COSC7502
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Visualising Daily Solar Supply

Project Proposal

Define Topic

Solar PV systems are increasing in their power supply capacity. The amount of solar power supply is changing and depends on factors such as the season, the weather and changes to solar installations. We aim to capture the current state of solar supply and present the information as a 3D visualisation.

This visualisation should be accurate to the current state of daily supply, and also be presented so that the information is readily usable in a solar project.

Data sources are available from the Australian PV Insitute [], which separates daily solar supply by postcode. This leads us to other geographical sources such as maps. Freely available data sources can be used to fill in further details.

Mapping and 3D visualisation can be used together to create virtual city models. Solar power is one aspect of a city and is connected with the weather and time of day, which in turn affects local power grids[3]. The aspects which could go into a visualisation are only limited by the scope of potential solar projects. Solar power visualisation is an important part of simulating a virtual city model[5].

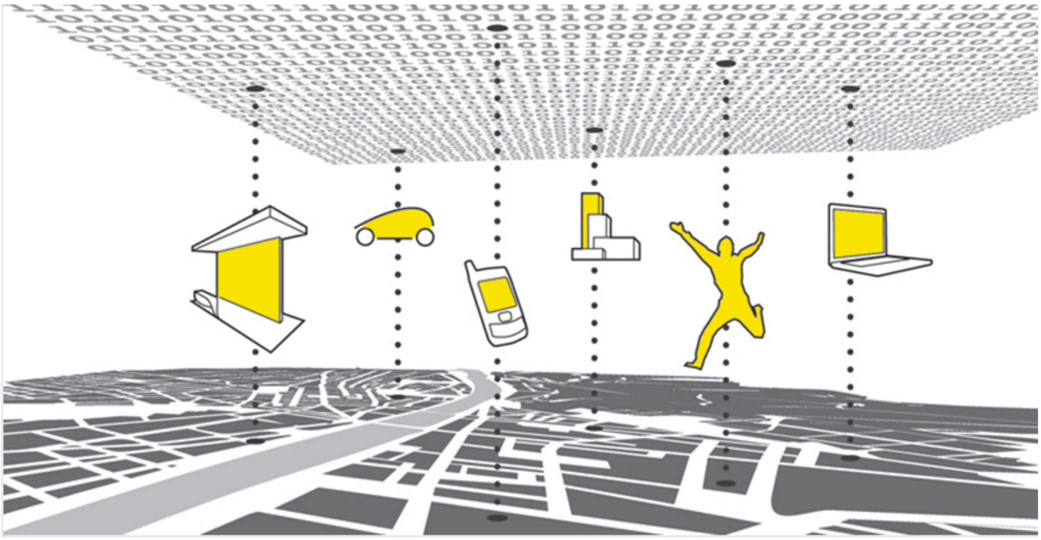

Figure 1: Schematic visualisation of a connected smart city, with integrated data networks and citizen engagement with digital tools. Source: MIT SENSEable City Lab senseable.mit.edu

Review of Background Material

Smart Cities

The concept of Smart Cities combines automation and citizen engagement with connected urban networks, for example traffic or in this case power.

A visualisation of daily solar supply will fit into a smart city virtual environment, and contribute by providing live feedback on supply as it happens. As more connected solar power supply data becomes available to the network, the more the data of the visualisation will be accurate to the real state of the world. This will increase general energy literacy by providing current information in a way that is accurate and easy to use and digest [7].

Review

Power supply from solar sources is increasing faster than before, and in 2018 showed more growth in capacity than in previous years. Solar supply depends on factors such as the weather and time of day, as well as changing factors such as new installations. Tracking the daily solar supply requires a number of data sources to be connected. The data will be meaningful and easy to navigate because daily solar supply visualisation will combine data sources with a simple visual interface.

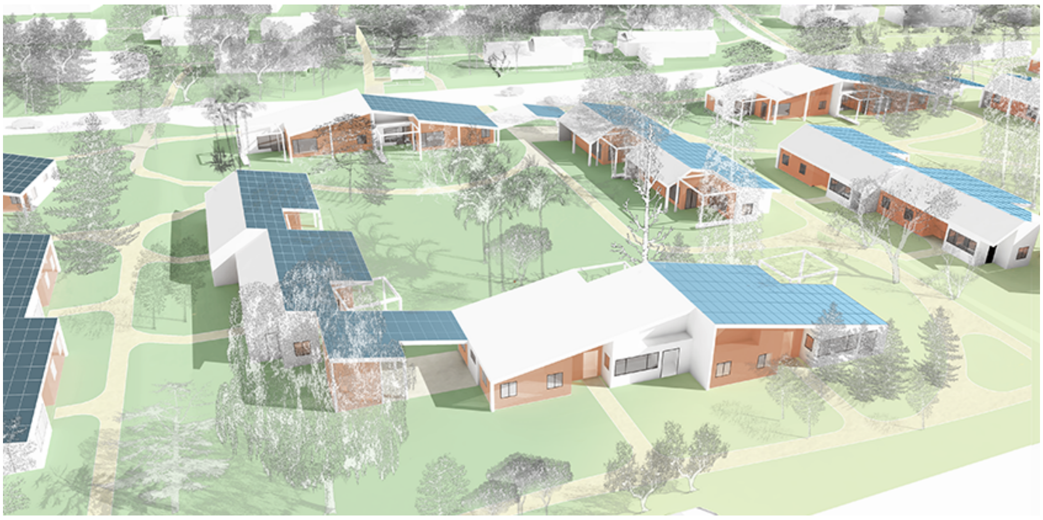

Figure 2: Small solar supply unit and connected solar supply scenario, in a visualisation of how solar supply might be installed. Source: Arpa Journal arpajournal.net

We have a lot of data that indicates the solar power supply, how much per day and in what region geographically. This will become a 3d visualisation that allows you to explore that data in real time. We can also include relevant data and models on the uptake[4], local policy[1] and the impact of the season and the weather[2][6].

The primary data source is http://pv-map.apvi.org.au/ which has data sets on solar supply and capacity. The data sets are divided by postcode area and are available as monthly increments.

Other data sources will provide relevant input, either maps or statistics. Each layer that is required to be visulaised should be able to be controlled. This could include different weather sources, current solar intensity or average solar intensity, or anticipated solar output from registered sources.

Data might also include cloud formation and a simulation of cloud cover and solar supply.

Geographic locations of power plants and large solar PV systems could be added to a map layer.

The layer could also import 3D geometry representing cloud layers, urban layers for buildings from shapefile or simulated sources, imagery or heat maps for supplied data sources.

This project will create a visualisation of daily solar supply. The aim is to build a 3d visualisation that shows for each area how much solar power is contributed. There are several data sources that we can use to present different

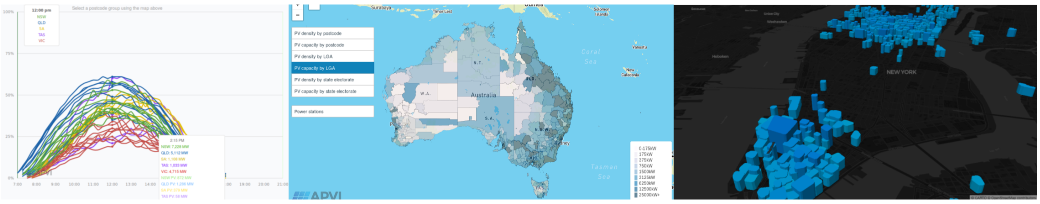

Figure 3: Visualisation example, showing time-series data, geographic data and a representative city model in 3D. Images from APVI (left), APVI (center) and www.sphinfo.com/carto-vector/ (right).

aspects of this information and bring them together into one visualisation.

The 3D visualisation should capture the data as a map, and be able to show geographic locations. You should be able to search and browse to navigate in the visualisation and be able to access the regional data for each place.

The visualisation should aim to include any specific piece of data with broad impact, solving the communication challenges of data, how the utility of solar supply intersects with energy literacy.

The range and scope of solar projects is broad, and covers geographic information systems, power grids and local policies.

There are existing 3D tools for creating procedural cities. Esri CityEngine is able to create 3D cities based on existing data and generation rules. DataCollider is an online tool for presenting visualisations of city data.

Weather data can come from various sources. Real time weather updates and forecasts can be found online with OpenWeather, NOAA, and the Bureau of Meterology. There is also the S2S4E Decision Support Tool (DST) which has climate data and specifically solar radiation.

Data Sources

The available data sources show what can be accessed and the method of access as well as how current the data is (historic, real-time, or forecasted).

Beaureau of Meteorology (bom.gov.au) Contains resources for climate data specific to solar intensity and radiation output. Data for daily supply in the form of a map grid. Also has data on yearly average solar supply.

National Center for Environmental Information (www.ncdc.noaa.gov) runs a Climate Forecast Model (CFM) and provides real-time and forecasted

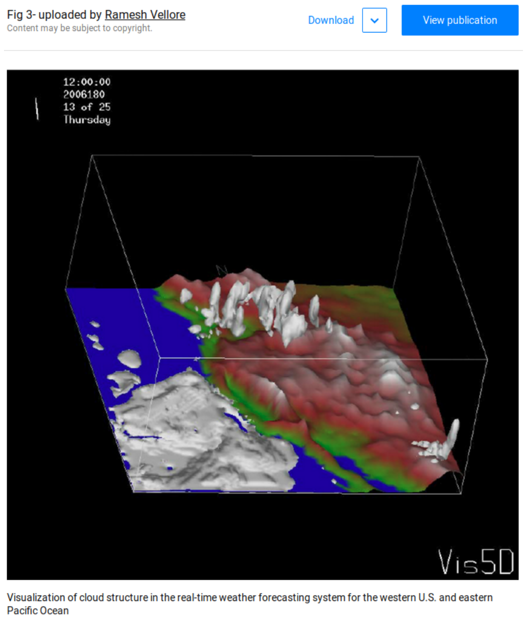

Figure 4: Existing cloud visualisation. Source: Ramesh Valore

gridded data sets through various access means including an API.

Open Weather Map (openweathermap.org) have a model for general weather information that can be accessed through an API.

SolCast (solcast.com) provide a paid service to access an API for solar intensity data.

SolarGIS (solargis.com) is a paid service for a two-way monitoring system that tracks solar power output, and feeds back into a forecast model.

OmniScale (maps.omniscale.com) provide free limited access to high quality map tiles suitible for use in mapping. Based on OpenStreetMap.

Visualisation Technologies

Visualisation should be made generally available and work on most computer platforms. It is possible to target desktop and mobile applications as well as web. Using html5 canvas element and WebGL can be a portable way to run visualisation apps in other environments.

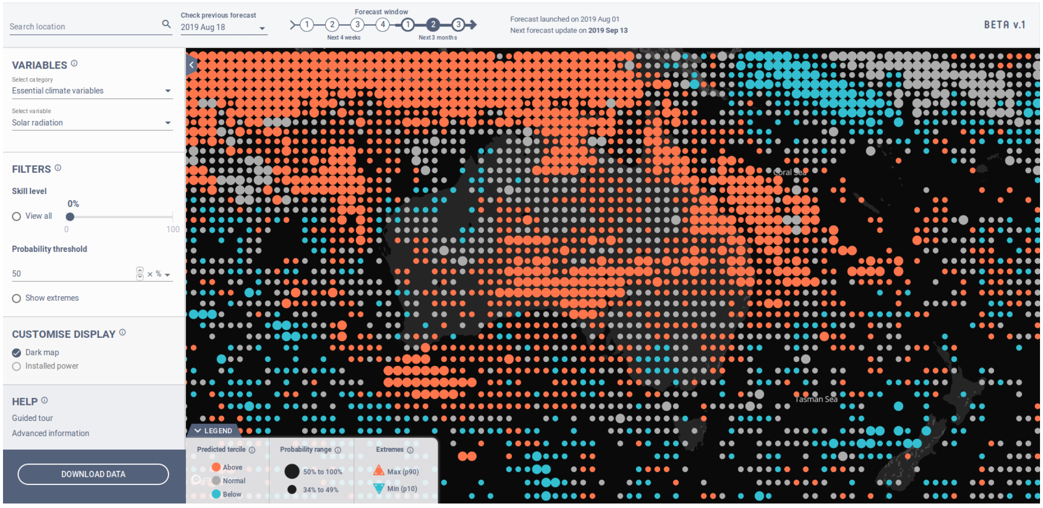

Figure 5: Existing tool for solar intensity. Source: bsc.es

Previous 3D visualisations have used custom rendering platforms to make some display of clouds and weather in 3D. Existing tools that focus on solar intensity are visualised with maps in 2D with weather data being overlayed on top.

Future visualisation work could combine these two elements into one visualisation. Taking the accessibility of maps and using 3D rendering to augment with additional data layers to create a virtual environment. Weather and geographic data can be shown together in the same visualisation.

Project Plan

The project will be completed as a software project, with the aim of being made as widely available as possible while also being compatible with as much of available data as possible. The product should be easy to use for anyone, and provide enough utility to use the data in a solar project.

Review of the background material shows that other projects make use of the solar intensity, which can be obtained from weather forecast models. Combined with the number of small, medium and large solar PV systems in each area, the daily solar supply can be calculated.

The project aims at combining a range of relevant data sets into a single visualisation and determine its effectiveness at displaying daily solar supply. Various abstract representations can be included such as city buildings and weather effects such as cloud cover, which can be generated by procedural methods based on the daily data.

There will be software procedures to convert each type of data layer to be displayed in the visualisation. Free online sources can be used to access daily data, and accessed though web APIs. The data can then be converted into an image or 3D geometry and displayed as required.

Where an API is not available, some kind of intermediate method will be developed to provide the data to the visualisation.

The visualisation itself can be created in OpenGL and compiled with c++ code. This method will give good access to manipulate the underlying data and remain portable to different platforms.

This method should result in a visualisation that is rich in the depth of data contained, but simple and intuitive to use. The presentation should be clear and fast. From within the visualisation you should be able to explore the available data in each area. The data should be visualised in a meaningful and useful format.

Proposal

The project output will result in a 3D visualisation program that can be accessed from any computer or online. In the visualisation you can search and navigate to different areas in Australia and view information on the daily solar supply. The visualisation will be provided with supporting documentation including a conference paper and poster, as well as a project report.

The visualiation will help to fill the gap of data availability. Relevant and current information will be provided to maximise energy literacy and planning capacity.

The project plan follows an iterative development model, processing the data and combining it into a visualisation, and then adding navigation features. In the next iteration, additional data, visualisation or navigation features can be added as required. There is a feedback stage in between development so that users who have interacted with the program can report issues with the design. Feedback will be taken into consideration during the next iteration phase.

Towards the end of the project there is an advanced features phase. This might cover some special data forecasts or visualisation tequniques that are not essential to the main project but would make useful additions. Advanced features would assume that the project is already enabled with critical features and runs fast and stable, providing a platform for more complicated layers and additions. Potential additions include an improved forecast model and realistic cloud cover rendering.

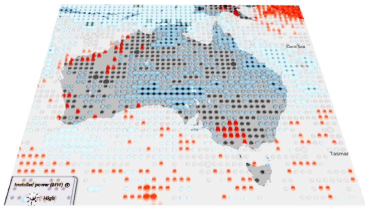

Figure 6: Perspective mockup - composite example of regional data display in a 3D visualisation. This example shows intensity data over a wide area.

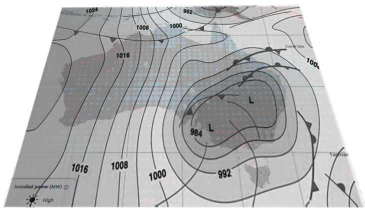

Figure 7: Isobar mockup - composite example of data display in an additional visualisation layer. This shows data in area contours instead of at points.

Timeline

The project timeline predicts the breakdown of tasks and completion milestones. A minumum viable product with some critical features is expected to be completed by November.

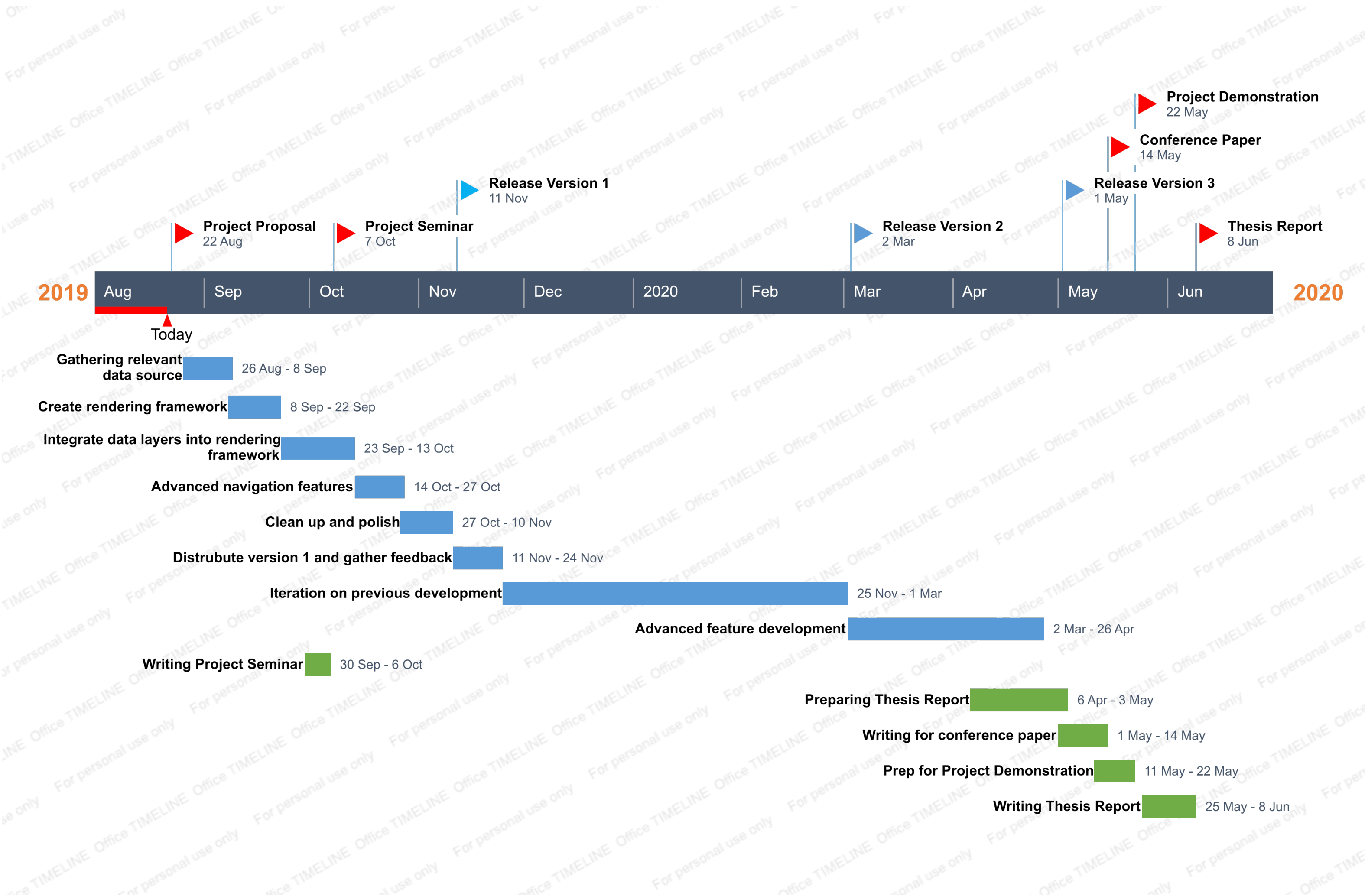

Figure 8: Project timeline

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