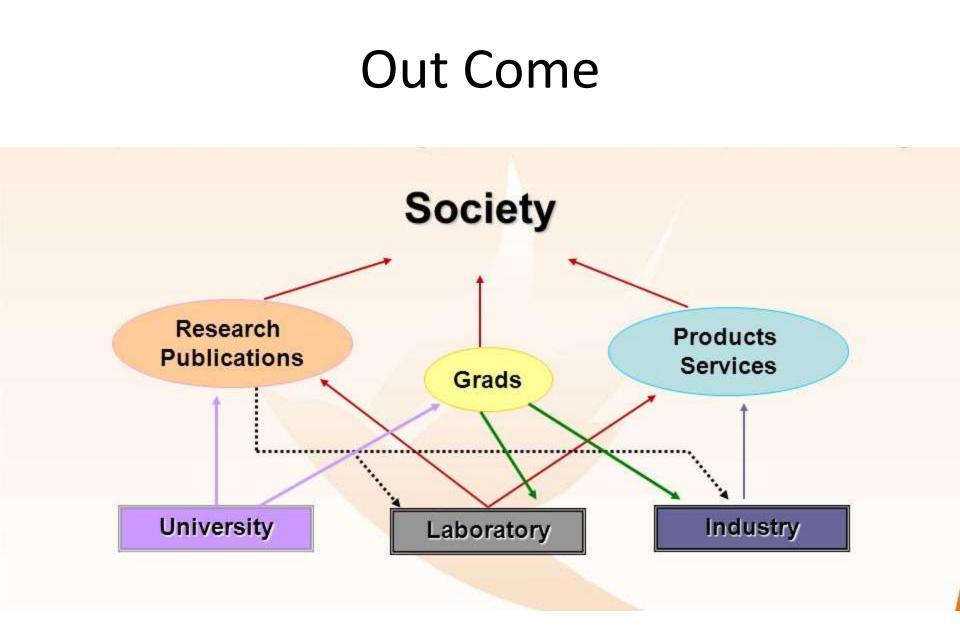
# Objectives of Industry-Institute Interaction by Bridging the Gap



#### **Immediate Action Needed**



All departments of Institute if, involved in industrial oriented activities on a continuous basis either in the form of consultancy or sponsored research or for curriculum development, it will give better results.



Industry-Institute interface promotes National Integration

- More employment lead to GDP growth
- Inclusive development of society-Industry-Institute
- Rate of crime can drop drastically
- Promote belongingness among all sections of society
- Educational interactions leads to better understanding and friendly atmosphere



Prof M.C.Rashid Khan, GSBA, Greater Noida, UP Ph: 09810902355,mcrashidkhan@gmail.com



"An ounce of practice is worth more than tons of preaching." \_ Mahatma Gandhi..

Thank You



Project Management, Commissioning, Stakeholders, and Network Building

> Gowrishankar Ramanan May 30, 2016





iPLON®/

KFW DEG

#### Project Management

#### **Device Details**

- Make & Model
- Number of Devices
- Communication Protocol Details
  - Baud rate
  - o Parity
- Inverter ?
- SMU ?
- Energy Meter?
- Weather Station
- Output: 4-20 mA / 0-10 V / RS485



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#### Project Requirements

Internet Details

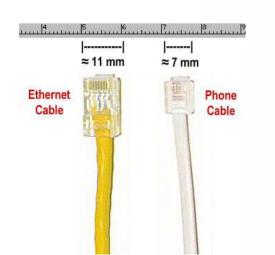
 GPRS ?
 DSL ?



- GPRS

   Sim Card Provider
- DSL

   IP Address Details







#### Portal Requirements

- Plant Capacity
- Plant Name & Address
- Date of Commissioning
- Module Type & Capacity
- Tilt Angel
- Orientation
- Area
- String Details

# Plant Overview Plant Information Installed Capacity Client information – Confidential Latitude 13.0389 Longitude 80.1906 Location Royapettah, Chennai Date Of Commissioning 29-April-2016

Total Energy Generation Client information - Confidential

Technical Data	
recrinical Data	
Module	Poly crystalline
Inverter	Delta RPI-M20A
Tilt Angle	11 <sup>0</sup>
Orientation	South
Area	240 m <sup>2</sup>





#### Internal Processes

- Architecture Design
- Assembly
- Software Configuration
- Testing with Simulation
- Delivery to Site

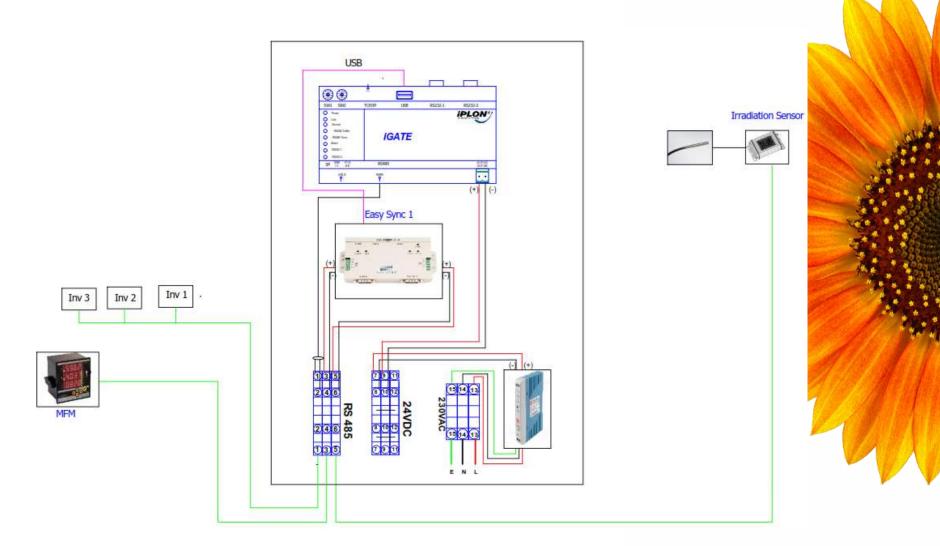


#### iPLON focus: ON-Time Delivery, with ZERO defects

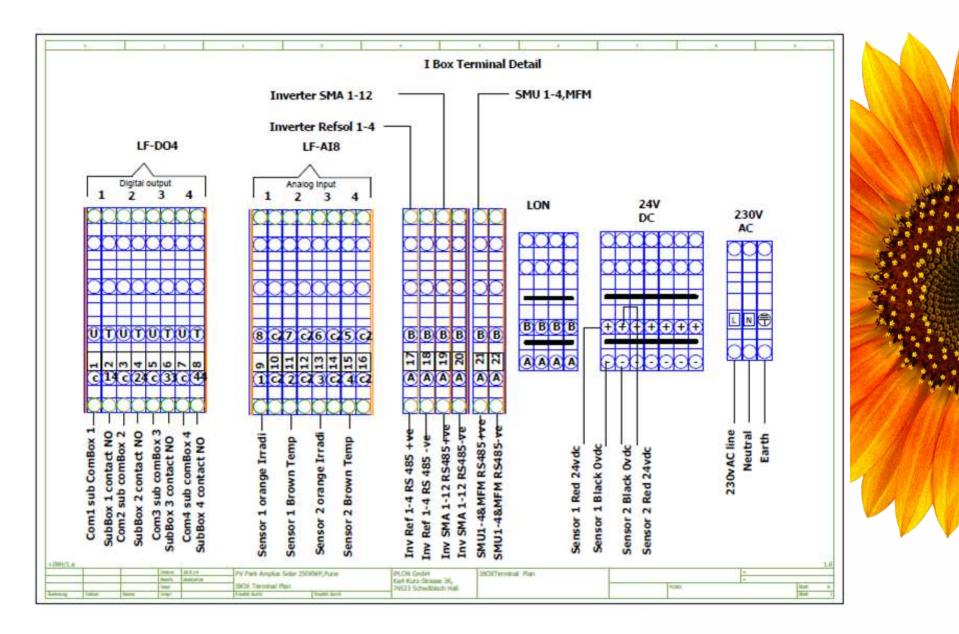




#### Architecture Diagram



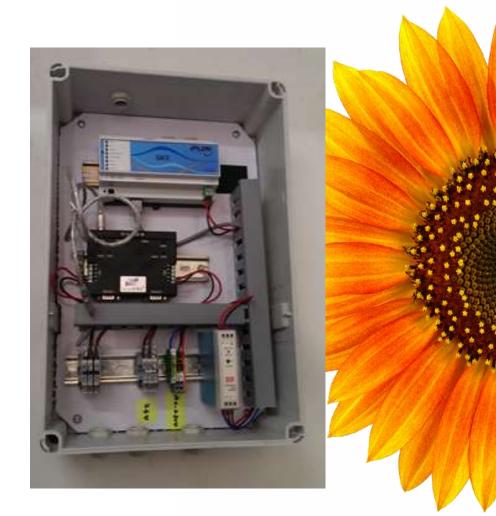






#### Assembly









### Software Configuration

- Flash the iGate
- Assign ID & IP Address
- Configure Internet
  - o **DSL**
  - o GPRS
- Configure Inverter / SMU / Energy Meter / Weather Station







## Testing with Simulation

- Simulate the values for field devices
  - o Inverter
  - o SMU
  - Energy Meter
- Connect Sensors & Validate the data
- Internet Connectivity
- Data Validation in Portal





### Installation & Commissioning



Before



After







### Commissioning

- Schedule
- Skills
- Tools
  - Laptop
  - o Internet
  - Required Software
  - $_{\odot}$  Multimeter, TCP Cable, Screw Set







### Configuration on-site

arminatic Promise

y from 192.168.1.1: Destination host unreachable. y from 192.168.1.2: bytes=32 time=1987ms TTL=128 est timed out. est timed out.

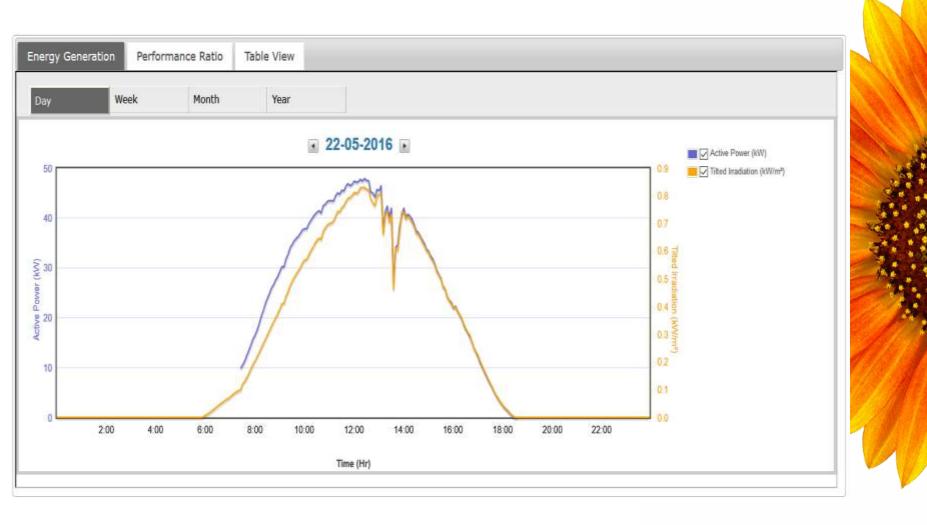
statistics for 192.168.1.2: Packets: Sent = 11, Received = 9, Lost = 2 (18% loss), eximate round trip times in milli-seconds: primum = 1987ms, Maximum = 1987ms, Average = 1987ms

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### Portal





leek	Month	Year					
			11-May-2016	5 To 17-May-2016			
xport						Search:	
Date		Energy Generation (kWh)	¢	Tilted Irradiation (kWh/m²)	¢	Performance Ratio (%)	¢
016-05-11	54.	59	4.17		19.43		
016-05-12	76.	57	5.56		20.42		
016-05-13	74.	33	5.29		20.67		
016-05-14	76.	29	5.55		20.44		
	71.	.95	5.29		20.16		
016-05-15			3.55		20.92		
	46.	.8	0.00		LV.VL		

What's the problem??

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## Some features of the portal

- Inverter graphs and data
- Weather station graphs and data
- Energy generated graphs and data
- PR
- Daily, weekly, monthly, and yearly wise comparison
- CO<sub>2</sub> savings
- ALARM filtering!



Compatible with different inverter makes, various plant data in ONE-SINGLE platform!





### Stakeholders

Producers & SuppliersInstitutionsOrganizationsInvestorsOrganizations
---

Stakeholders	Roles/Functions	
Technology producers &	Prime movers of the solar industry	
suppliers	Manufacture/assemble products	
Knowledge Institutions	R&D activities	-
	Capacity building programmes	1
Advisory Organizations	Technical & Policy assistance to the Government	
	Organize training facilities	A
Investors	Rupee term loans to renewable energy projects	
Governmental Organizations	Regulate the tariff of the generated power	] /
	Generation & distribution of electricity	
Consumers	Adoption of technology, disseminating awareness	]

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### Other factors to be considered

- Safety certificate required for above 10kW
- 3<sup>rd</sup> party sale of electricity
- Excise duty, import duty
- MNRE certificate
- Prevention of the spread of DC arcing



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#### Gujarat farmers to be roped in to tap solar energy

PTI Aug 17, 2015, 09.56AM IST

Tags: solar energy | Saurabh Patel | Gujarat State Electricity Corporation Limited | Gujarat Power Corporation Limited

AHMEDABAD: Gujarat is going to become the first state in the country to launch 'Agro-Solar policy' under which farmers will be roped in to tap energy from sun which will also help them earn additional income from power generation companies, according to officials.

According to officials in Gujarat Energy Research and Management Institute (GERMI), farmers and power generation companies will be in a win-win situation with generation of solar energy in agricultural fields.

(Gujarat is going to become ...)

GERMI Director Prof T Harinarayana told PTI that the state-run companies will set up Solar Photo Voltaic (SPV) plants in different farms fields and experiments were conducted in different agricultural universities in the state.









# Solar energy system must for special buildings in cities, towns



The developer has to use a minimum of one-third of the terrace area for installing solar photovoltaic cells. File The photo

The Hindu

The Housing and Urban Development Department issued a Government Order to this effect recently.





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#### Feb 2016

- 4<sup>th</sup> Feb:
   'Final DEG meeting'
- 18<sup>th</sup> Feb:
   'Rooftop
   workshop'

 Training programmes for EPC's

Mar - Aug

2016

- Workshops in Madurai, Coimbatore, Dindigul
- Hands-on experience: Workshops in collaboration with Universities

- Sep Dec 2016
- Road shows &
   Workshops on
   'Smart Grid'
   and 'Smart
   City'
- Chennai, Bangalore, Delhi, Mumbai

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#### Know-how

In Zakarth werden jamafe Labargen minner wichtiger. Eine der Herausforderungen, denen wir uns schon heuter stellen, til die Zusammenflunging diskontituetterlen Einerplangen und nachsche wir Wehngebalden, dierschlene Einerplangen und müsche Smart Grids, also Intelligente Strometze, werden in Zukurft elektriche Einergie aus Wei- und Wasserkraft, aus Protovoltatiund Biogesamigen auf die Grundlage stelligenere Regelungealgorithmen zusammenfihmen und damit die takak Einergieanzeigung enger an die Bedürfnisse von lokaten Verbrauchem ankoppetie.

We bei IPLON entwickein bereits heute die Lösungen für die Herausforderungen von morgen.

Smart solutions will become more and more important in the neur/Mare, AI IFLON we accept the dare to bong together both, discontinuous energy production from renewable sources and dynamic energy consultation by homes, public administration and the industry sector.

We think that the grid of the future should be smart and should continie energy tiom whole, and hydropolier, from solar power systems, and thom blogas plants by using intelligent control systems. By doing so, local energy production and local energy consumption can go hand in hand.

We at IPLON develop loday the solutions for the challenges of tomorrow.







www.iplon.de www.iplon.in www.re2tn.org www.youtube.com/user/iPLONChannel





# Best Practices Smart City



### Mr. Carlos Valencia, Senior Plant Managment, iPLON Date : 30<sup>th</sup> May 2016

KFW DEG



# Best Practice Renewable Energy





•





Schwäbisch**Hall** 

#### **SMART CITY DEFINITION (EU)**

ENVIRONMENT	Reduction of CO2 emissions; Use of renewable energy sources, monitoring on energy consumptions
LIVING	Co-working, Cultural initiatives, Living-Lab, crowdsourcing co-design
MOBILITY	Development of technologies to improve urban mobility, low envoronmental impact
GOVERNANCE	Starting of processes for the involvment of citizens about topics of public rilevance
ECONOMY	Cooperation among public and private actors, developmento of social incubators and of small and medium enterprises
People	Sharing of data, security and protection of sources, networking and comunication





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#### http://smartcities.gov.in/

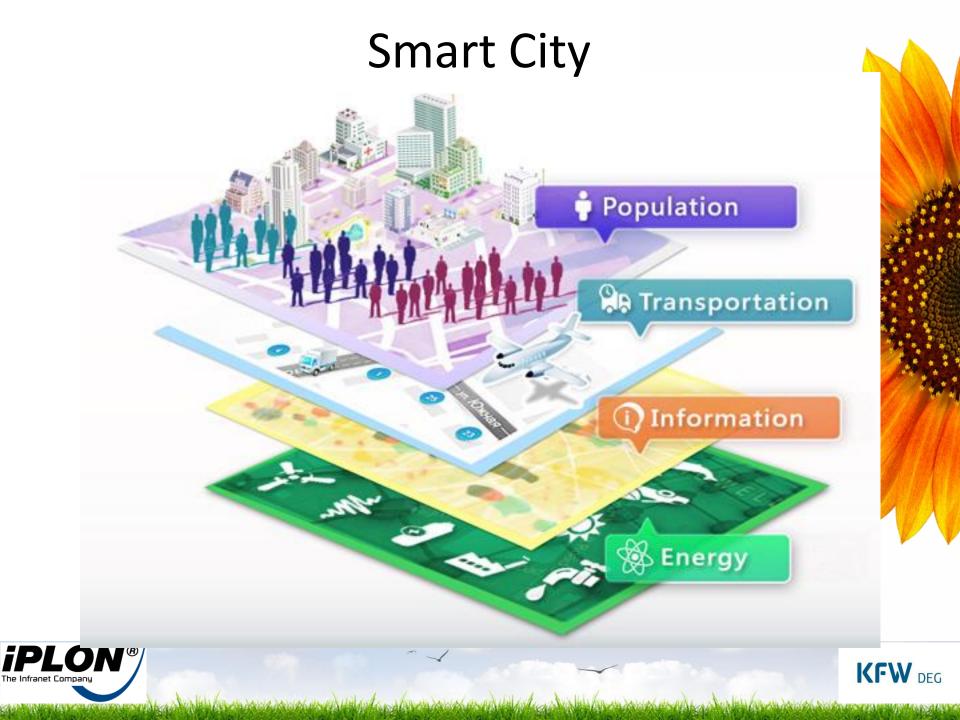


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## Schwäbisch**Hall**













😽 Schwäbisch**Hall** 







The Infranet Company



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#### mart Grid Multi utility control room at Stadtwerke Schwäbisch Hall



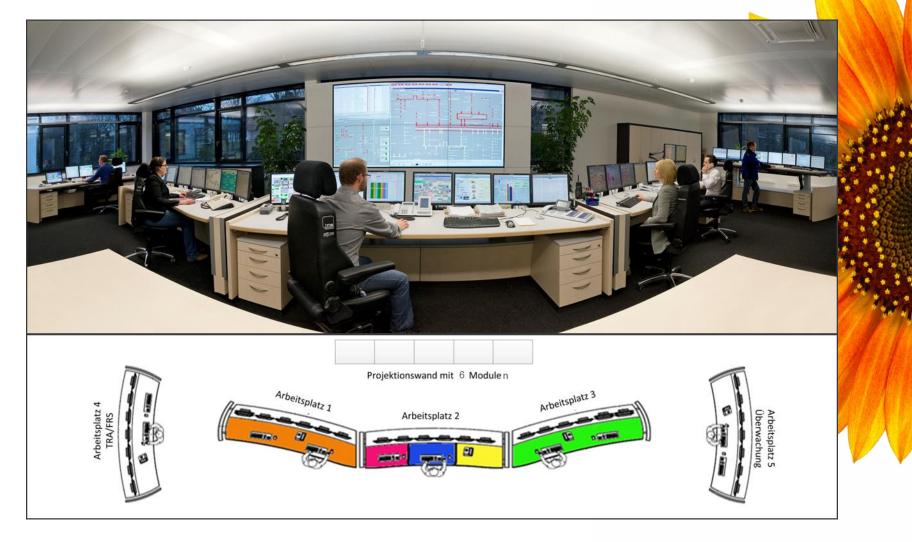






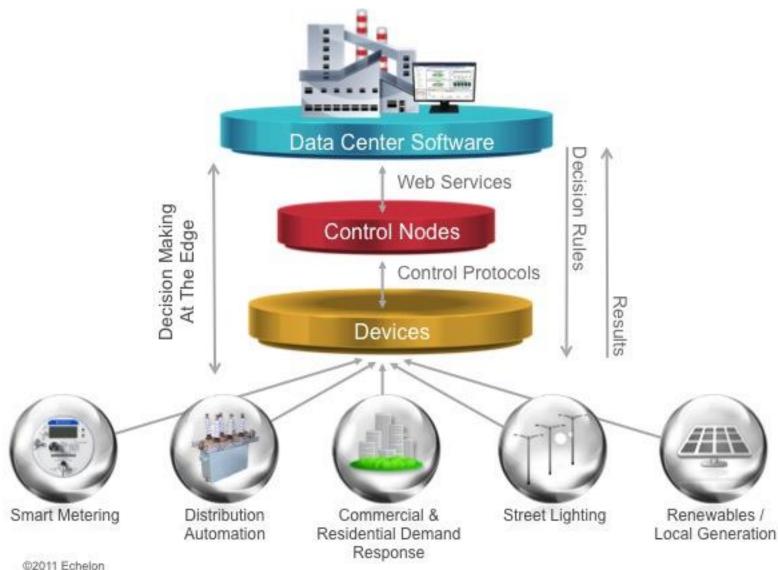
#### **Smart Grid**

#### Multi utility control room at Stadtwerke Schwäbisch Hall





# Smart Grid Energy Control Network



The li

64 A.

#### Smart meter



#### Mechanic Meter

- Manual metering
- Progressive rates

*iPLON®* 

The Infranet Company

#### **Electronic Meter**

E-43

09331091

104 10 0 10 0 11

- Manual metering
- TOU
- Firmware upgrading

#### Smart Meter

CTATUNE ETA-315 Smart Ma

63630269

- Remote recording
- Dynamic electricity price

TATUNES 170

- Real-time info.
- Remote controlling
- Quality monitoring
- Event feedback
- Remote firmware upgrading

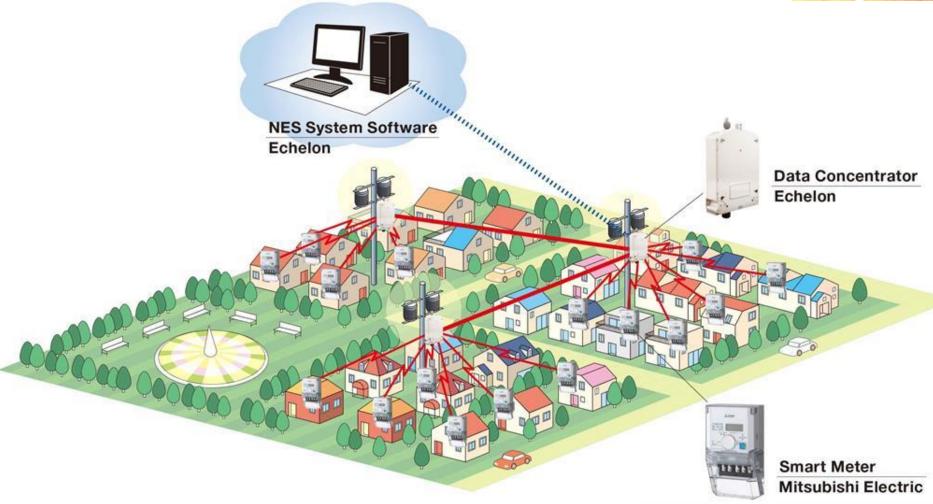
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#### **Smart meter**



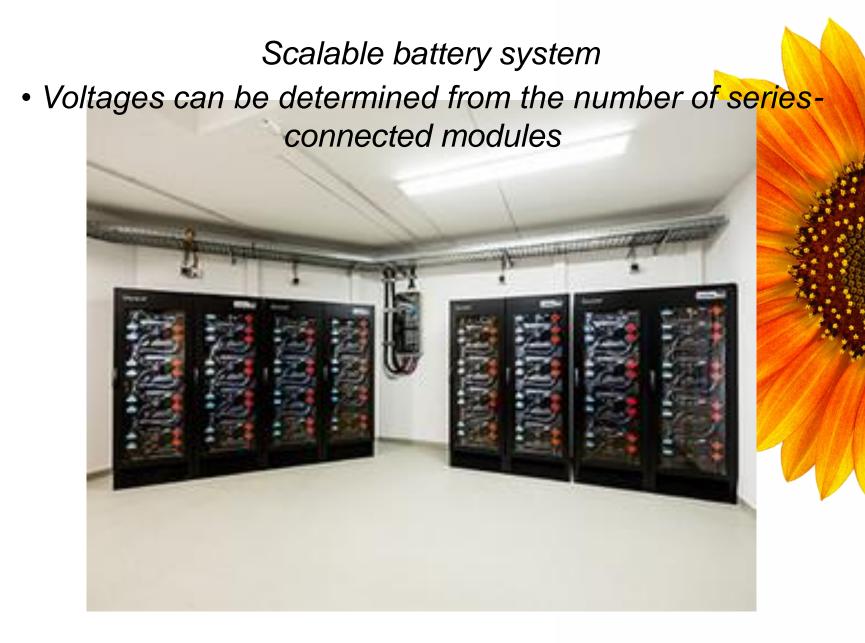




## Storage (Li Ion Battery : 2\*1 MW)

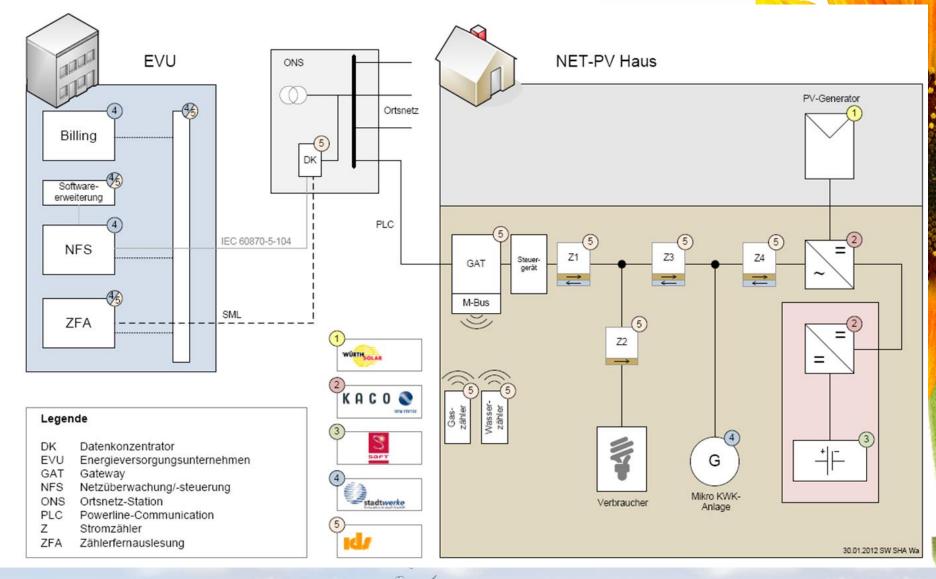
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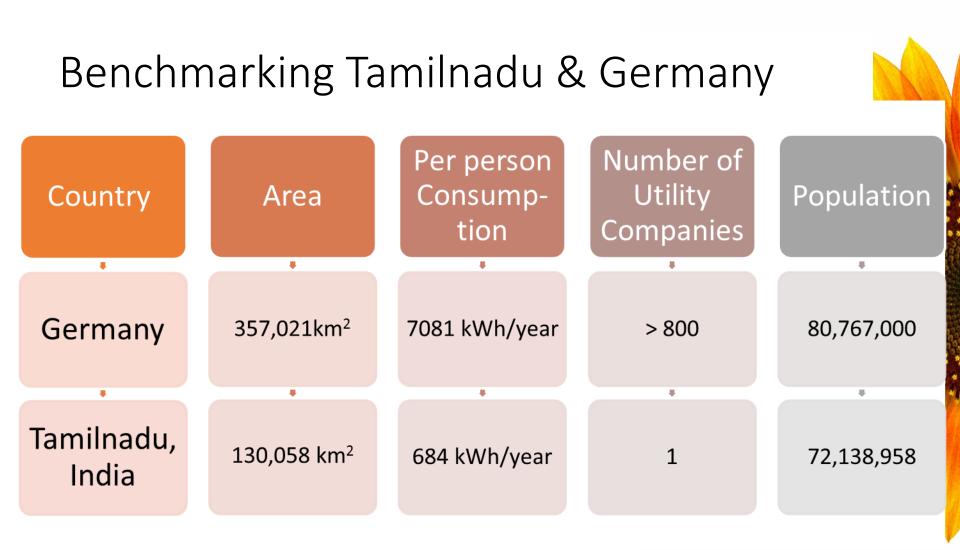
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## NET-PV (Captive and storage)



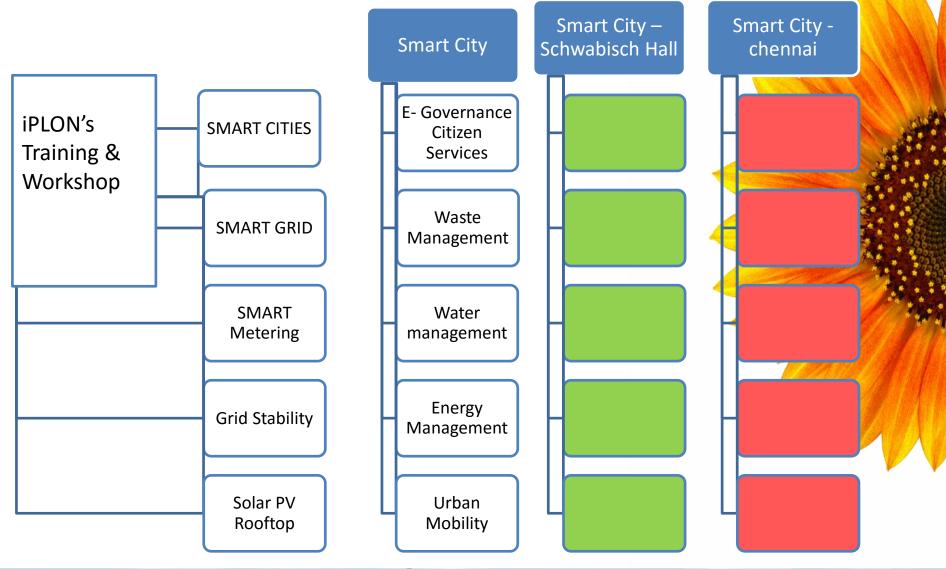
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# **Overview of Smart Cities**



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KFW DEG



### Thank you



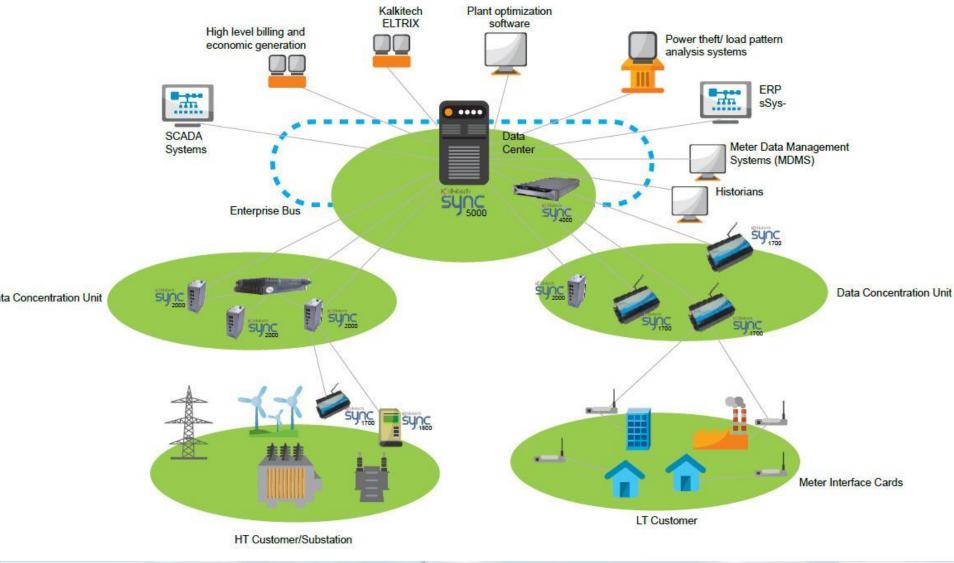
















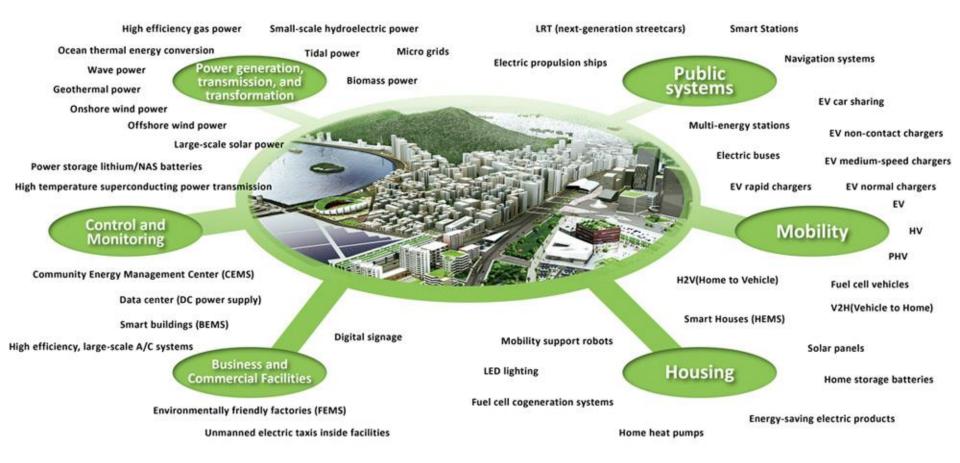






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#### **SMART CITY DEFINITION (EU)**

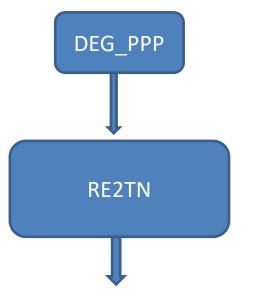
ENVIRONMENT	Reduction of CO2 emissions; Use of renewable energy sources, monitoring on energy consumptions
LIVING	Co-working, Cultural initiatives, Living-Lab, crowdsourcing co-design
Mobility	Development of technologies to improve urban mobility, low envoronmental impact
GOVERNANCE	Starting of processes for the involvment of citizens about topics of public rilevance
ECONOMY	Cooperation among public and private actors, developmento of social incubators and of small and medium enterprises
People	Sharing of data, security and protection of sources, networking and comunication





×.

#### Roadmap



DemonstratorsTraining in RENetwork building

Rural Decentral RE Generation
Smart grids ; smart Chennai
Multi utility company
Investments in TN

Post carbon society

#### "post Carbon Nadu"

# Need your support

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