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Research & Ideation

Transparent Charging Square Pilot — Meeting #1

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Today

10:00 Welcome

10:15 Flexpower specification

10:30 User research

10:55 Break

11:00 Ideas

11:30 Discussion

12:00 Next steps & collaborations

12:30 Lunch 🥪🥬

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Goals for today

1. Decide on a concept direction
2. Align expectations of user experience
3. Align understanding of Flexpower 2 algorithm
4. Strategy to engage Amsterdam Engineering Department, Vattenfall

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Updates

- We have researched, discussed, ideated, called, emailed, composed…
- We have a press release 🎉

- TCS presented at We Make The City
- TCS permanently moved to Amsterdam Smart City office
- TCS featured in upcoming ClickNL publication

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Flexpower specification

User research

Ideas

Discussion

Next Steps & Collaborations

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Summary

- There is no specification yet. (right?)
- Impact of ‘fellow charger’ can be so profound that it cancels out ‘smartness’
- ‘Smartness’ has little effect on single phase, 16A cars.

- These effects impact the user experience, and therefore the design.

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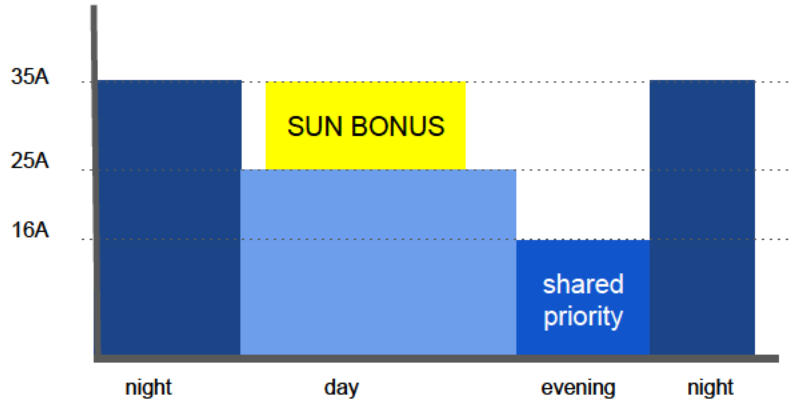
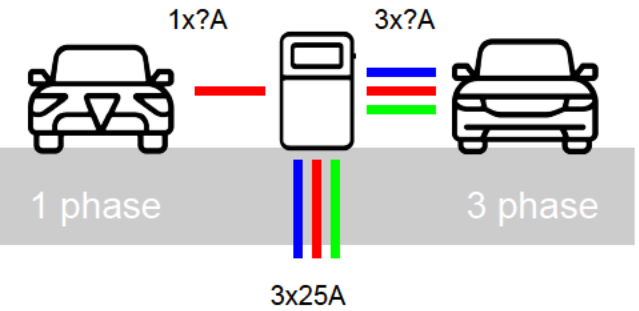
Assumptions

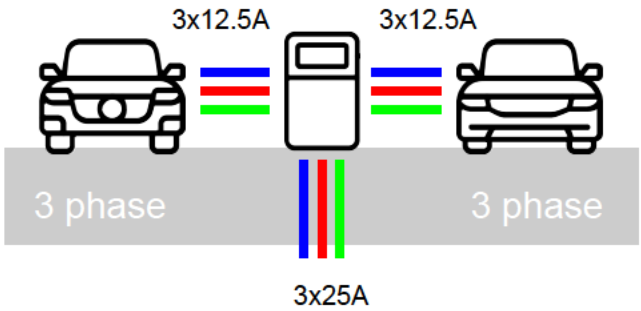
1. Flexpower has 3 levels: 16, 25, 35A
2. Shared cars can only be prioritised at peak hour
3. Sun Bonus…
   a. … only occurs between 9:00 - 18:00
   b. … is predetermined each day.
   c. … can only be 10A.
4. Power distribution
   a. Cars cannot charge below 6A, so dynamic switching is necessary
   b. Some cars can charge a maximum of 32A and others a maximum of 16A.
   c. Every charging station gets the same power, which the station divides between max. 2 cars.
   d. We can exclude 2-phase charging.

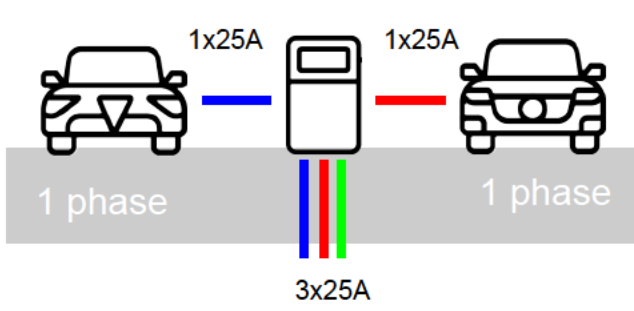


Standard charging stations

Each charging station has 3 phases and usually 2 charge points per station. Standard charging stations can deliver 25A per fase. Most cars can either charge using 1 phase or 3 phases. Two single-phase cars can use one phase each and could theoretically charge at 25A, although most cars charge at a max of 16A. Two 3-phase cars will split the power per phase and will each charge at 12,5A per phase.

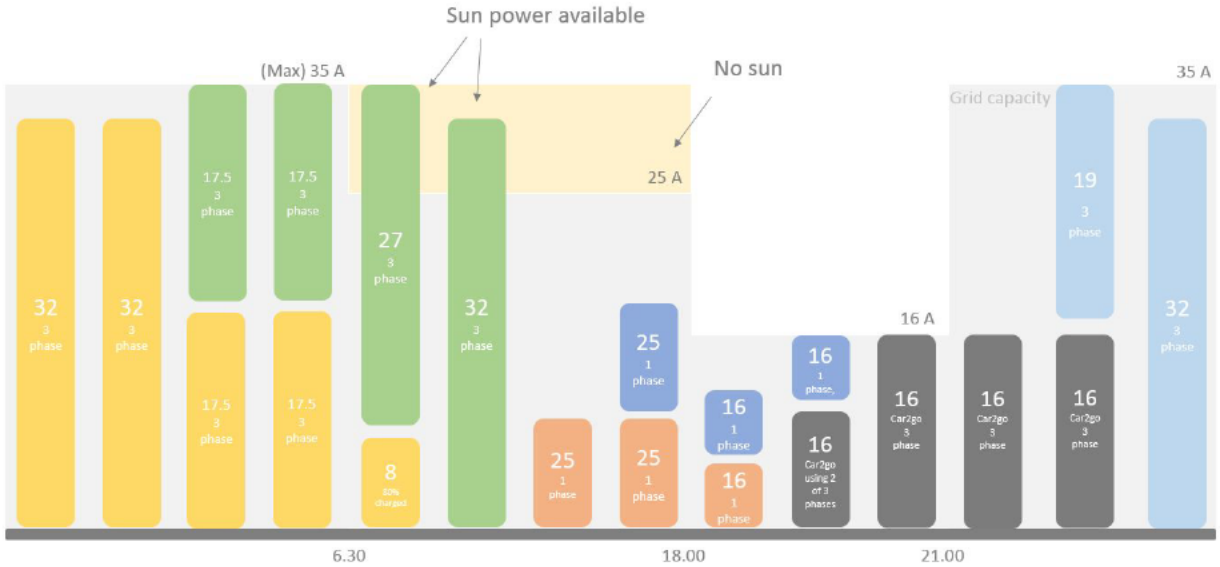






Car variables

Cars differ in the number of phases they use to charge and the maximum at which they can charge. They will have different battery capacities and mileage rations. Some cars will also charge the remaining 20% at a lower rate. This creates many variables that influence the rate at with your car can charge and how to evaluate a fair distribution.



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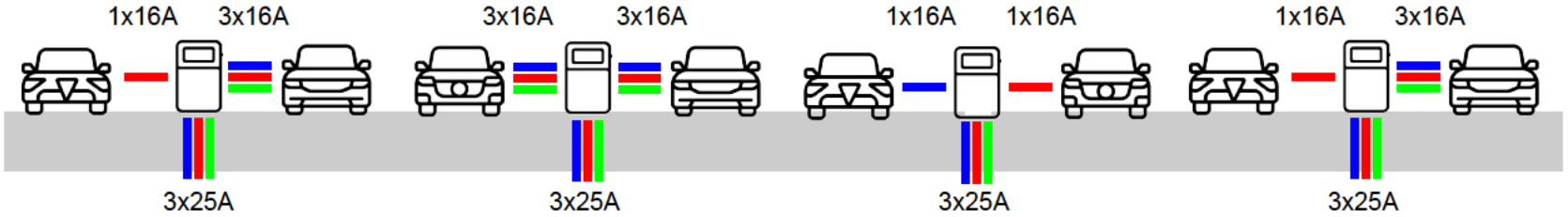
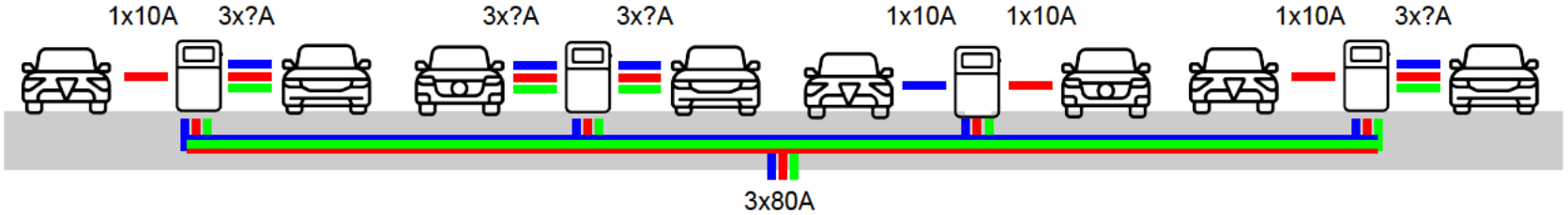
Raamplein

The 4 charging stations on Raamplein currently have a connection each, meaning they can independently provide up to 3x35A. It is therefore not a true charging square (laadplein) where a single connection could deliver up to 3x80A. With such a setup all cars would notice a reduced output if more cars would charge.

Current situation at Raamplein



A charging square

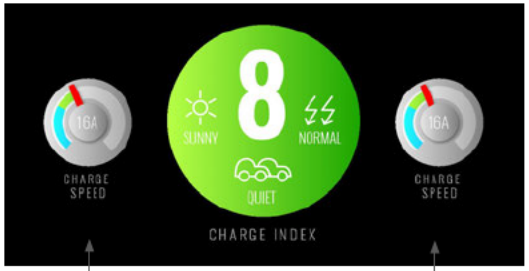


Different frictions

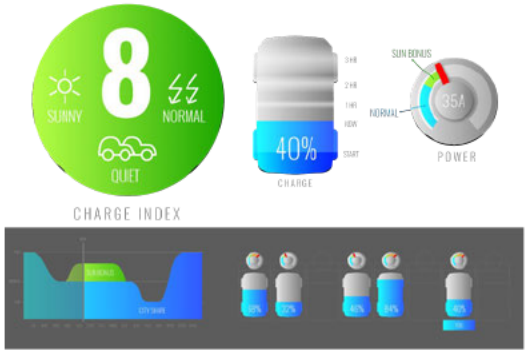
The frictions that seem to most prevalent are the amount and type of cars that are charging and the low supply during peak hours. In the current situation this only holds between the two cars that are both using a charging station, not between all 8 cars that can charge there.

The design solutions might use similar solutions, but might differ quite a bit. To proceed with the design process it would be good to answer this question.

QUESTION:
Do we design the pilot around the current setup and focus on frictions per station or do we design for a charging square?



Compare 2 cars



Compare 8 cars

Distribution rules

Car share advantage	**200%**	Percentage car shares get compared to normal cars
Phase distribution model	**Assign Phase**	Distribution model between single phase and 3-phase cars. Split phase: equally divide single phase between cars. Assign phase: fully assign one phase to single phase car and assign remaining 2 phases to 3 phase car. Custom: another model presented by Elaad

When single phase cars share, there is only impact from lower power levels

3 phase car shares can have a large impact because they can command a lot of power

Friction Matrix

		Normal cars				Car sharing				Normal cars				Car sharing			
		1x16A		1x32A		1x16A		1x32A		3x16A		3x32A		3x16A		3x32A	
		Ah	%max	Ah	%max	Ah	%max	Ah	%max	Ah	%max	Ah	%max	Ah	%max	Ah	%max
1x16A	35	16	100%	16	100%	16	100%	16	100%	16	100%	16	100%	16	100%	11,7	73%
1	25	16	100%	16	100%	16	100%	16	100%	16	100%	16	100%	8,3	52%	8,3	52%
16	16	16	100%	16	100%	16	100%	16	100%	16	100%	16	100%	5,3	33%	5,3	33%
1x32A	35	32	100%	32	100%	32	100%	32	100%	32	100%	32	100%	19	59%	11,7	36%
1	25	25	78%	25	78%	25	78%	25	78%	25	78%	25	78%	8,3	26%	8,3	26%
32	16	16	50%	16	50%	16	50%	16	50%	16	50%	16	50%	5,3	17%	5,3	17%
3x16A	35	32	67%	32	67%	37,3	78%	32	67%	48	100%	48	100%	48	100%	35	73%
3	25	32	67%	32	67%	32	67%	32	67%	37,5	78%	37,5	78%	25	52%	25,0	52%
16	16	32	67%	32	67%	32	67%	32	67%	24	50%	24	50%	16	33%	16,0	33%
3x32A	35	64	67%	64	67%	64	67%	64	67%	57	59%	52,5	55%	57	59%	35	36%
3	25	50	52%	50	52%	50	52%	50	52%	37,5	39%	37,5	39%	37,5	39%	8,3	9%
32	16	32	33%	32	33%	32	33%	32	33%	24	25%	24	25%	24	25%	5,3	6%

When 3 phase cars share the power levels impact charge rates. The impact is higher because they can charge more

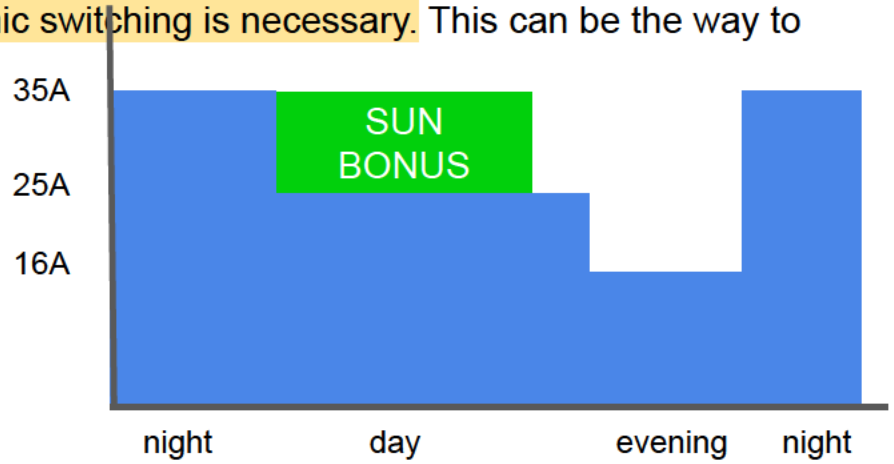
Flexpower 2

Flexpower 2 has **3 distinct power levels**:

- **16A** in the evening during peak demand
- **25A** during the day,
- **35A**
  - at night
  - during the day if the sun is shining (this bonus is predetermined before the day)

Next to that it will be possible to **prioritise car sharing** vehicles (most of the time single phase cars) during the peak hours.

Cars cannot be charged below 6A, so dynamic switching is necessary. This can be the way to prioritise car sharing vehicles.



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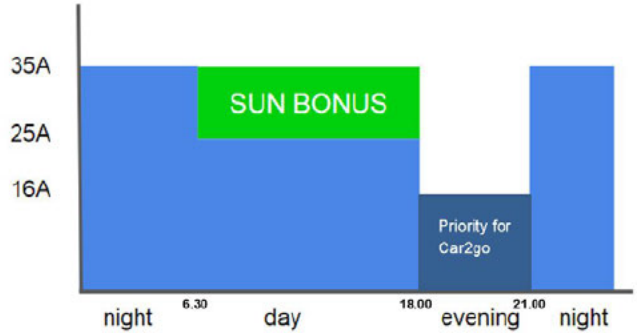
Assumptions

Extra energy from the sun can only occur between 6.30 and 18.00. When this extra energy is present, the power will go up to 35 A, so the energy available between 6.30 and 18.00 is either 25A or 35A (nothing in between).

The amount of energy from the sun that will be available is decided beforehand based on the weather forecast.

From 18.00 till 21.00 is the only time Car2go cars get priority while charging. The power available will always be 35A, 25A or 16A. (3-phase)

We assume that during low power periods the power is not divided per car, but the charge time is, where every car will be charged with full power, half of the time. We also assume that Car2go will get more time than normal cars, for example, a normal car will charge full power for 20 min in an hour and the car2go will charge for 40 minutes.



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Some cars can charge a maximum of 32A and others a maximum of 16A.
Every charging station has the same power, which the station divides between a maximum of two cars.

We can exclude 2-phase charging.

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Influence of other cars on your charging speed

	Sharing with 1 phase 16A	Sharing with 1 phase 32A	Sharing with 3 phase 16A	Sharing with 3 phase 32A
Charging speed of 1 phase 16A	Maximum possible speed	Maximum possible speed	35A max 23A max or lower 16A max or half	35A max 23A max or lower 16A max or half
Charging speed of 1 phase 32A	Maximum possible speed	Maximum possible speed	35A max or half 23A max or half 16A max or half	35A max or just above half 23A max or half 16A max or half
Charging speed of 3 phase 16A	35A max 23A max or lower 16A max or half	35A max or lower 23A lower 16A lower	35A max 23A lower 16A half	35A max 23A lower 16A half
Charging speed of 3 phase 32A	Lower than maximum speed	Lower than maximum speed	35A just above half 23A half 16A half	Half of maximum possible speed

The charging speed is rated in comparison to what the car would charge in this situation, when it did not have to share.

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Questions about power distribution

- Do 1-phase cars always charge with a maximum of 32A or can this also be 16A?
- Do 3-phase cars always charge with a maximum of 32A or can this also be 16A?
- How is power divided between a 1-phase and 3-phase car?
- How is the power divided when one car is at 80%?
- What kind of connection do shared cars have? (expectation, 16A with 3-phase)
- How do Car2go cars get priority? (When sharing with 3-phase and 1-phase car)
- What happens when the power from the sun is not as expected? Can it be adjusted later during the day or is other energy used to compensate?


Discussion
Algorithmic friction

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Discussion
Algorithmic friction

- 3 phase car sharing vehicles can severely impact your charge rate
- Single phase car sharing vehicles have a relatively small impact.
- Cars with higher charging capacity (phases and amps) tend to ‘suffer’ more
    - They cannot charge as much they could and will experience it as slow
- What is fair? Should we find a more neutral metric like mileage?

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Flexpower specification

User research

Ideas

Discussion

Next Steps & Collaborations

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Research

1. When, why, and how can we engage EV-drivers with the Flexpower algorithm?
2. How should we intervene in the public space and place the monitor?

Outcome Scenario for projected experience

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Research

- Site visit + interview
- 5 in-depth interviews with EV-drivers (read here)
- Paper prototype

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Insights EV-Drivers

1. There is **limited attention** in the charging process
2. Drivers need information about their ‘treatment’ **before** charging, not after.
3. Smart charging is acceptable as long as it does not drastically **limit mobility.**

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#1 — Limited attention

- **Low interest** The initial interest in understanding the algorithms seems low
- **Limited attention** Drivers indicate that they do not pay attention to any information outside of:
  - the lights on the charging station
  - the dashboard of the car
  - the car app
- **Cognitive overload** Drivers' stories of charging in a public space seem to suggest that there is quite a cognitive load and perceived stress that might make it difficult to turn their attention to something else

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#1 — Limited attention

"I doubt if knowing the algorithm makes sense, there's probably nothing that can be done about it"
- Rob (40), Outlander hybrid

"I get so much information every day, I assume it will be fine"
- Karen (48), e-Golf

"I only pay attention to the info when something went wrong"
- Karen (48), e-Golf

"I have a love-hate relationship with charging. (...) It happens that I stand there like an ass (klojo)"
- Rob (40), Outlander hybrid

"As long as it is charged, I don't need to know more"
- Dirk-Jan (36), Tesla Model S

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#2 — Information before charging is key

- Drivers express a need to be informed before they start charging of their ‘treatment’.
- Drivers want to know how much they can charge in what period of time
- This means that the station will have to do a ‘prediction’ of some kind. It will have to give an impression to the driver of what he or she can expect in the coming hours.

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#2 — Information before charging is key

"If you don't know beforehand, I think that's punishment according to criteria you knew nothing about. Dat would give me a feeling of unfairness, because I did not get to make a choice. That's not really transparent to me."
- Rob (40), Outlander hybrid

"I would like to know beforehand, yes. (...) Getting the information afterwards does not seem useful to me"
- Karen (48), e-golf

"I want to know what I can expect. Not really why but how much I can charge. To know for the next time."
- Janneke (19), e-golf

"Yeah of course, i'd like to know up front so I can then maybe skip that station and look for another one"
- Dirk-Jan (36), Tesla Model S

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#3 — Acceptability of smart charging

- Drivers express that smart charging is fine, as long as it does not limit their own mobility
- Not knowing what to expect hurts the trust in charging station
- Not knowing how much you can charge evokes a lot of negative emotions in drivers

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#3 — Acceptability of smart charging

"As long as I get to where I need to go without too much trouble all is fine by me"
- Karen (48) e-golf

"I can understand prioritization, as long as it doesn't become some kind of class-system"
- Roelof (45) Tesla Model S

"If I do not charge enough that would be total sh*t. I could really make a fuss about that"
- Rob (40), Outlander hybrid

"You mean if other people charge before me? If there is no good reason then that really is injustice."
- Dirk-Jan (36), Tesla Model S

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Insights Raamplein

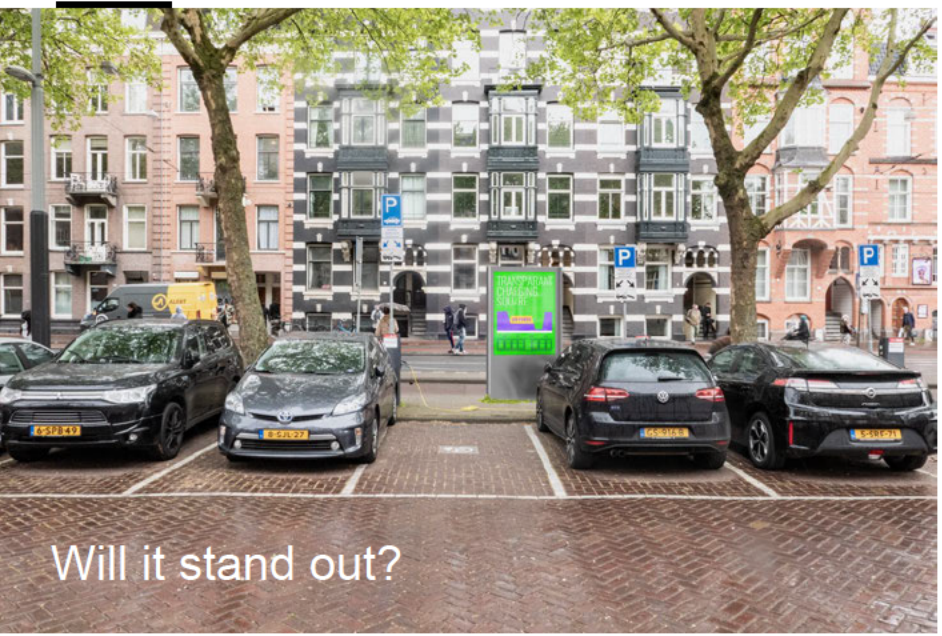
- The space does **not** lend itself to the **placement of a single screen** to explain the design
- The space is not a true charging **square**; a screen per station is probably more fitting

Placement of a single screen

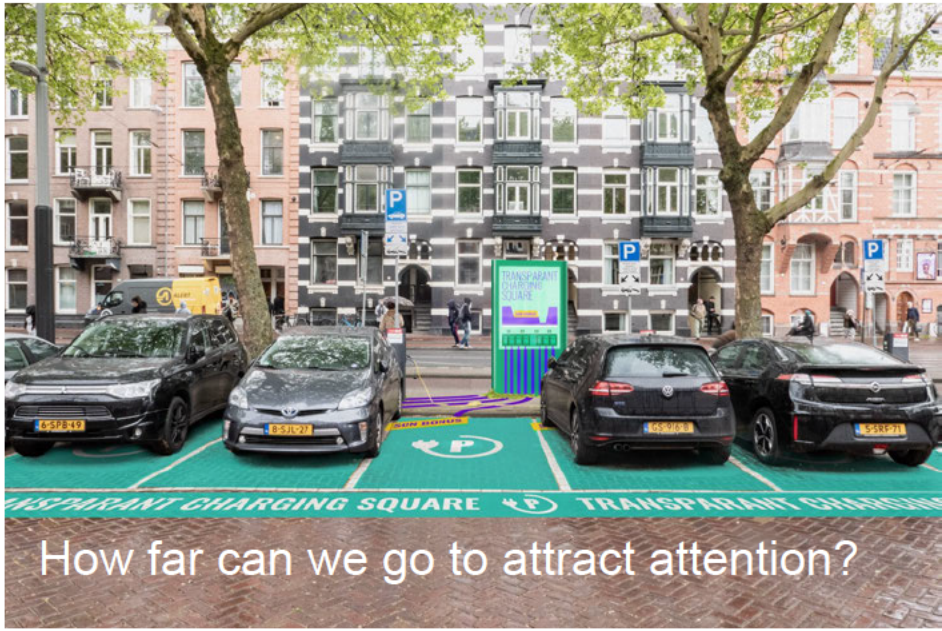
The space does not naturally guide users next to the charging station to a centrally placed screen between the charging stations:

- The viewing angle from the different charging stations makes it difficult to look straight at the screen (more likely to see the sides)
- Trees and traffic signs block or compete for attention in the field of view
- The distance to the screen from the outer charging points is around the width of 3 parking spots, which might require the screen to be quite large in order to be identified

Again, other interventions might be needed to guide users to the screen.



Impression JCDecaux style screen



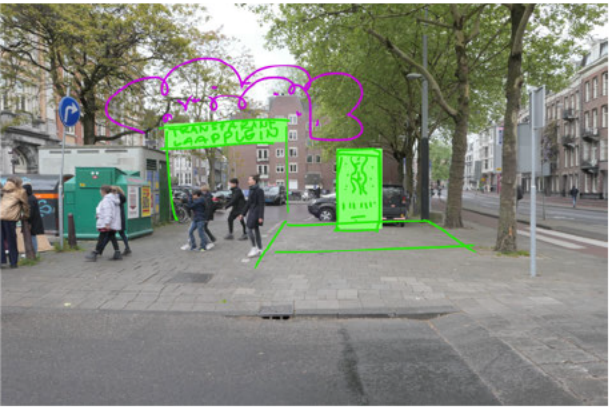
Impression color interventions to guide attention

- A standard screen might not stand out in the environment since it is already quite feature-rich: charging stations, street signs, trees, traffic, decorative architecture all compete for visual attention
- An intervention to attract attention might have to be quite ‘loud’ to capture the attention of the user. This might not fit the public space and is not very scalable

A screen per charging station

We suggest to not proceed with a single screen as a main direction, but to investigate a screen for each charging station

- A single screen can still be used for explaining the story to the public
- The challenge is still to fit the action of reading the screen into the many steps in the charging flow
- We need to be extra aware of the practical possibilities with regards to sourcing etc



Main screen for the public at the entrance?

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Storyboards

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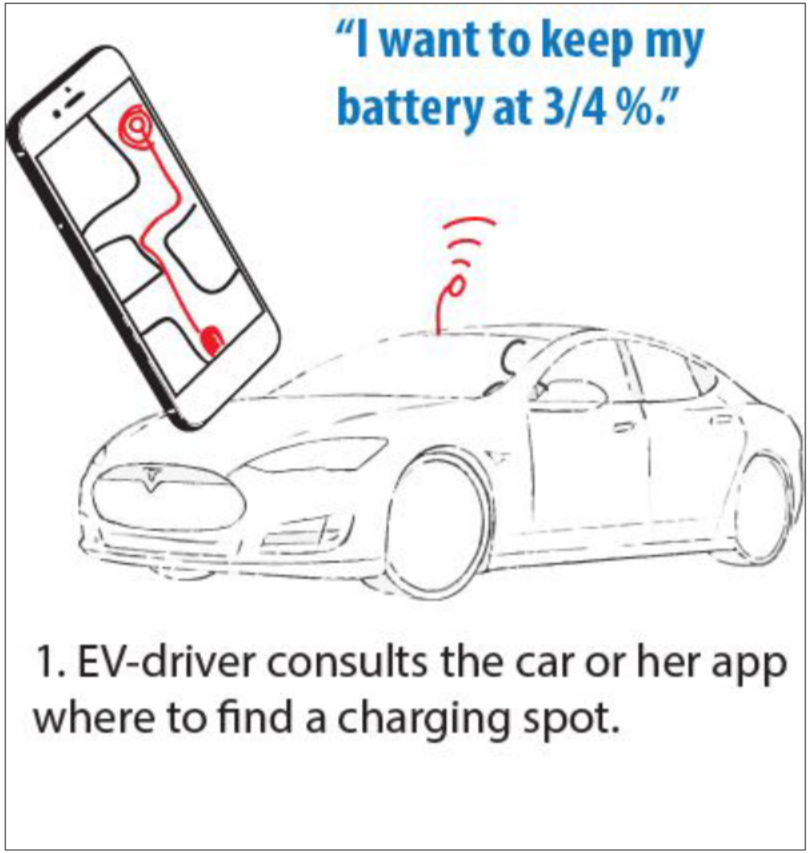
Current situation



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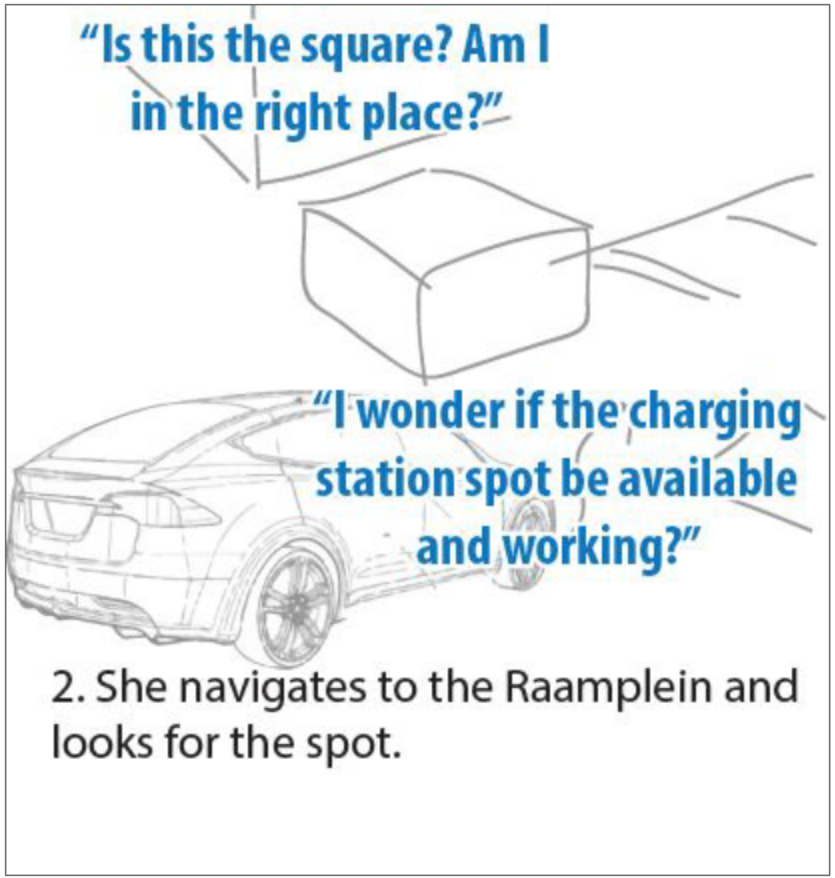

2. She navigates to the Raamplein and looks for the spot.

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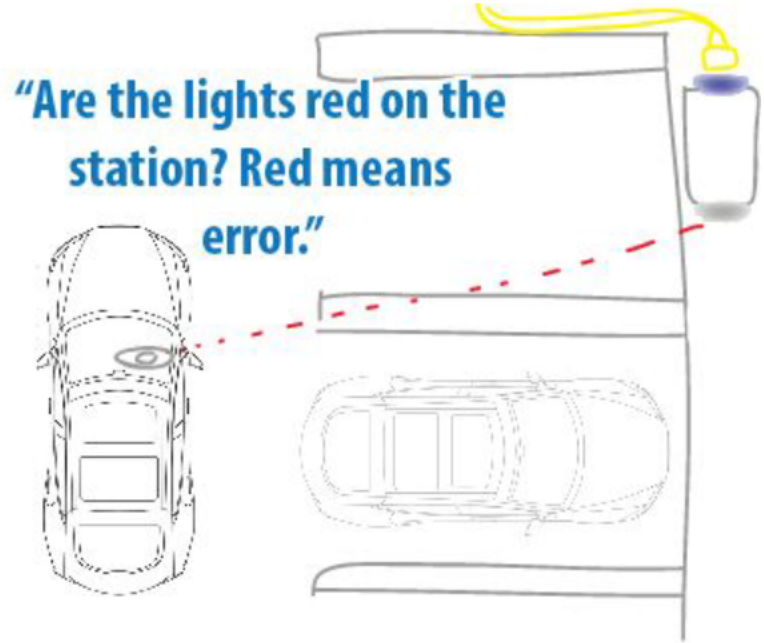
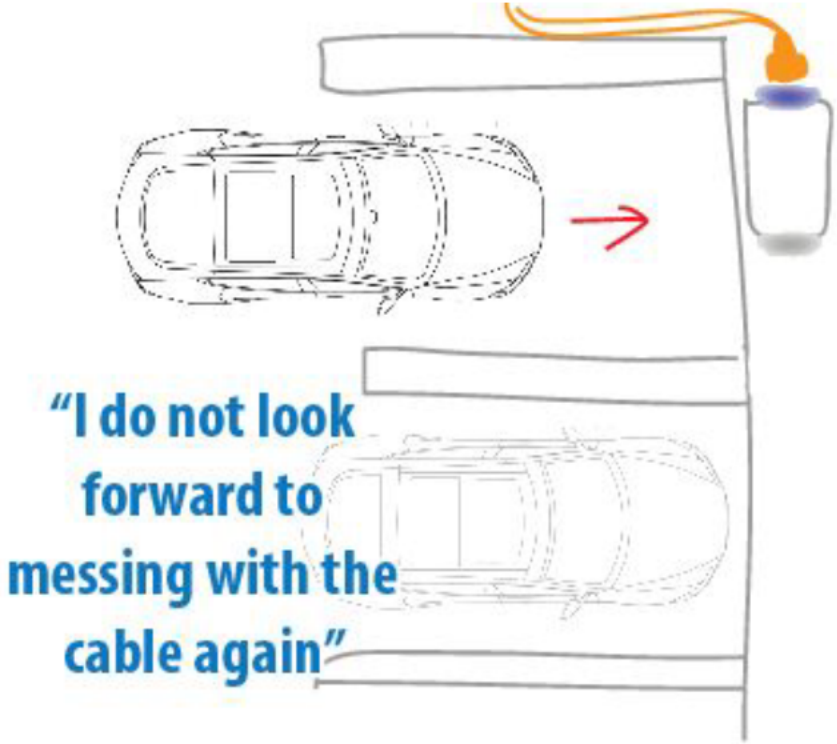


3. She checks from a distance if the charging spot is active and working.



4. She parks the car in a suitable spot.

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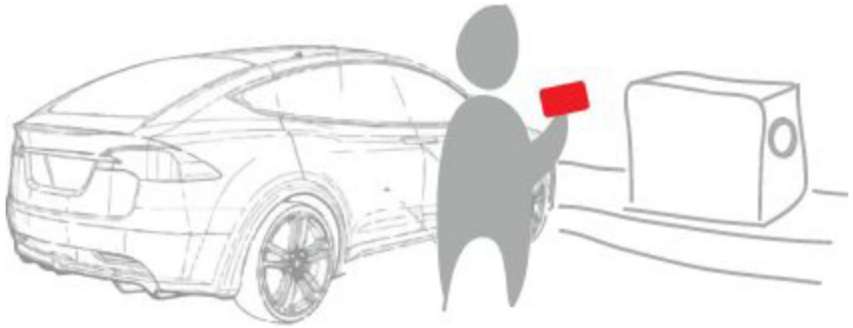
"The charging point is Vattenfall so i'll get my Vatenfall card"



5. She takes a suitable chipcard and exits the car.

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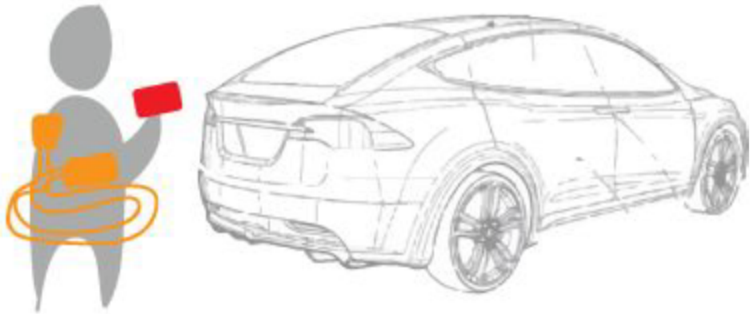
"The cable is big and heavy, and still dirty from that rainy day last week"



6. She gets her charging cable from the trunk.

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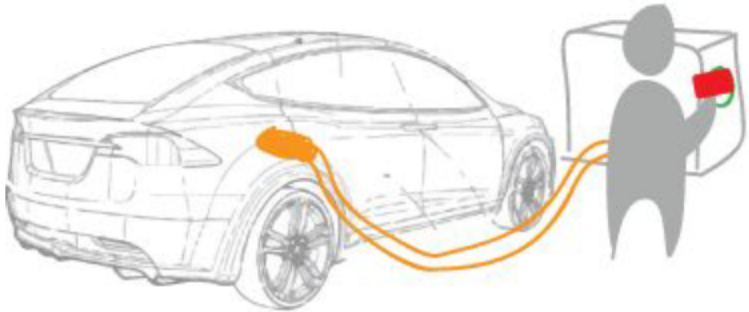
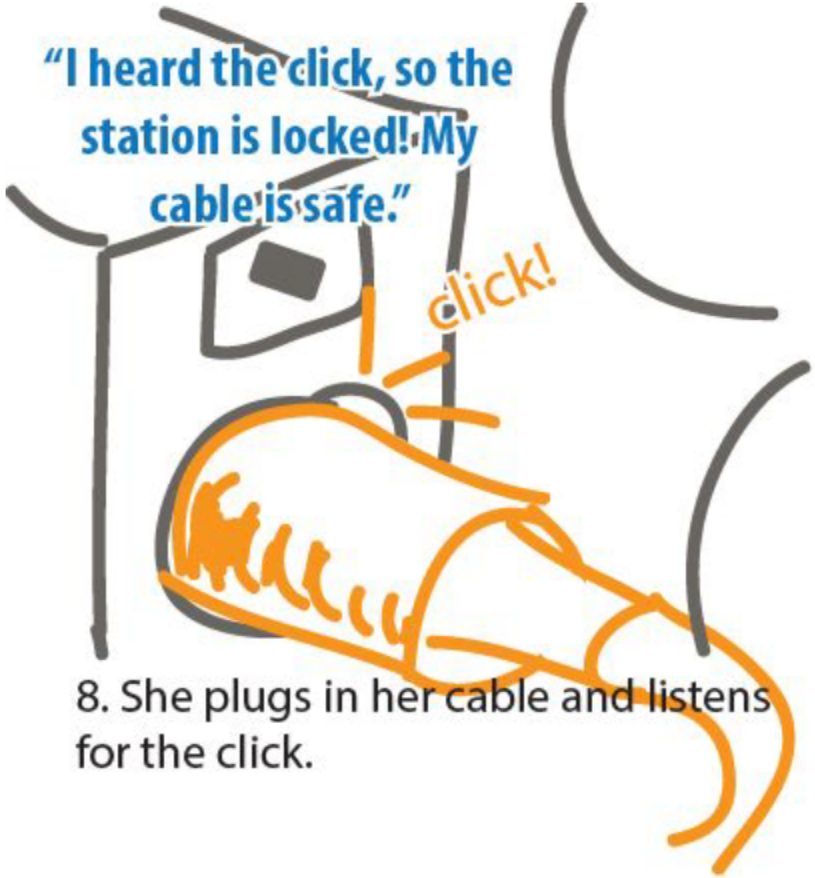
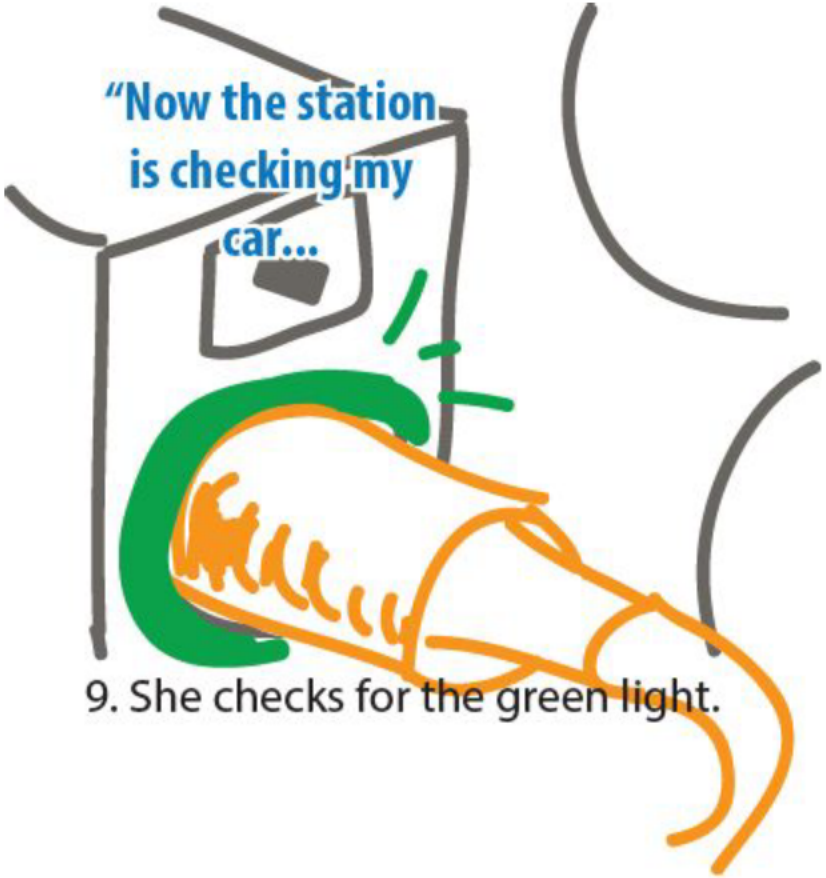
"I wonder how this station will work? Do I swipe first or plug in first?"



7. She plugs the cable in his car, walks up to the station and executes her usual routine.



8. She plugs in her cable and listens for the click.



9. She checks for the green light.

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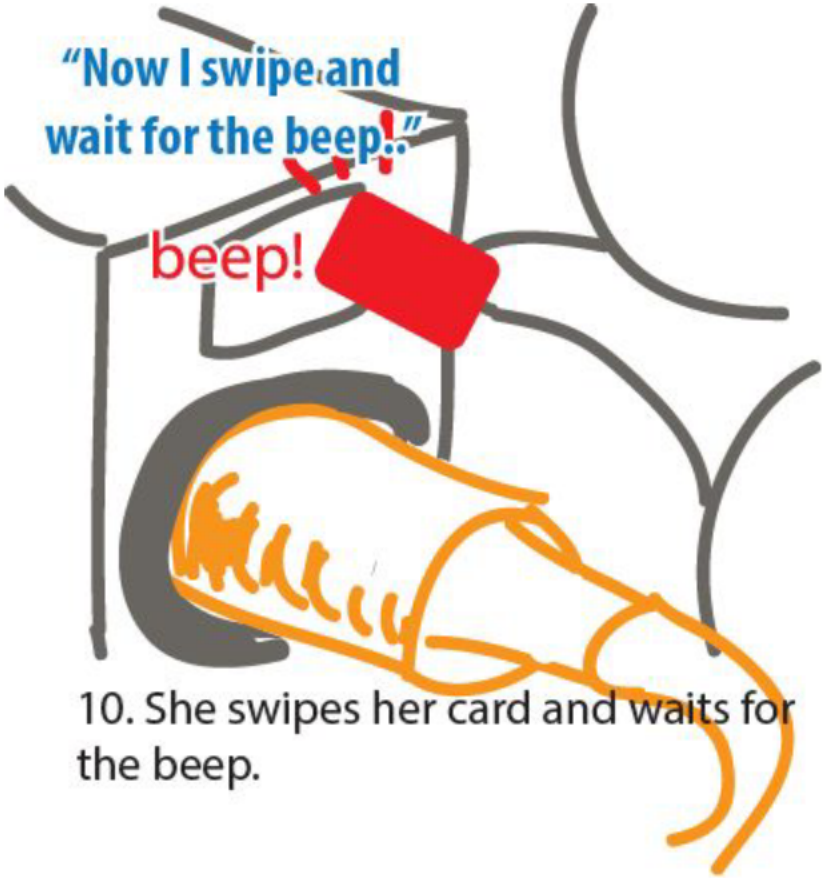

10. She swipes her card and waits for the beep.

11. She waits for the light to turn blue.

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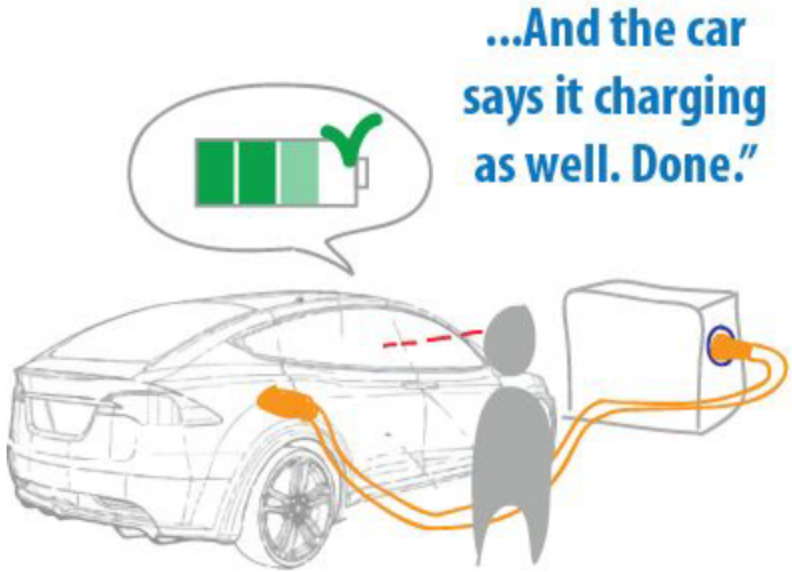
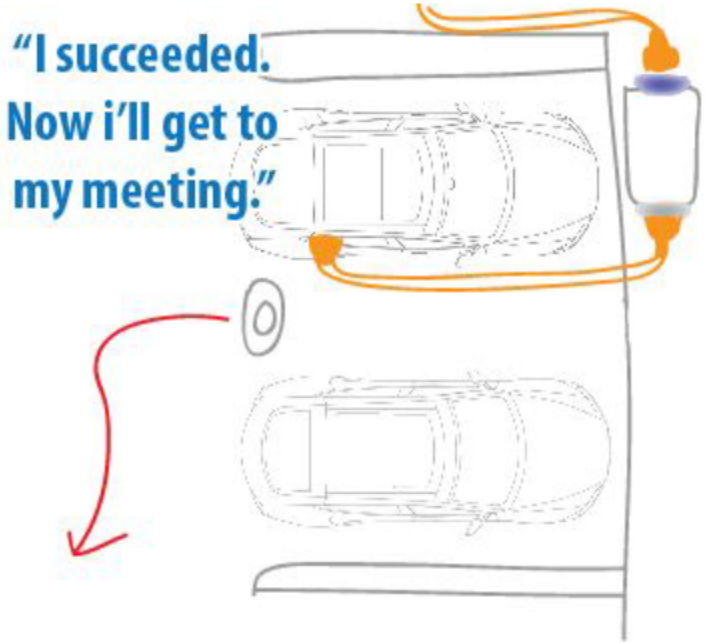


12. She returns the card to the car, and checks in the car if the car is charging.



13. She locks the car and walks away.

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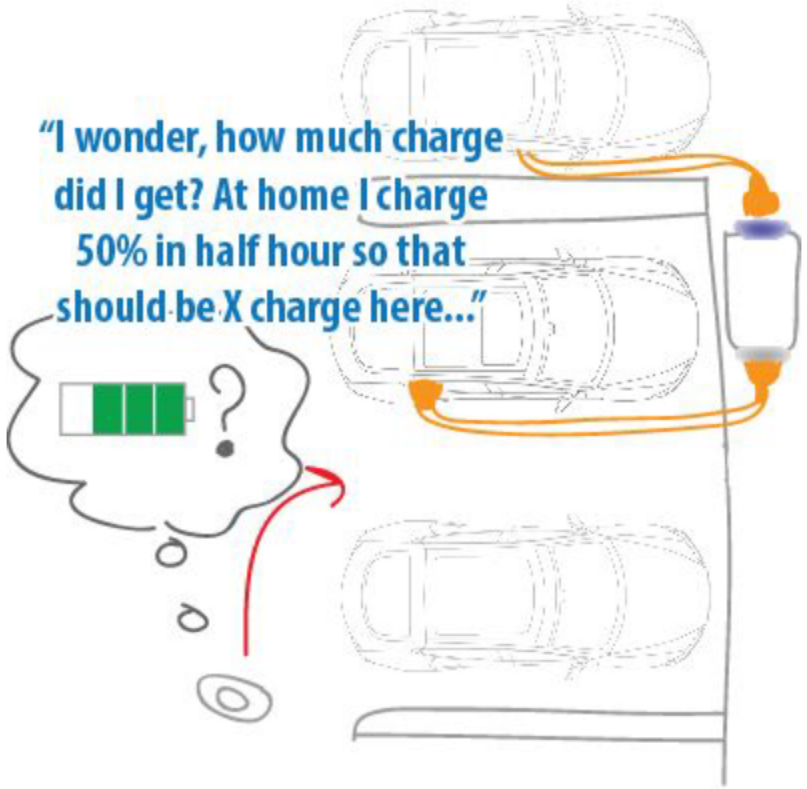
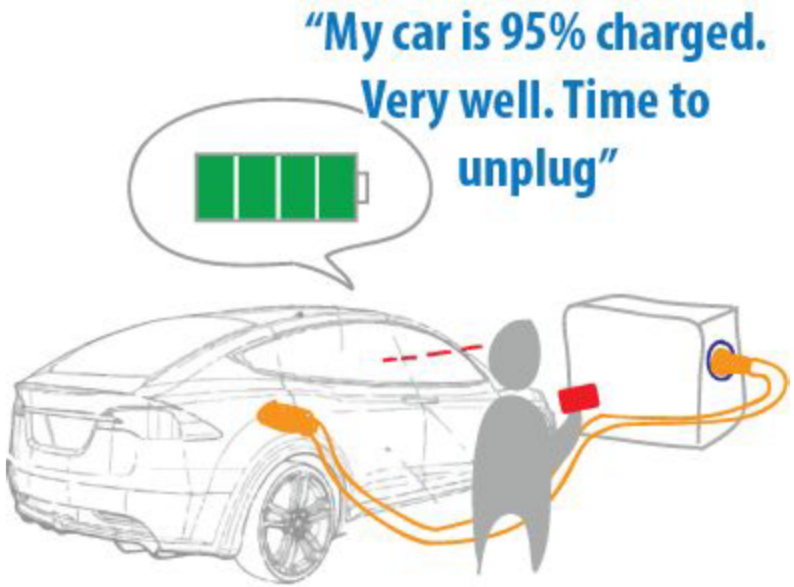
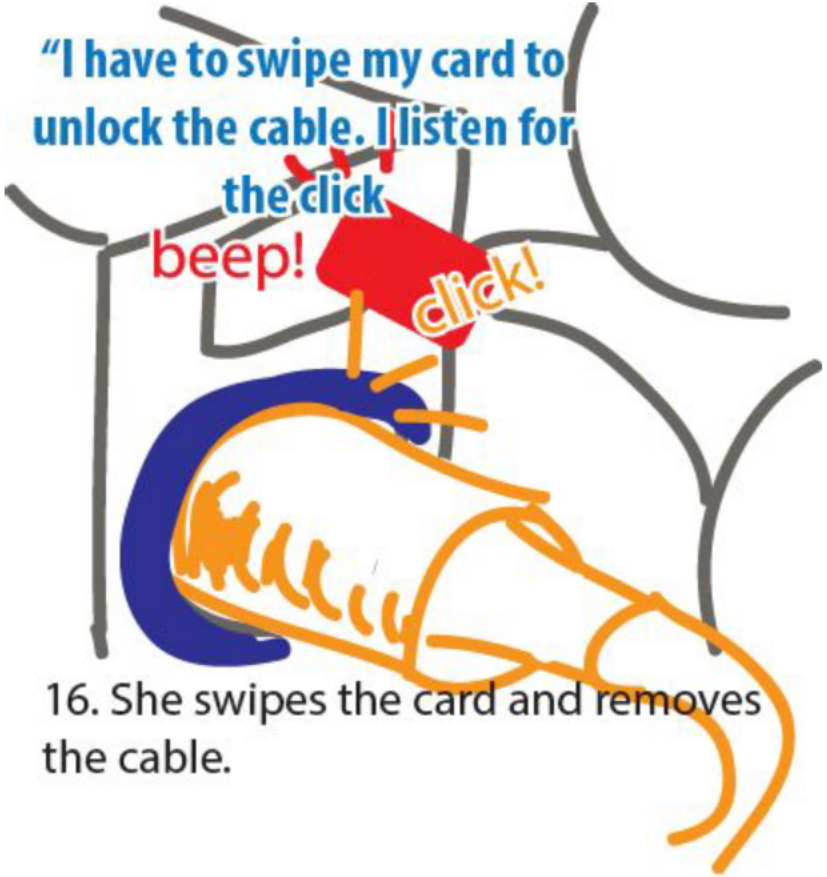


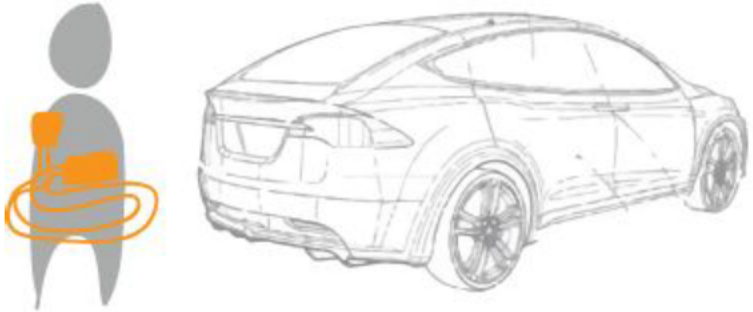


15. She returns to car, opens the car, checks if the car is charged and gets the correct card from the car.



16. She swipes the card and removes the cable.

"The cable is still heavy and dirty."

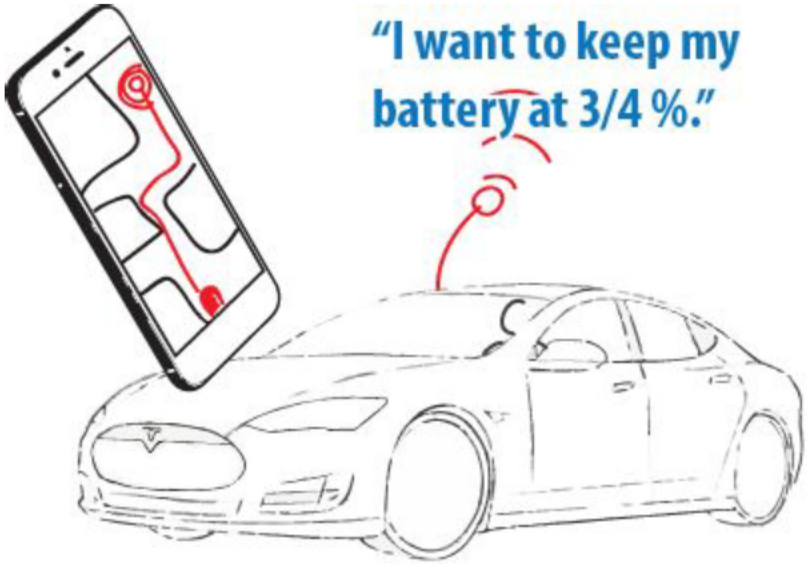


17. She returns the cable to the trunk.

18. She enters car and drives away.

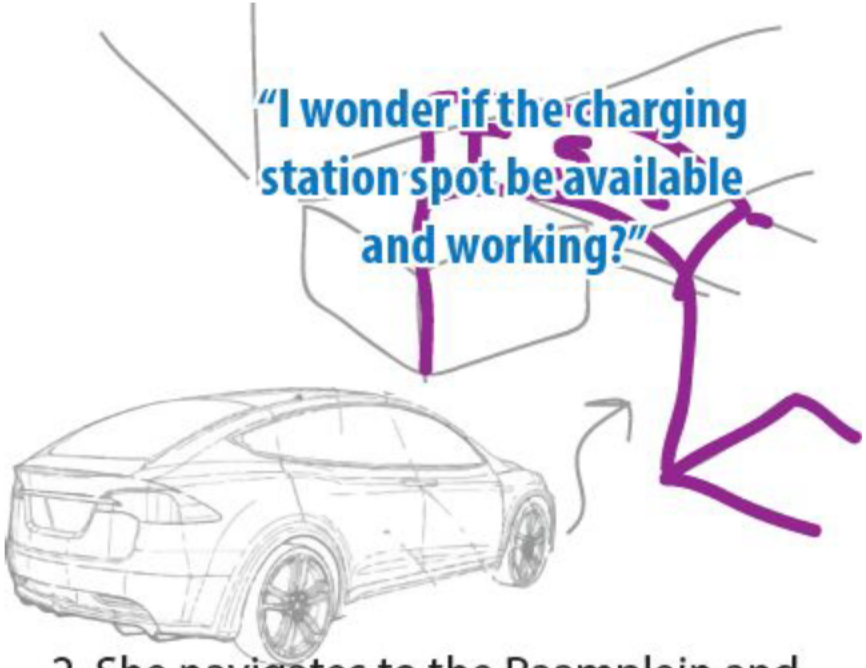
The→ Incredible →Machine

Desired situation

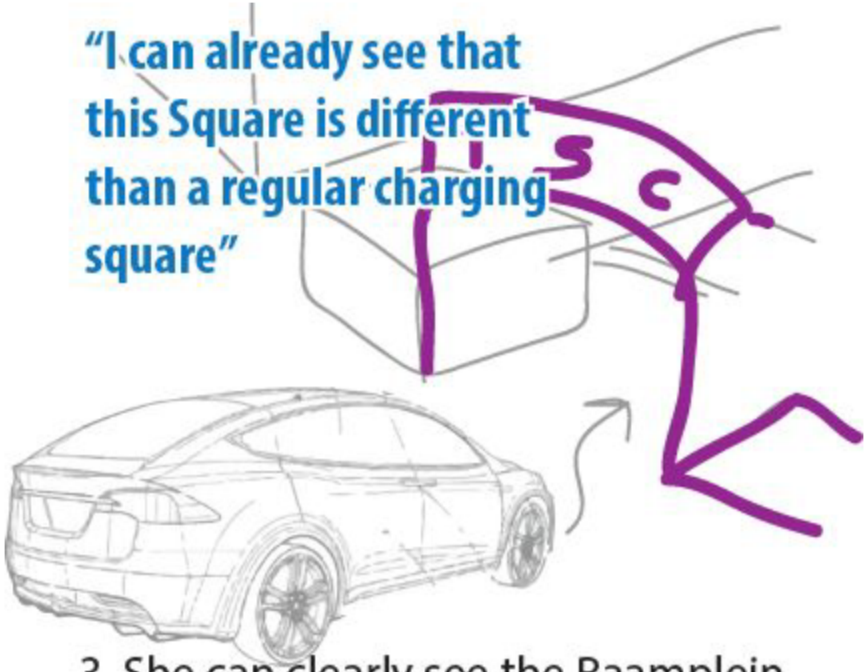


1. An EV-driver consults the car or her app on where to find a charging spot.

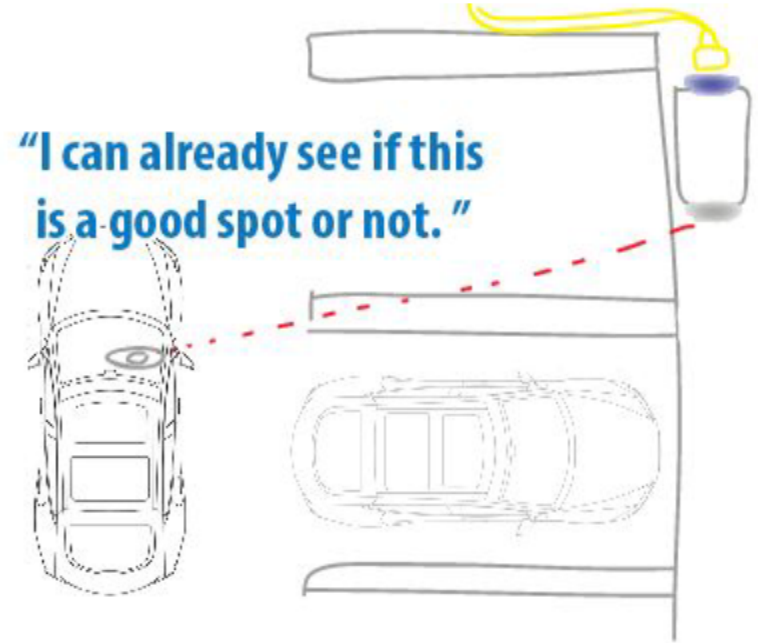
The→ Incredible →Machine



2. She navigates to the Raamplein and looks for the spot.

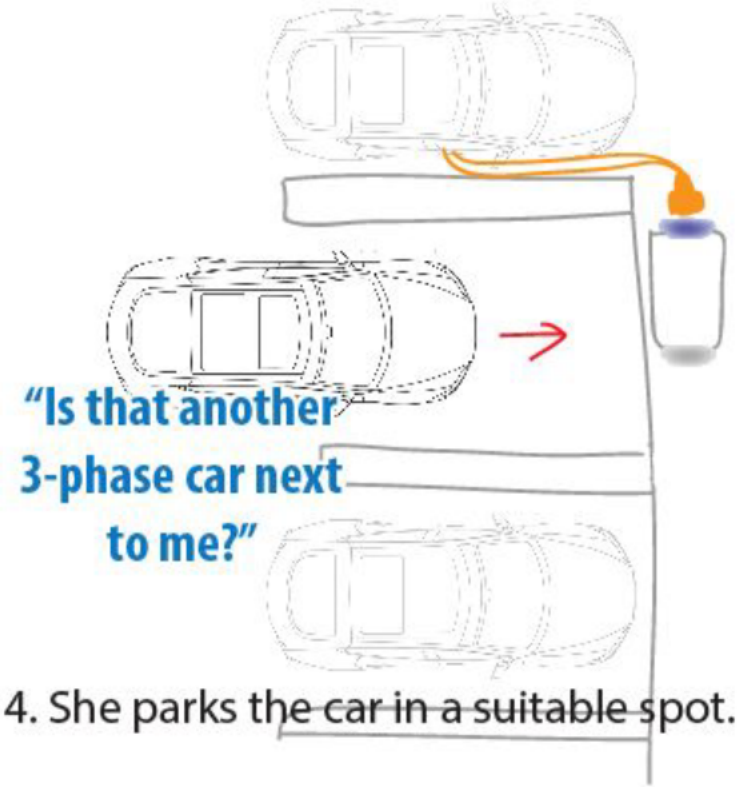


3. She can clearly see the Raamplein and where to go.

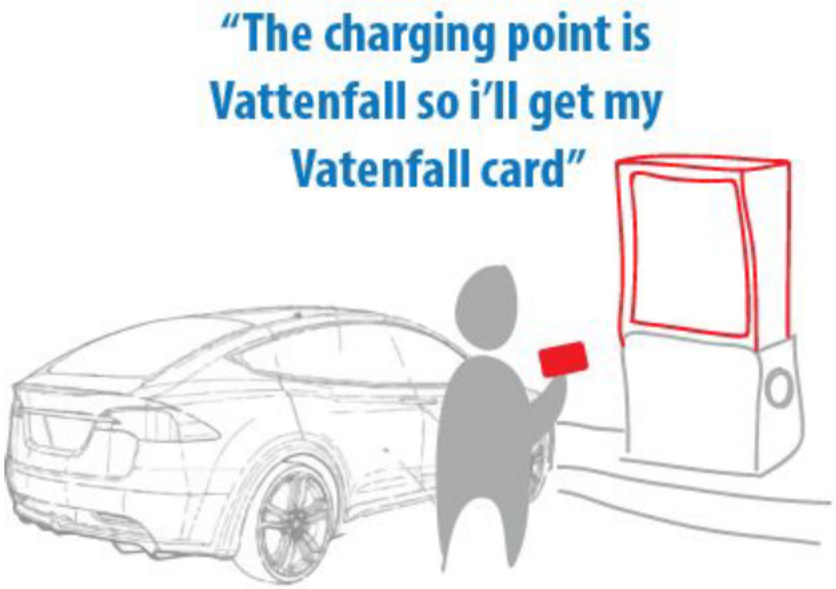


3. She can see from a distance if a station is working and roughly how much charge she'll get out of it.

The→ Incredible →Machine



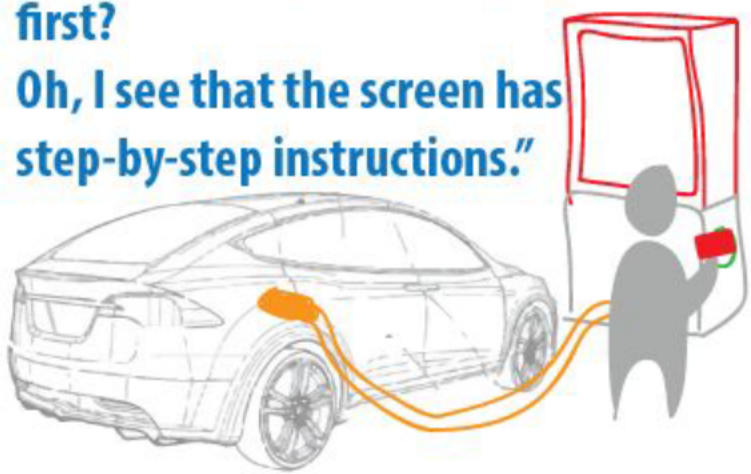
4. She parks the car in a suitable spot.



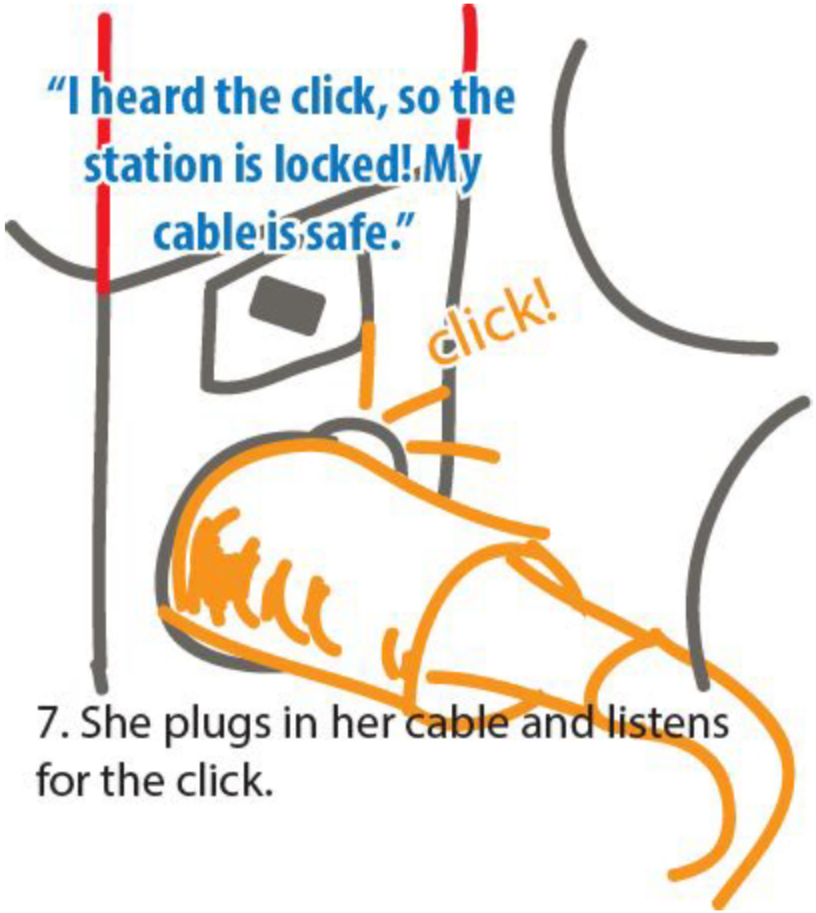
5. She takes a suitable chipcard and exits the car.

The→ Incredible →Machine

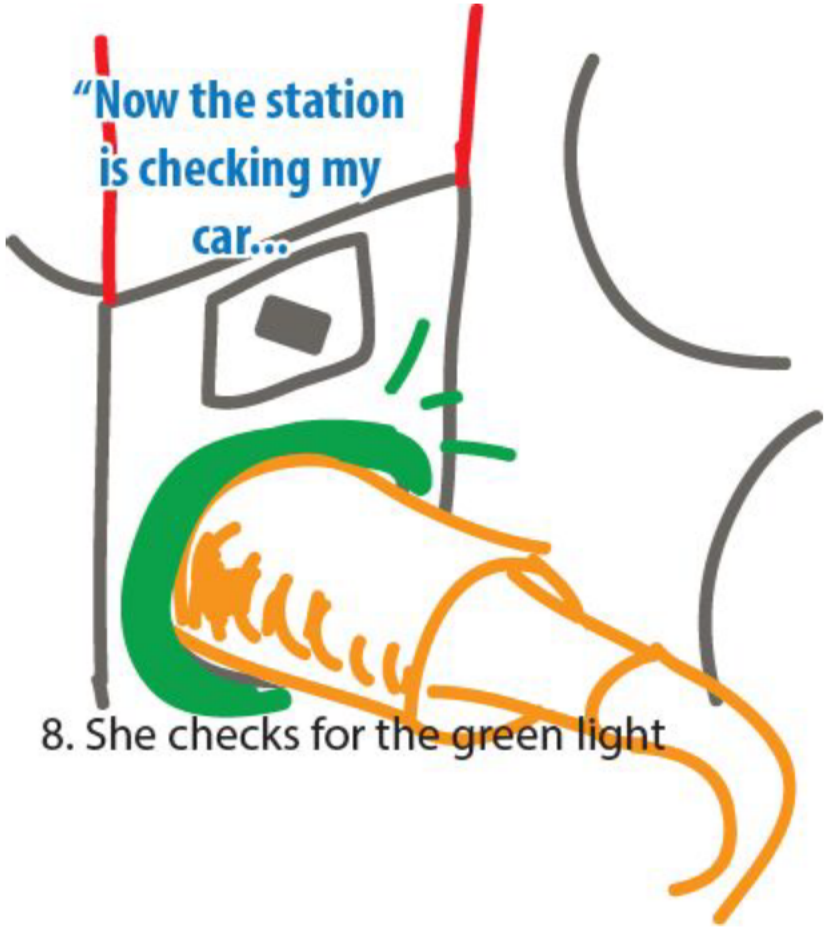
"I wonder how this station will work? Do I swipe first or plug in first?
Oh, I see that the screen has step-by-step instructions."



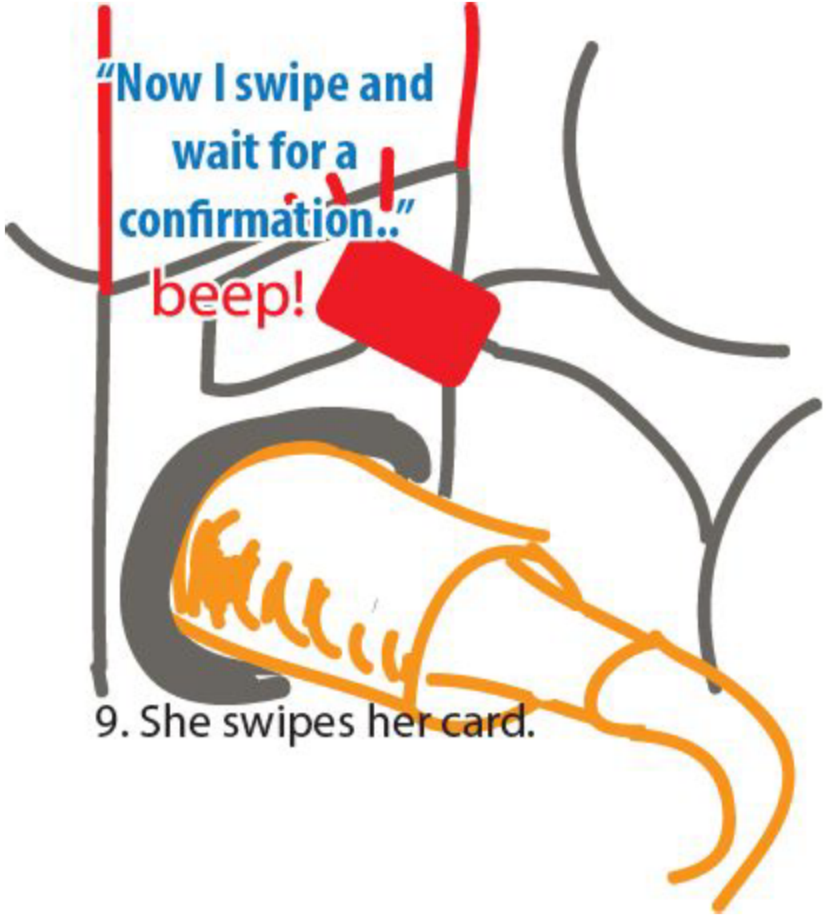
6. She reads the info on the screen on how to charge, and transparent charging.



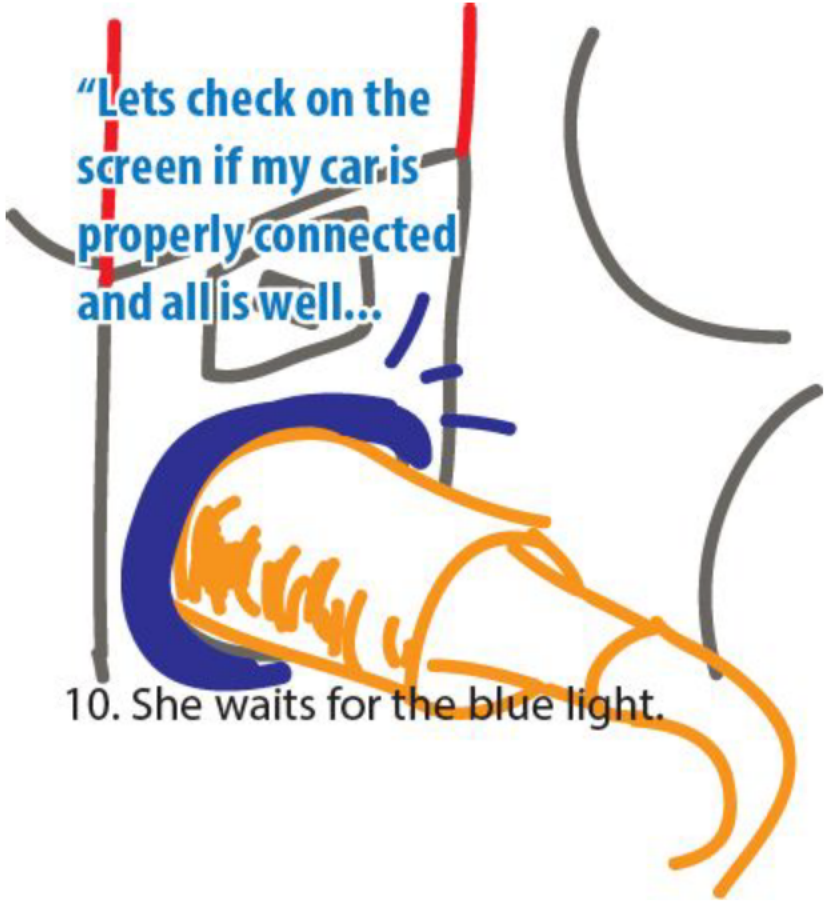
7. She plugs in her cable and listens for the click.



8. She checks for the green light



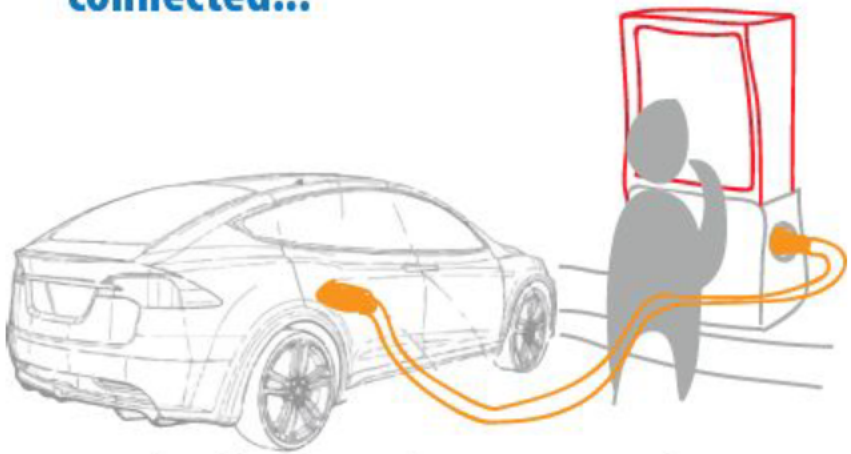
9. She swipes her card.



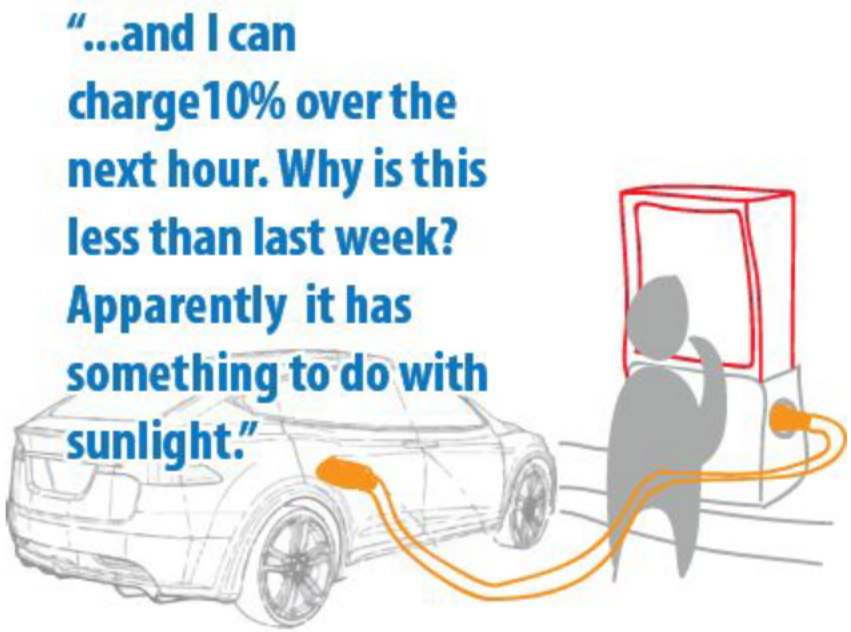
10. She waits for the blue light.

The→ Incredible →Machine

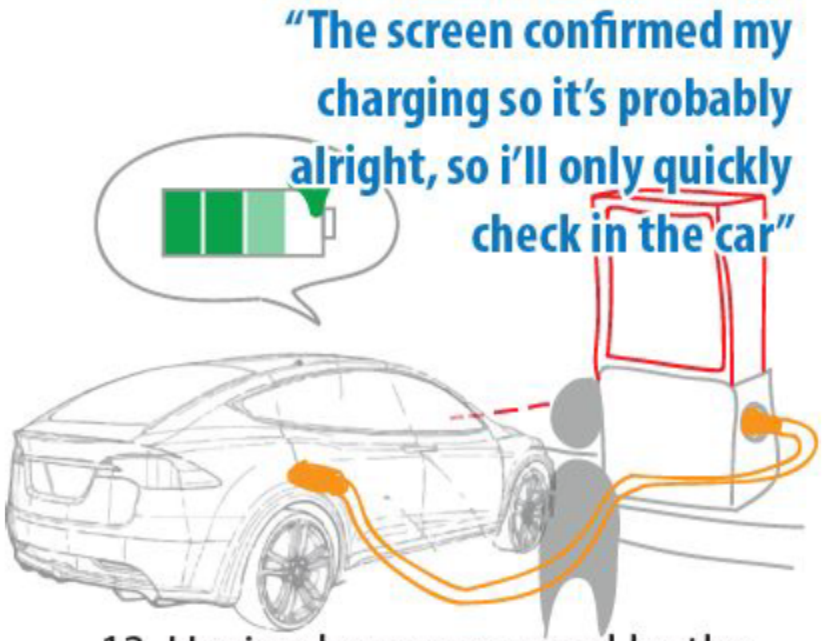
"The screen tells me that all is well and connected..."



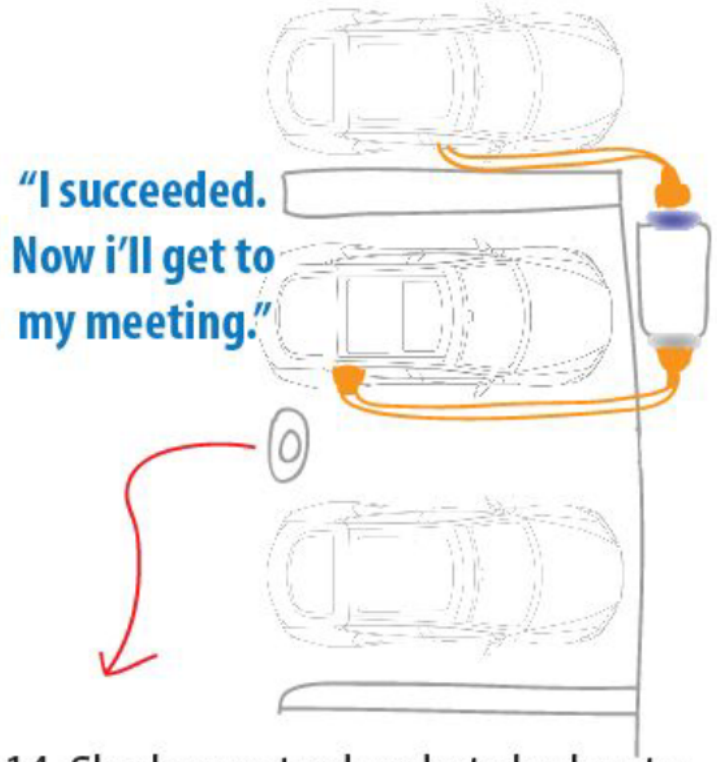
11. She looks at the screen and sees that all is well and connected.



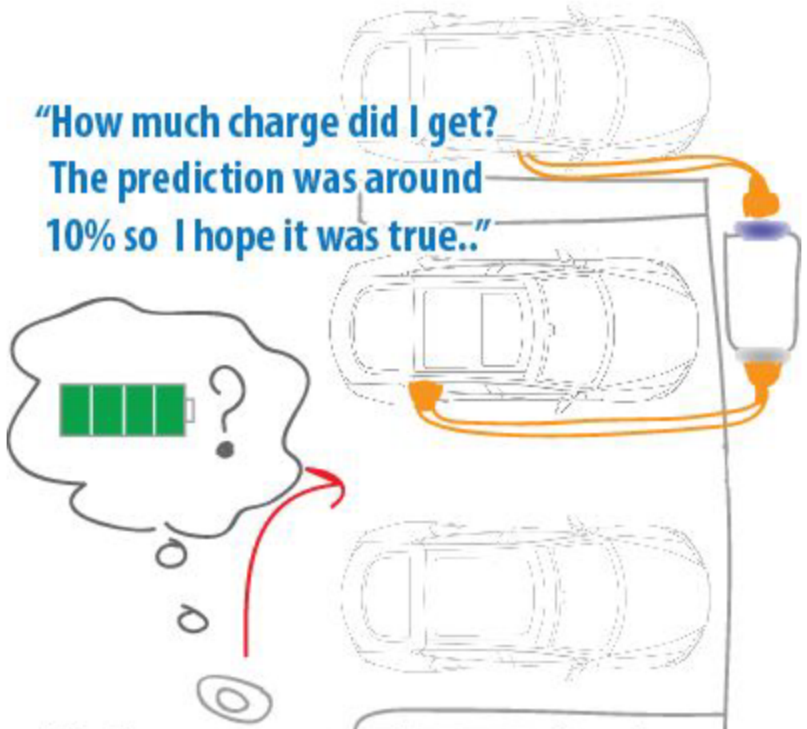
12. The screen tells her an estimation of charge.



13. Having been reassured by the screen, she only briefly checks the car.

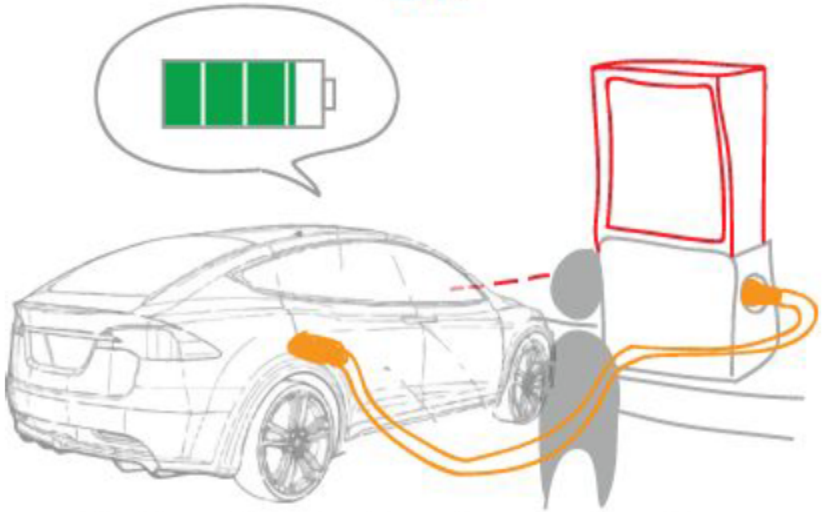


14. She leaves to do what she has to do.



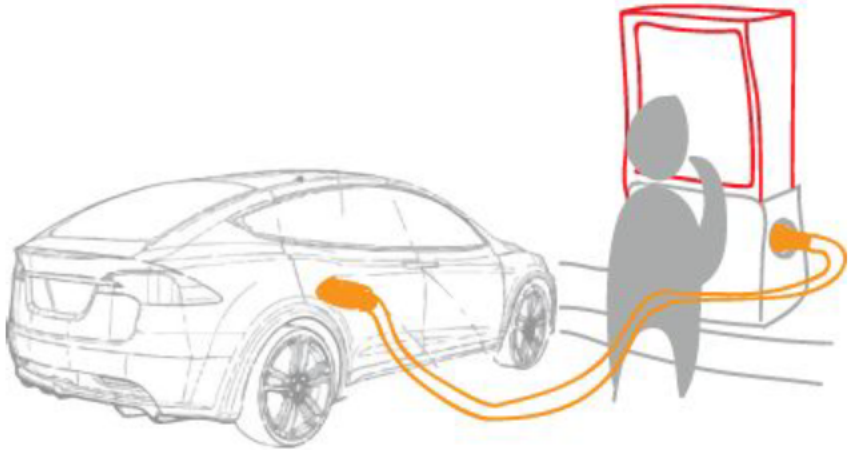
15. She returns to the car after her activity.

"8%. So thats less. Not too bad but still.. why?"

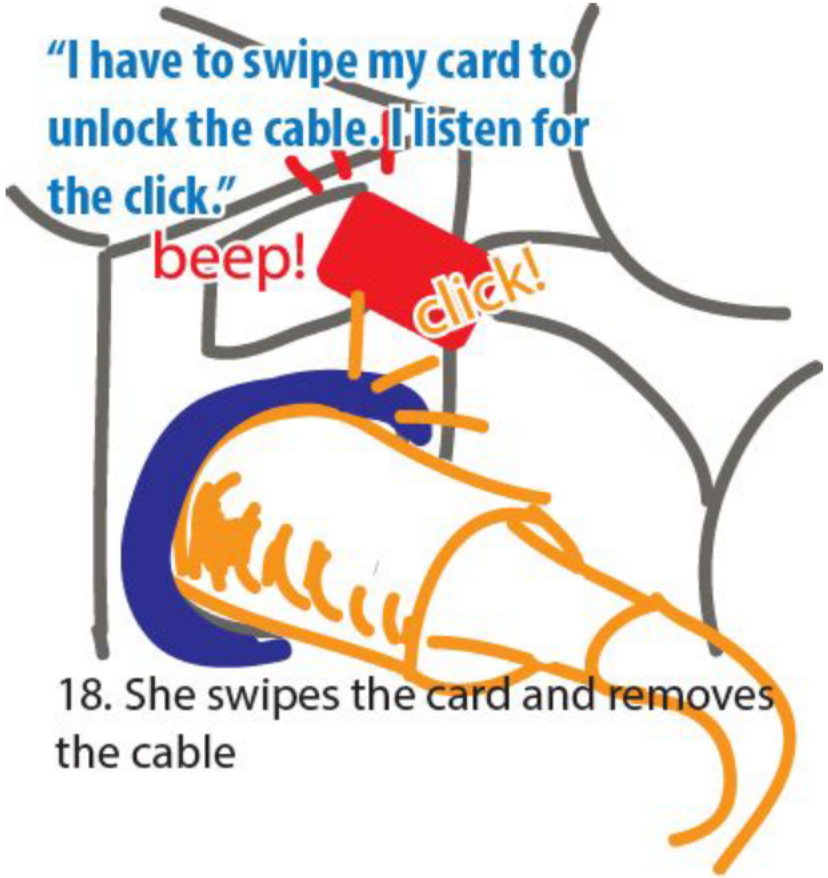


16. She checks the charge level in the car.

"Ah there was less sun than expected.. I guess that's fair."



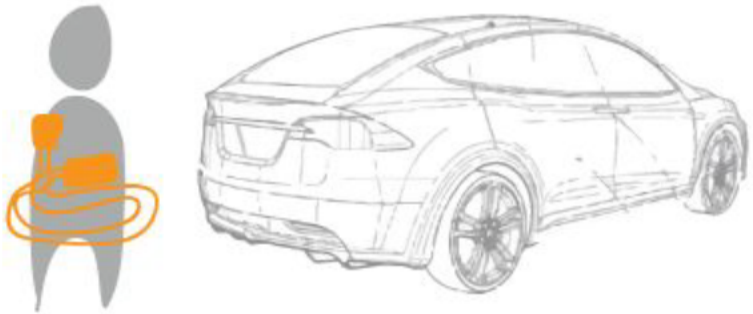
17. She checks the screen for an explanation.



18. She swipes the card and removes the cable

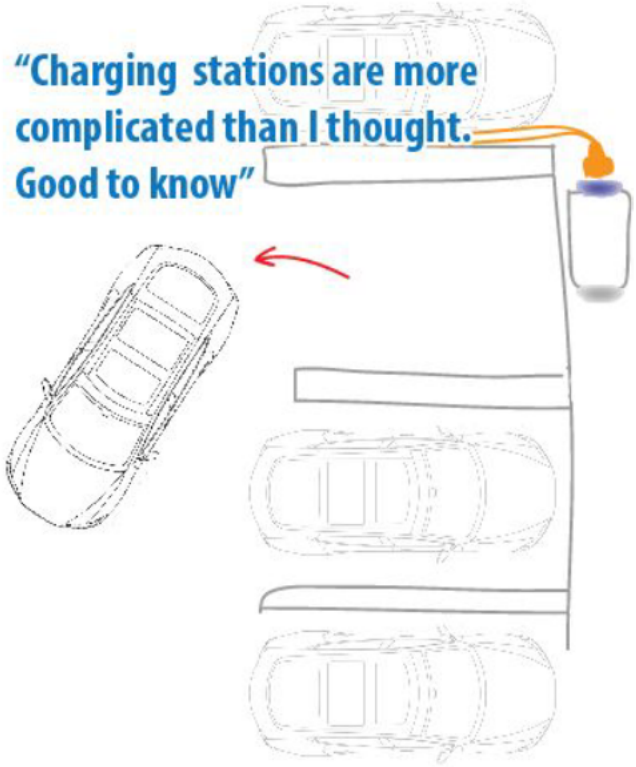
The→ Incredible →Machine

"Still charged enough to get where i'm going"



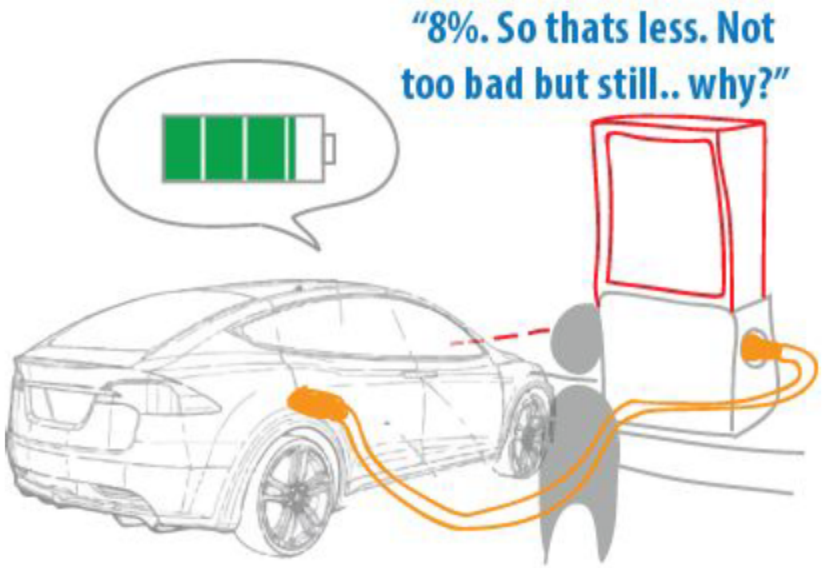
19. She returns the cable to the trunk.

The→ Incredible →Machine



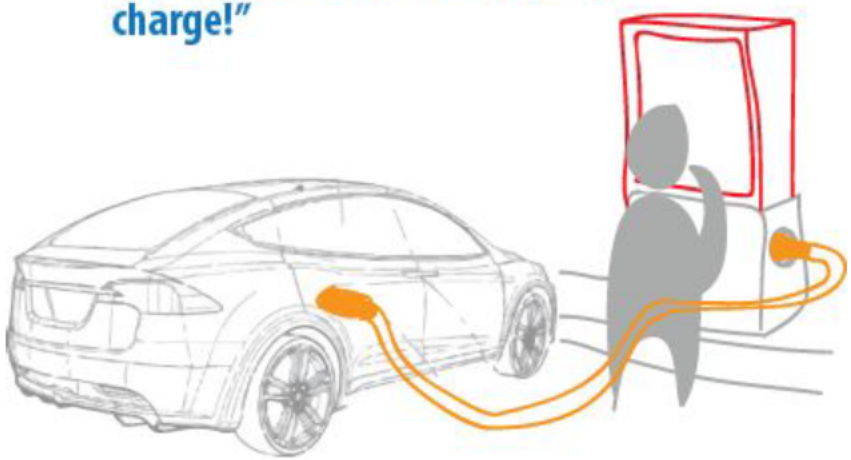
The→
Incredible
→Machine

Flow for disagreement



16. She checks the charge level in the car.

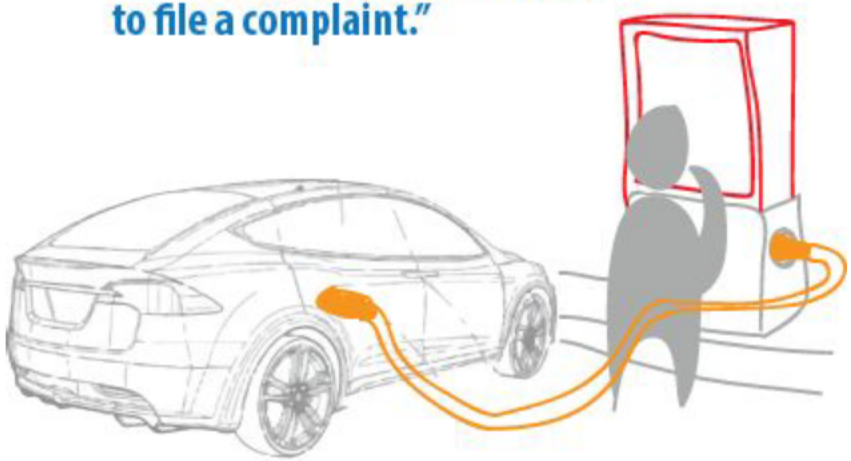
"Ah there was less sun than expected? But I needed my 10% charge!"



17. She checks the screen for an explanation.

The→ Incredible →Machine

"I can read how I can contact the municipality of Amsterdam to file a complaint."

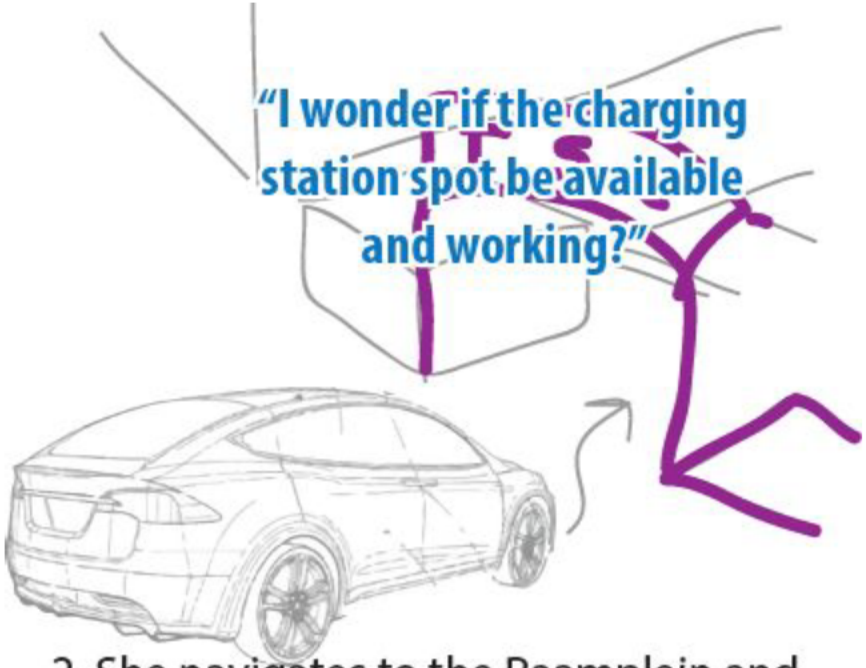


18. She checks the screen for an explanation.

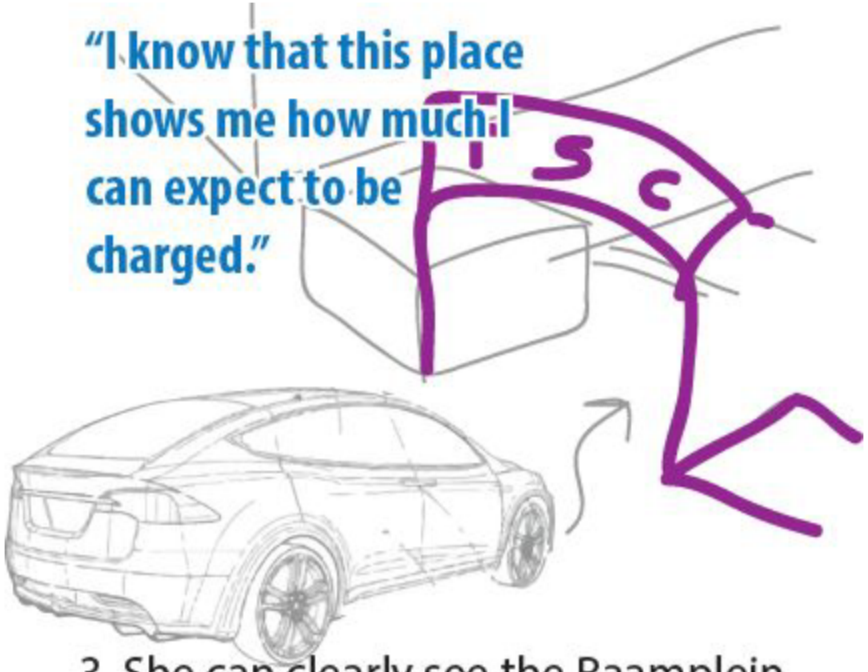
The→
Incredible
→Machine

Flow for returning users

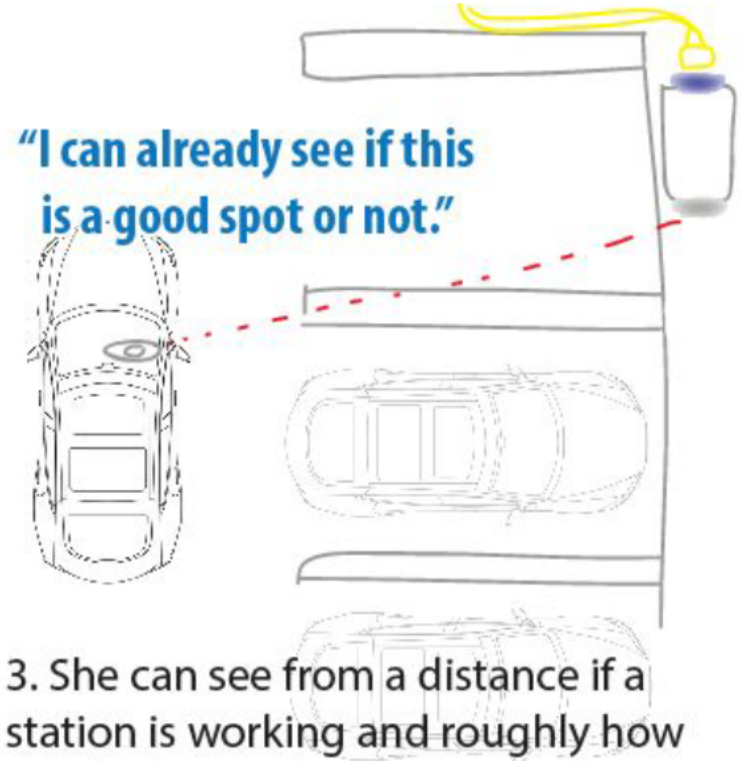
The→ Incredible →Machine



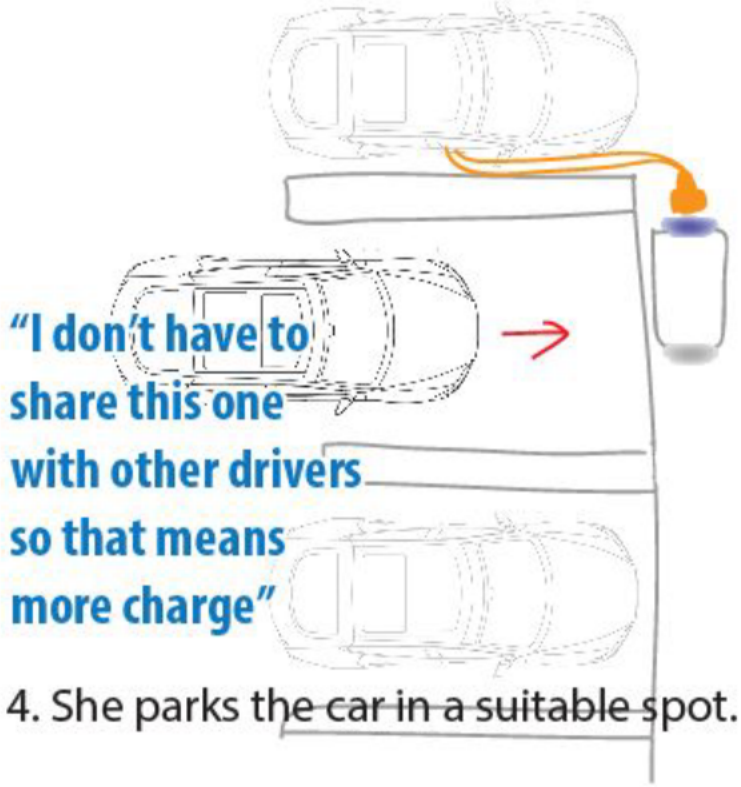
2. She navigates to the Raamplein and looks for the spot.



3. She can clearly see the Raamplein and where to go.



3. She can see from a distance if a station is working and roughly how much charge she'll get out of it.



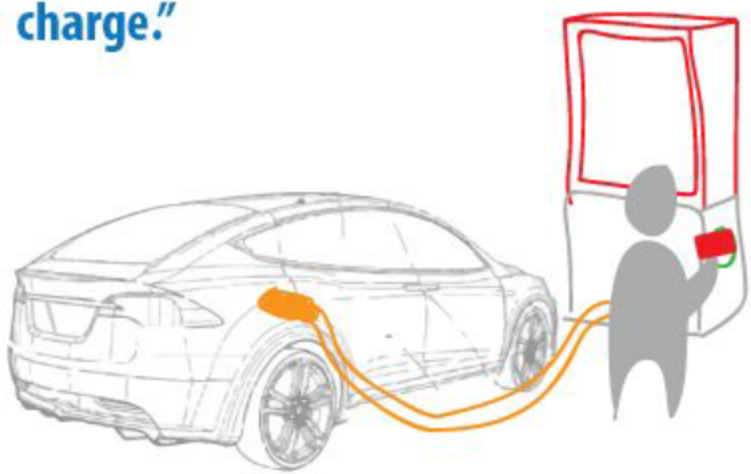
4. She parks the car in a suitable spot.

The→ Incredible →Machine

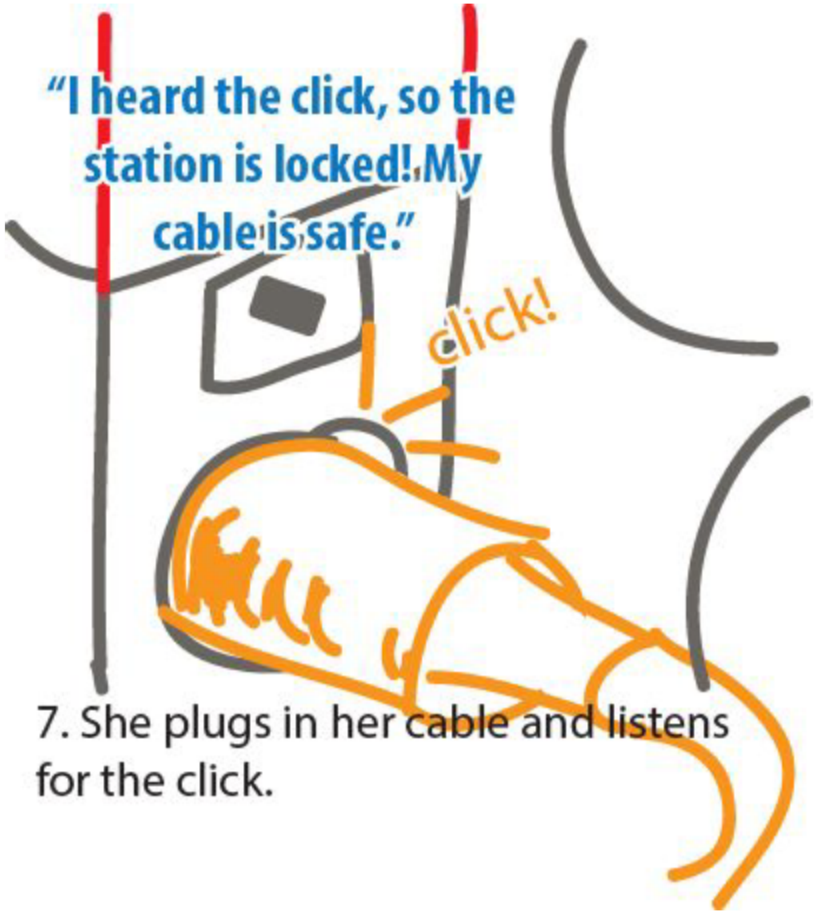
5. She takes a suitable chipcard and exits the car.

The→ Incredible →Machine

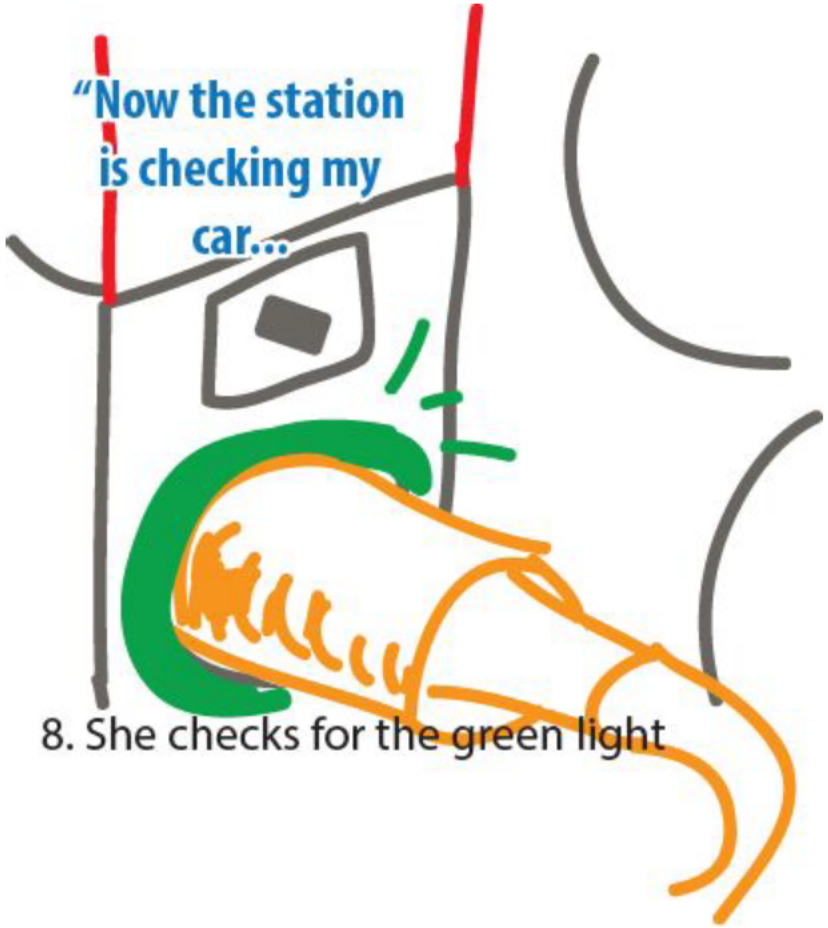
"I know how this station works. Let me double-check the expected charge."



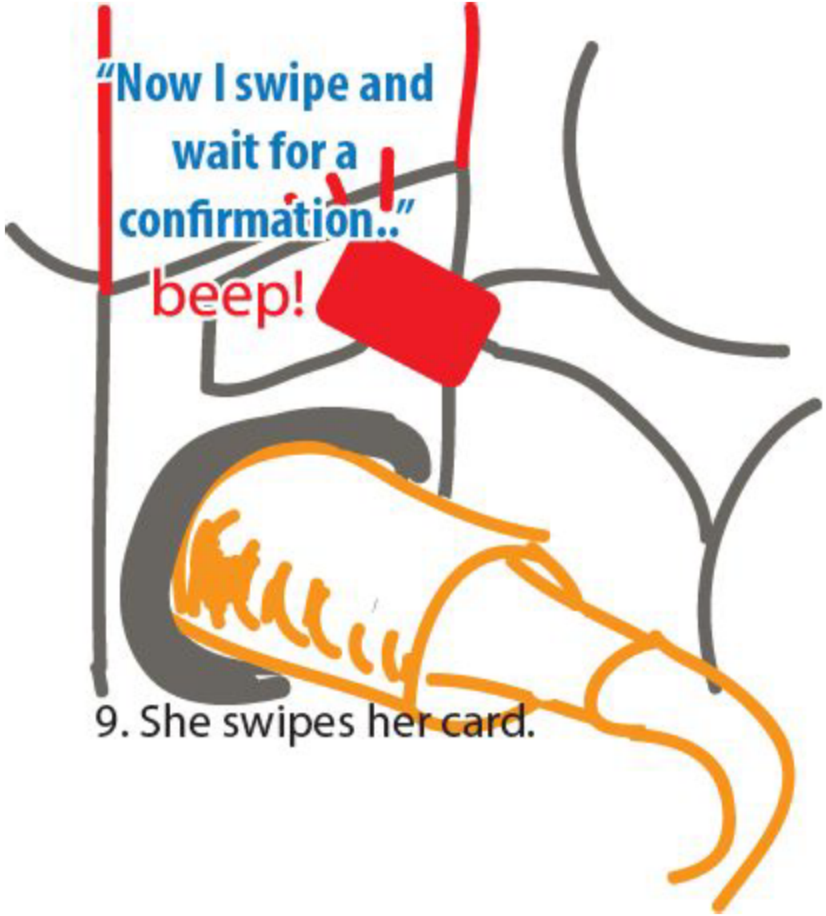
6. She reads the info on the screen on how to charge, and transparent charging.



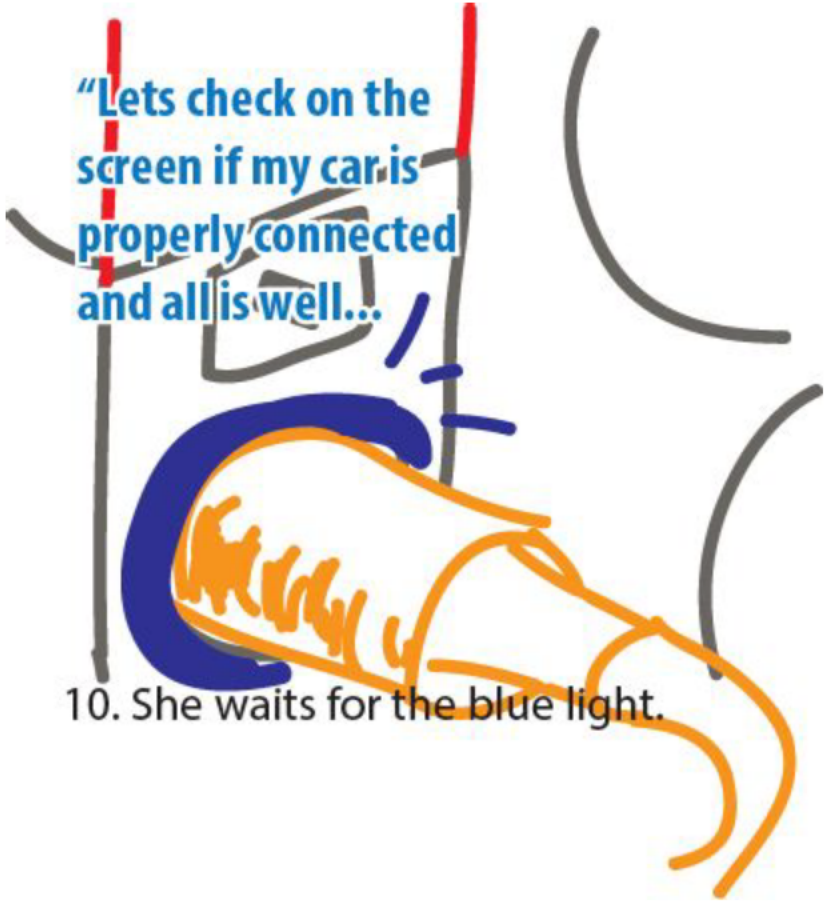
7. She plugs in her cable and listens for the click.



8. She checks for the green light



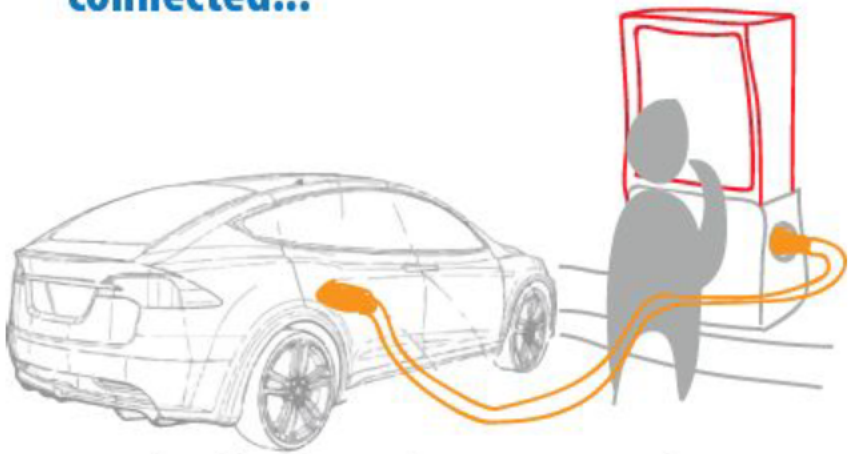
9. She swipes her card.



10. She waits for the blue light.

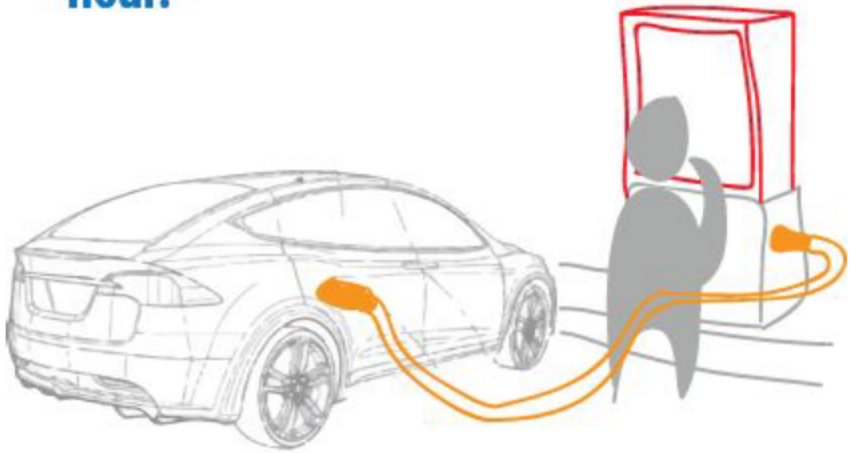
The→ Incredible →Machine

"The screen tells me that all is well and connected..."

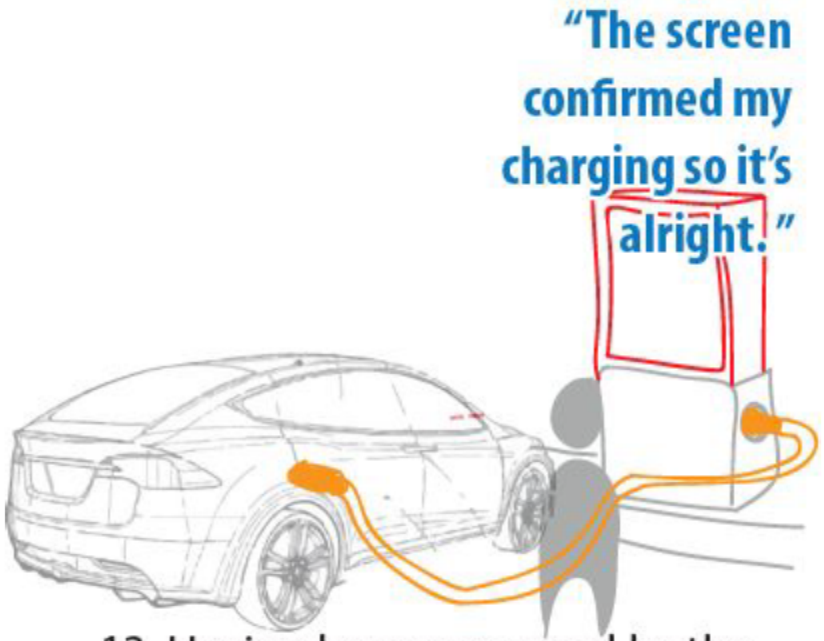


11. She looks at the screen and sees that all is well and connected.

"...and I can charge 10% over the next hour."

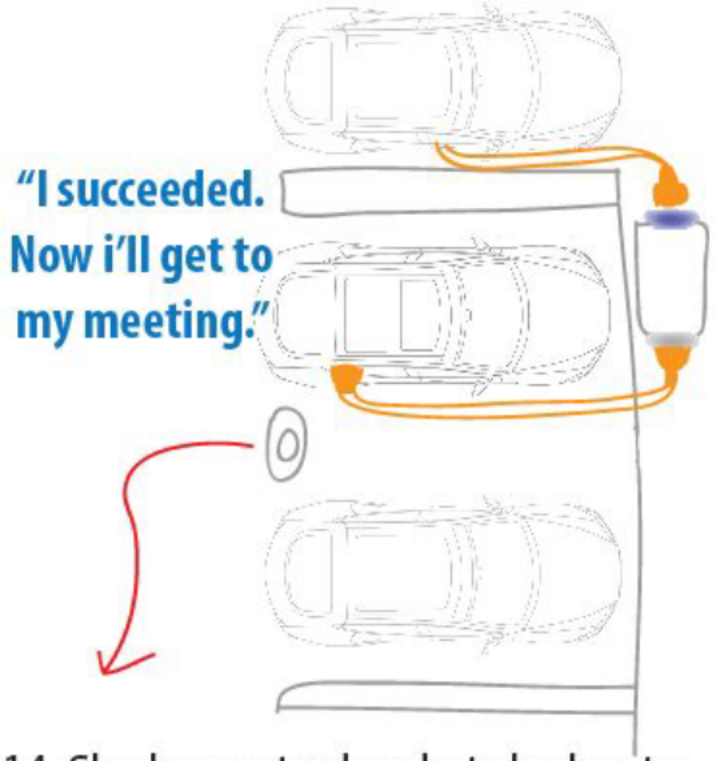


12. The screen tells her an estimation of charge.

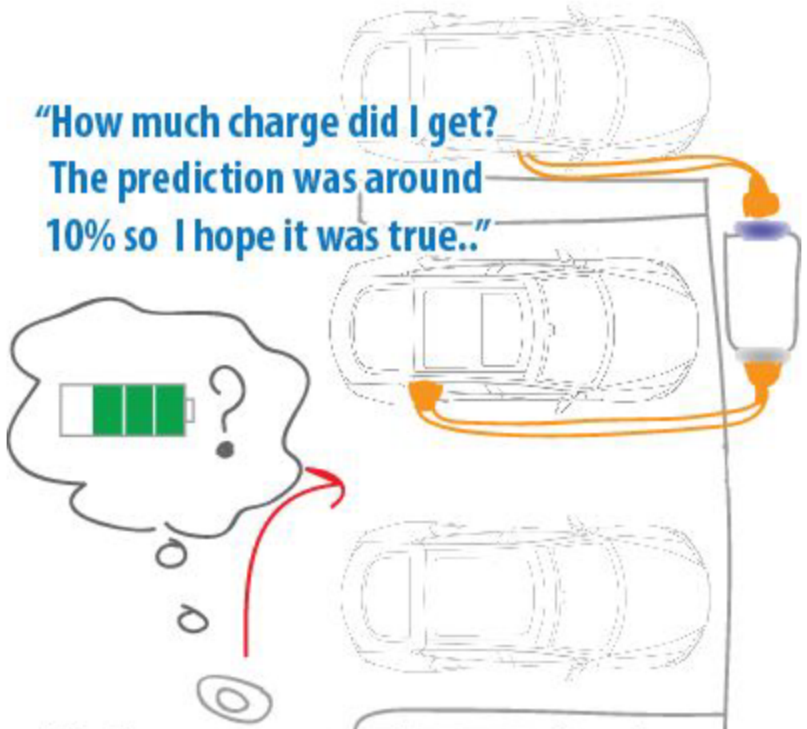


13. Having been reassured by the screen, she only briefly checks the car.

The→ Incredible →Machine

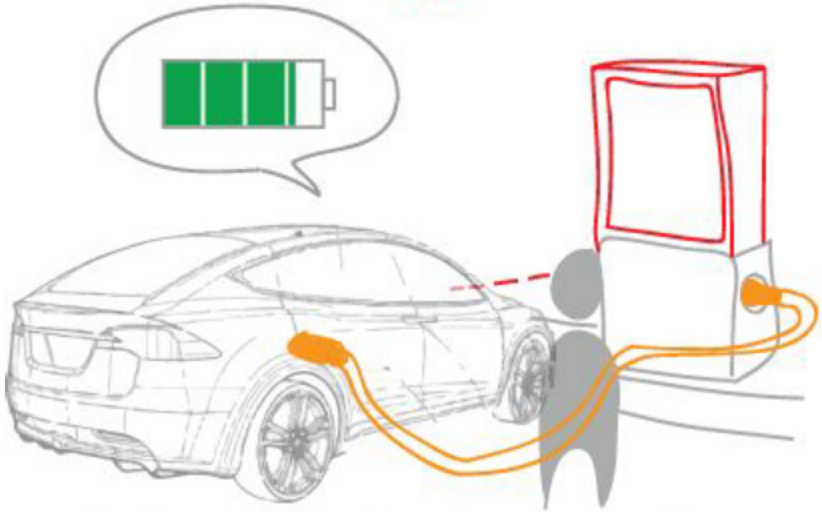


14. She leaves to do what she has to do.



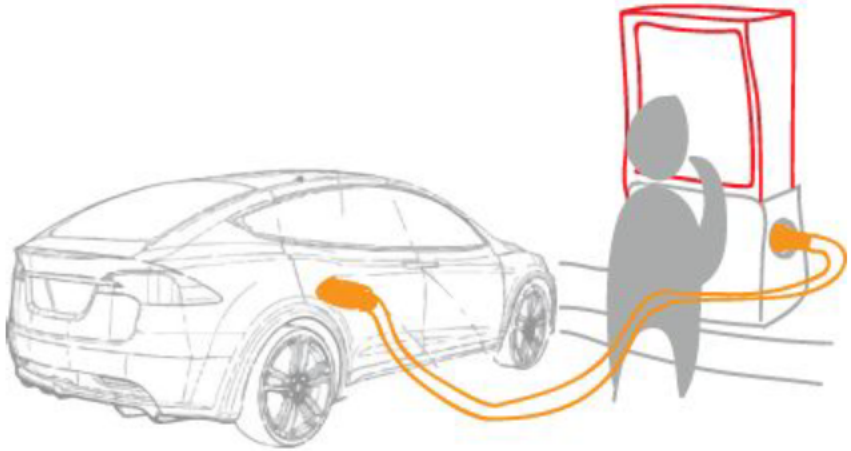
15. She returns to the car after her activity.

"8%. So thats less. Not too bad but still.. why?"

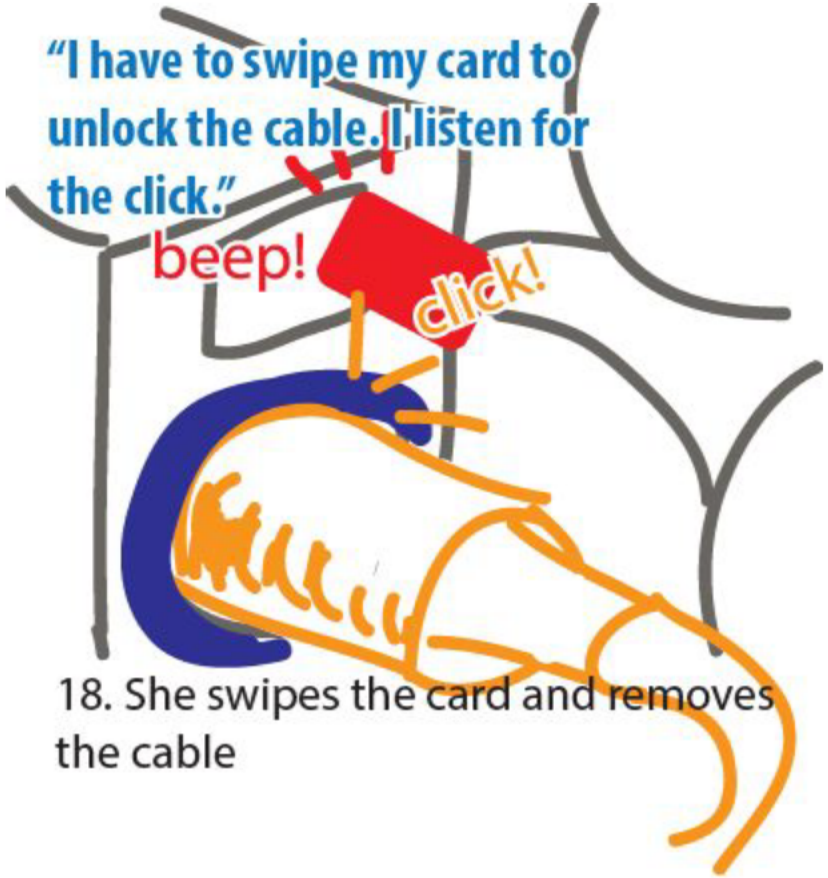


16. She checks the charge level in the car.

"Ah there was less sun than expected.. I guess that's fair."



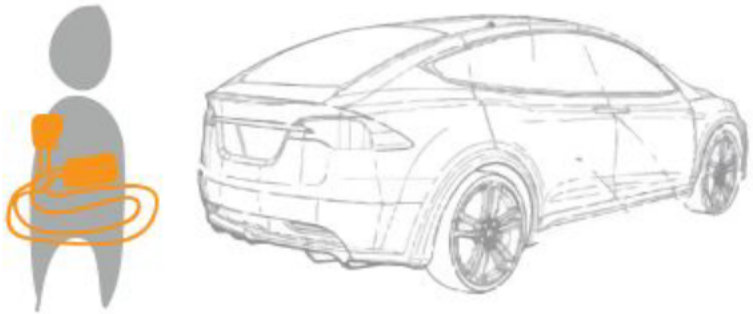
17. She checks the screen for an explanation.



18. She swipes the card and removes the cable

The→ Incredible →Machine

"Still charged enough to get where i'm going"



19. She returns the cable to the trunk.

20. She enters car and drives away

The→ Incredible →Machine

Flexpower specification

User research

Ideas

Discussion

Next Steps & Collaborations

The→ Incredible →Machine

Main considerations

1. Previous TCS showed how the algorithm defined the **planning**, whereas Flexpower 2 is an algorithm that distributes energy over all participants at **any given moment**.
2. It is not about understanding fairness by comparing your treatment to that of fellow chargers, it is about whether you think the (choice for) parameters and weights is fair.
3. We design for users and citizens, not for what *we* find interesting or important.

The→ Incredible →Machine

Core

Algorithm

Focus on working of algorithm

Outcome

Focus on outcome of the algorithm

Trade-off

Focus on impact on personal situation

Expectations

Focus on time and planning.

Parameters

Focus on parameters of algorithm

Explain

Present interpretation of the algorithm

Marble Machine

Tetris+

Speed-o-matic

Clock

Weather report

Conversation

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Transparency

Algorithm — computation / logic

Outcome — distribution of resources (TCS 1)

Your situation — how your capabilities are affected

Parameters — what is looked at to craft

Reasons — and omit computation

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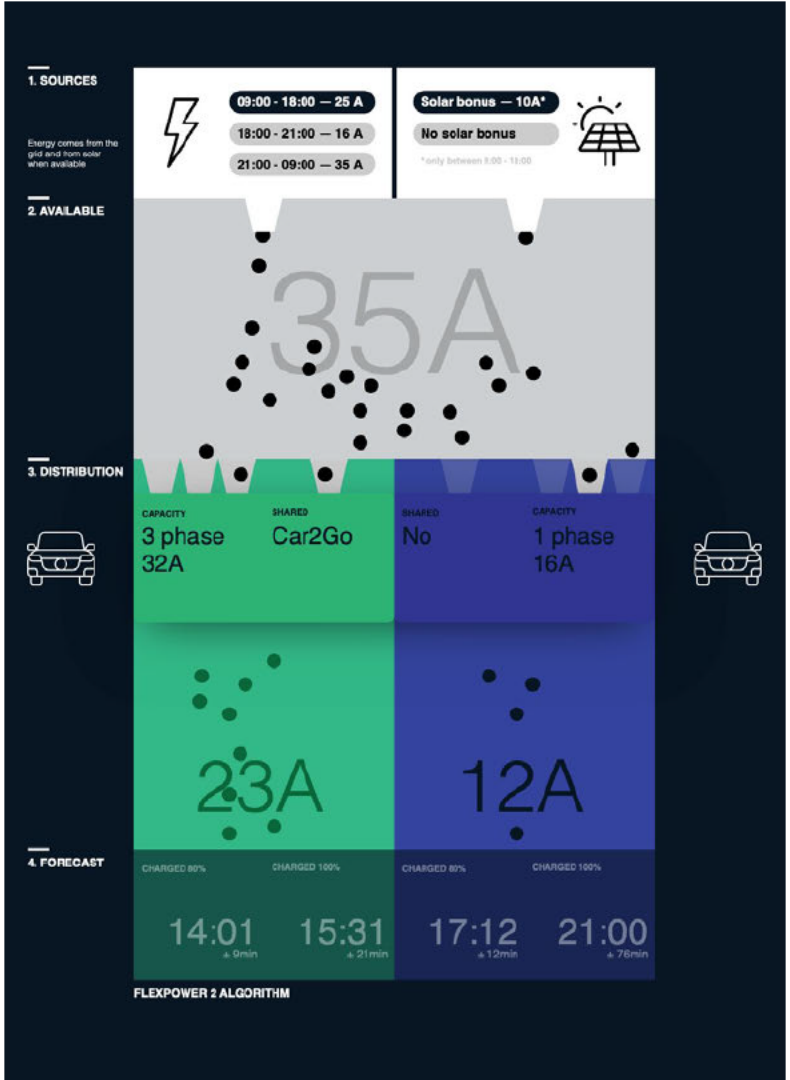
Concept 1 — Marble Machine

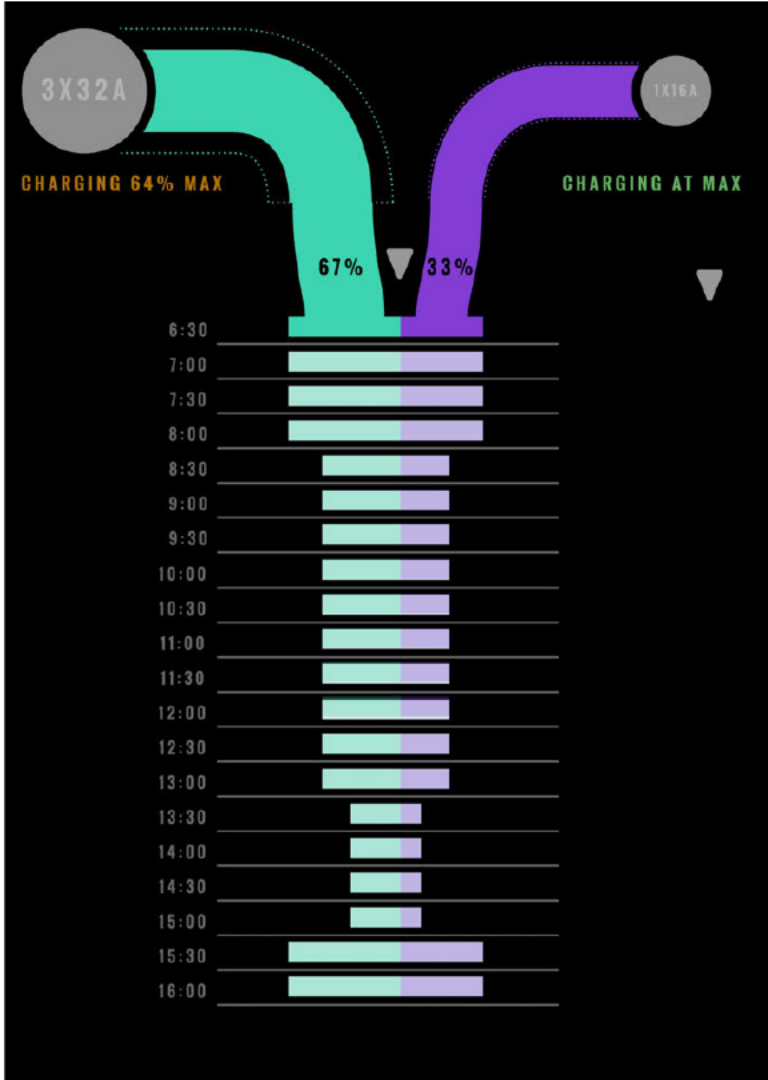
By taking the idea of marbles we make an algorithm intuitive.



The→ Incredible →Machine

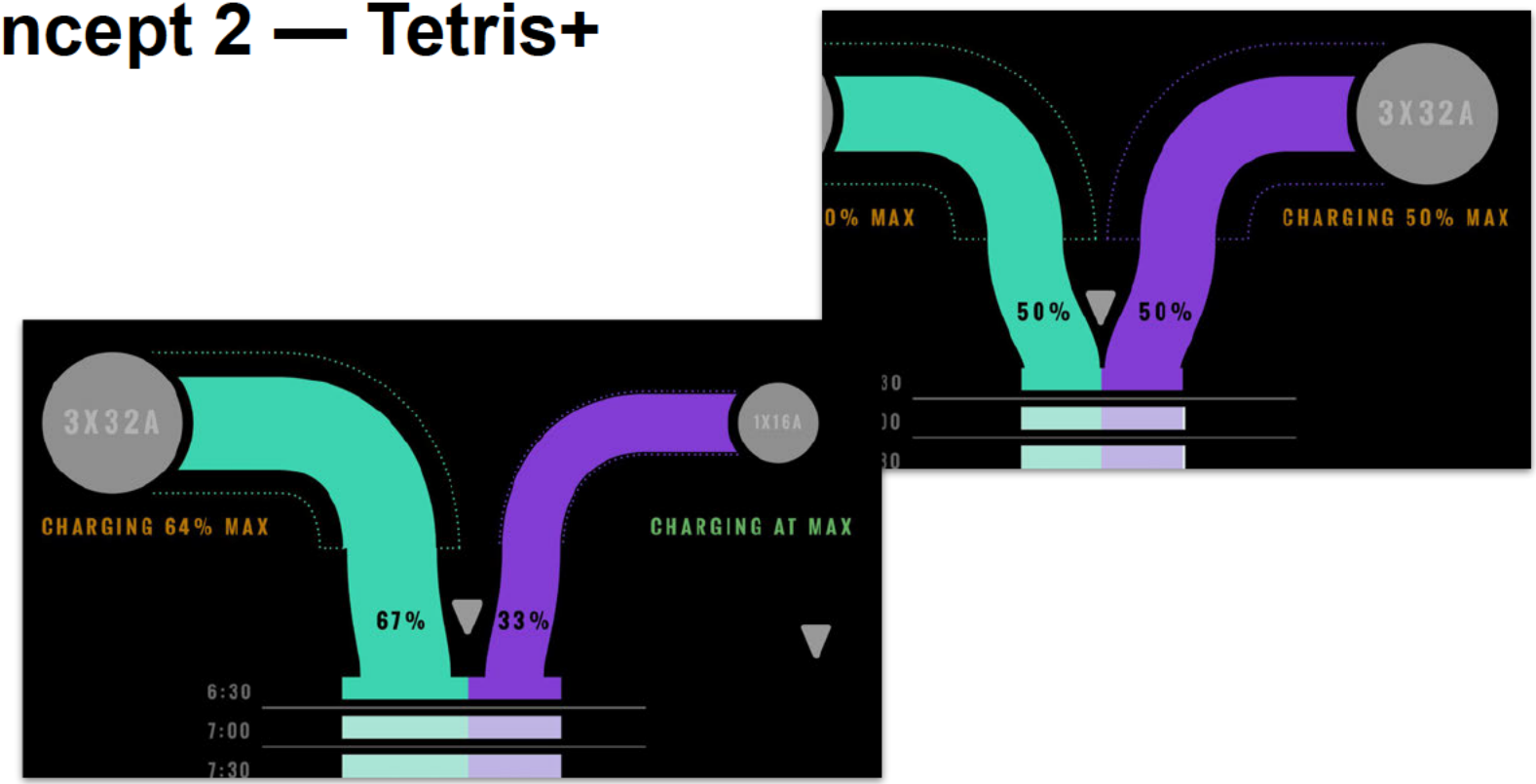
Concept 2 — Tetris+

A newer version of the TCS design.



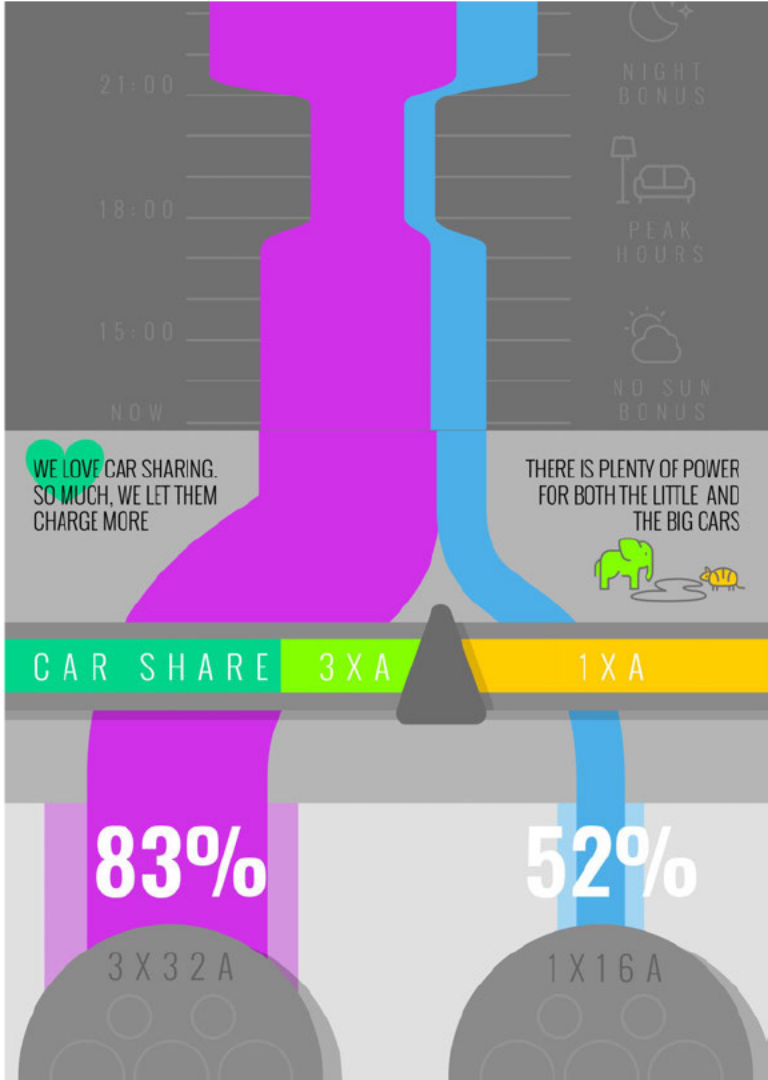
The→ Incredible →Machine

Concept 2 — Tetris+



The→ Incredible →Machine

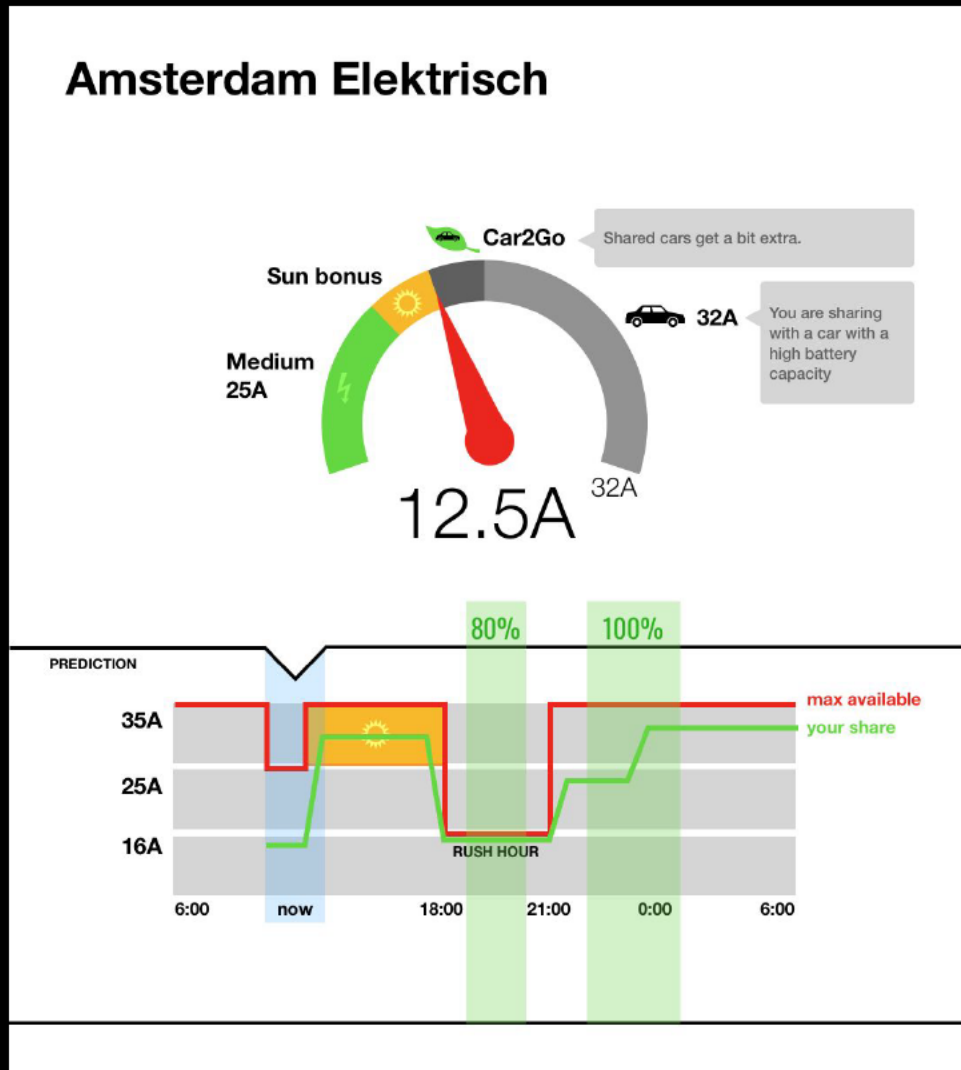
Concept 2 — Tetris+



The→ Incredible →Machine

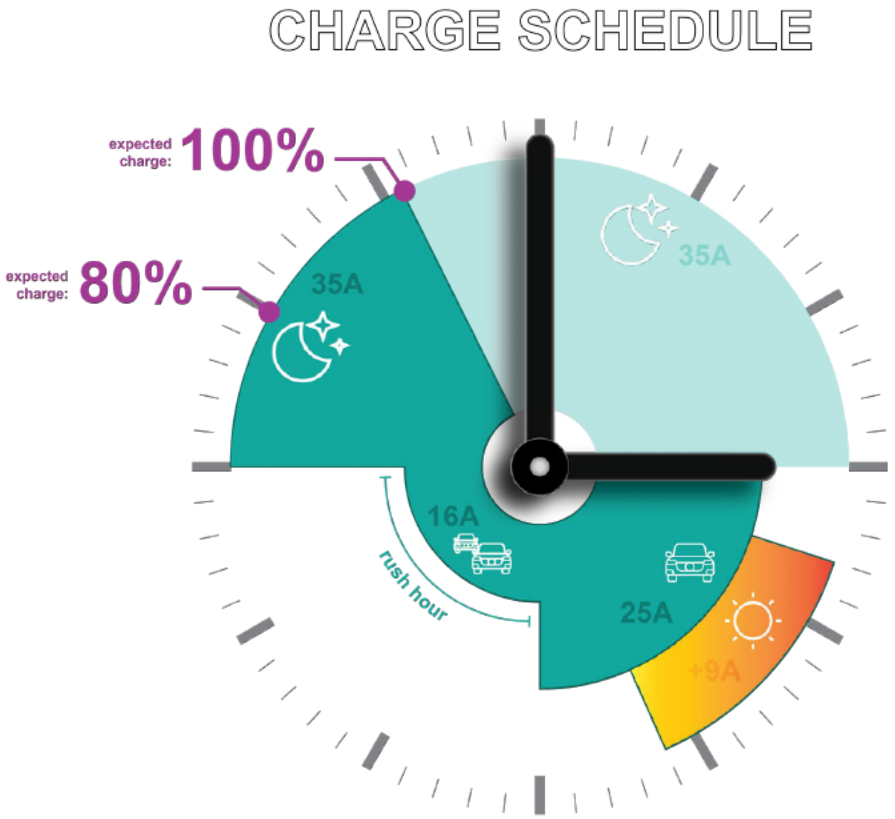
Concept 3 — Speed-o-matic

Here we show to what extent yo
charge at your maximum speed
often you will find some factors
this speed, like fellow chargers,
lack of sun today.



The→ Incredible →Machine

Concept 4 — Clock

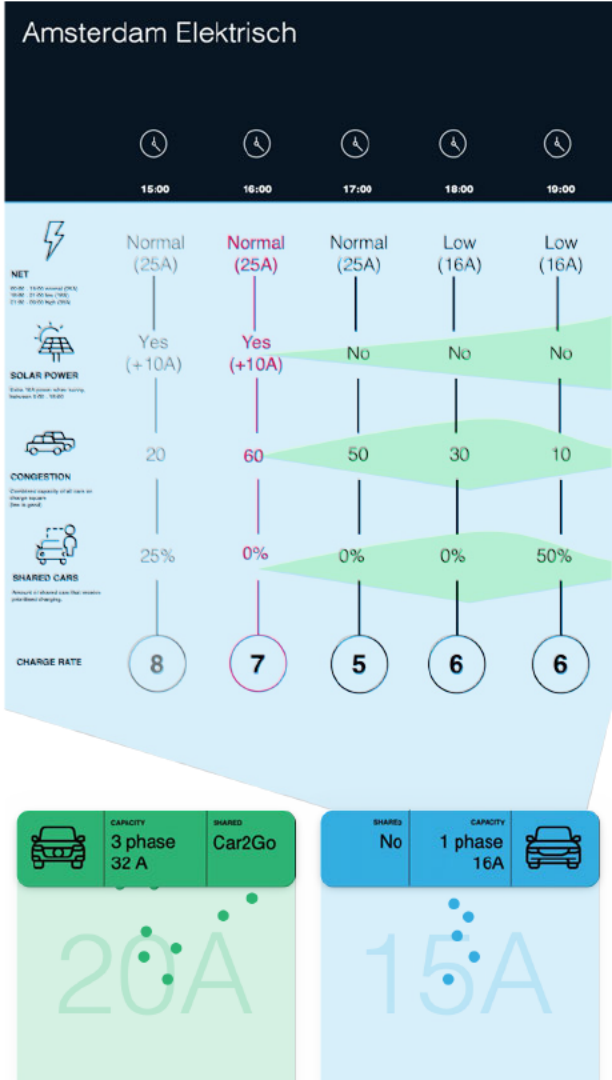


Immediately demonstrate the amount of energy is not fixed, but changes over time. This should make planning easier.

The→ Incredible →Machine

Concept 5 — Weather report

Here we obscure the complexity of the algorithm, but we show what factors have an influence, and whether you are in for an ok treatment.



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Concept 6 — Story

Amsterdam Elektrisch

Right now, we can charge you at 75% of your max. rate. Expected charge: 80% in 2hrs and 100% in 3hrs.

You are sharing 35A (max) with another car, that is a high capacity shared car.

Rates will go down to 16A in 2 hours, and you will be sharing 90% of the time. So that's not ideal.

Want to know more? Scan this code and let's chat!

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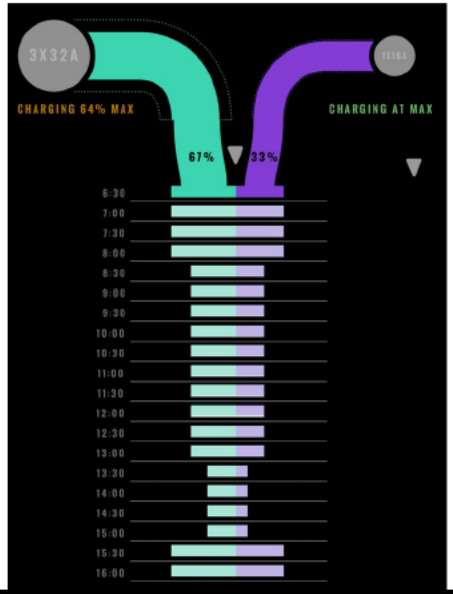
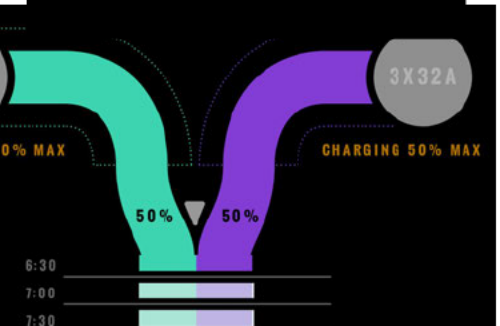
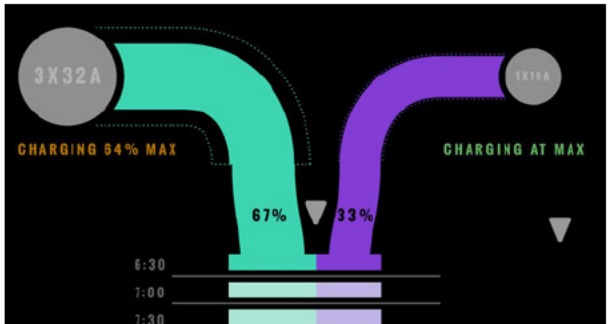
The Tetris+

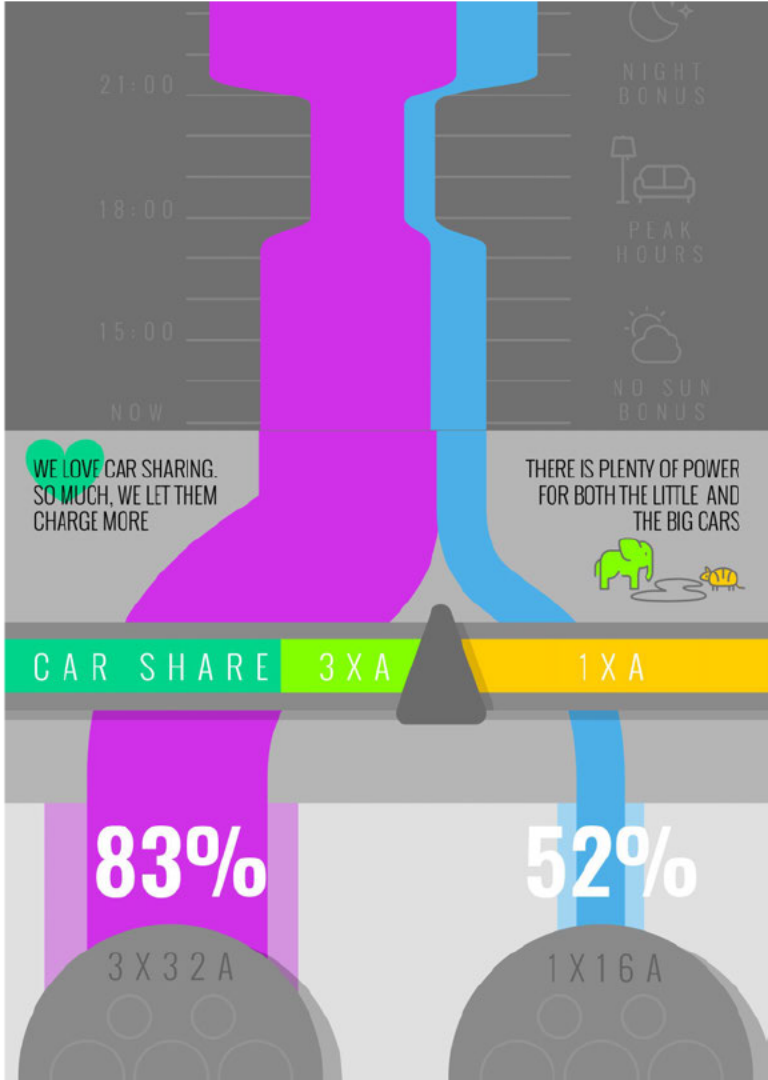






+ Continuation of first TCS
+ Helps understand future

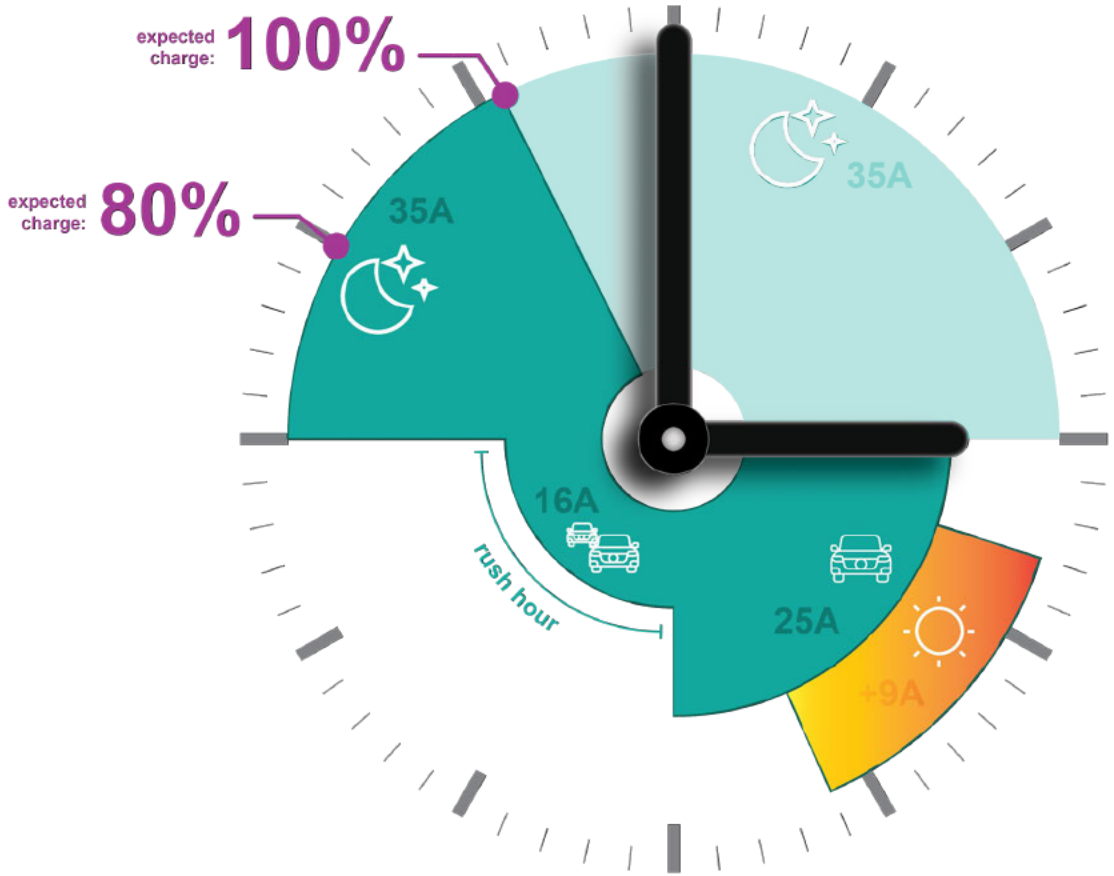
- Quite some information
- Timescale flipped



The Clock”

+ Charge perspective at a glance
+ Anyone can read a clock
+ 12-hour overview

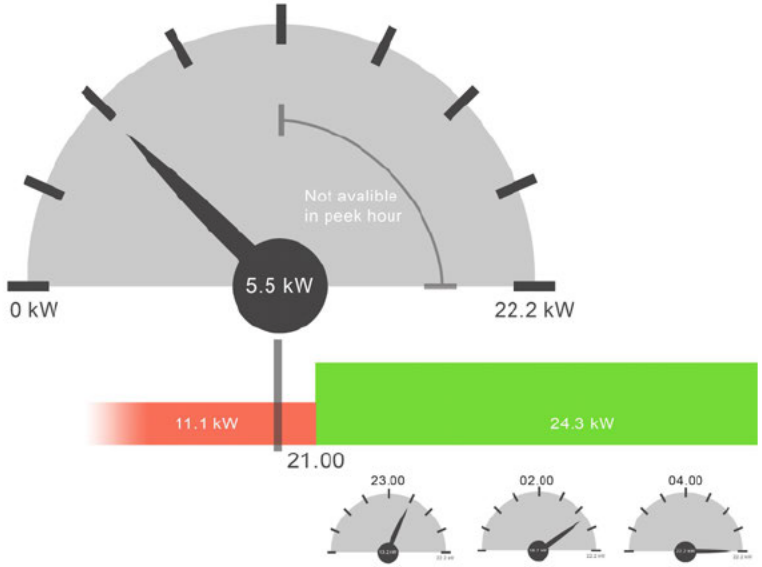
- Hard to compare 2 clocks (when charging together)
- Hard to show uncertainty

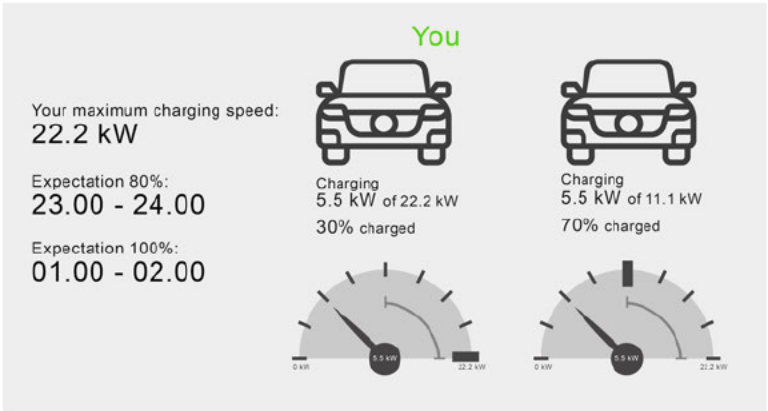


Speed-o-matic”

+ Personal charging speed visible
+ Visible how your charging speed relates to your neighbour

- Speedometer are also present in cars; visual prone to confusion
- Information overload





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Flexpower specification

User research

Ideas

Discussion

Next Steps & Collaborations

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Flexpower specification

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Ideas

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Next Steps & Collaborations

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Collaborations

Ingenieursbureau

Vattenfall

Integration ElaadNL / Asset mgmt

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Next meeting

Concept with all states

Estimation of complexity realisation